DEPARTMENT OF THE INTERIOR

REPORT

OF THE

CHIEF ASTRONOMER

FOR THE

YEAR ENDING MARCH 31

1909

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REPORT

OF THE

CHIEF ASTRONOMER AND INTERNATIONAL BOUNDARY COMMISSIONER.

DEPARTMENT OF THE INTERIOR.
DOMINION ASTRONOMICAL OBSERVATORY,
OTTAWA, CANADA, May 1, 1909.

W. W. CORY, Esq.,
Deputy Minister of the Interior,
Ottawa.

SIR,—I have the honour to present the report of the Astronomical Branch of the Department of the Interior for the year ending 31st March, 1909.

The correspondence in the twelve months was:—

Letters received	1,841
Letters sent	2,997
Accounts examined	815

The work of the photographer was as follows:—

Survey plates (developed),		8 x 10	360	
"	"	11 x 14	40	
"	"	16 x 20	161	
"	"	$4\frac{3}{4}$ x $6\frac{1}{2}$	1,158	
				1,719
Films	"	$3\frac{1}{4}$ x $5\frac{1}{2}$	180	
"	"	5 x 7	1,104	
"	"	$4\frac{3}{4}$ x $6\frac{1}{2}$	120	
				1,404
Bromide prints	"	4 x 14	24	
"	"	11 x 14	1,208	
"	"	16 x 20	527	
"	"	9 x 36	469	
"	"	12 x 30	61	
"	"	24 x 36	69	
"	"	20 x 24	23	
				2,381
Blue prints	"	24 x 36	10	10
Contact prints	"	4 x 6	531	
"	"	5 x 7	3,338	
"	"	8 x 10	189	
				4,058
Transparencies	"	4 x 5	137	137
Total				9,709

The Library on March 31st last contained 3,400 volumes and 260 pamphlets. It increases by several hundred volumes each year, principally by exchanges with other observatories and by the binding into volumes of the scientific periodicals, so that additional shelf space will be needed before very long. A card index of subjects and authors has been installed which has proved a great convenience.

The mechanical parts of a single-prism spectrograph designed by Mr. Plaskett for the avoidance of flexure, and of the solar spectrograph, of 23 feet focus, to be used in connection with the coelostat, have been constructed in the workshop.

The pivots of the meridian circle, as received from the makers, having been found to be of too soft metal, rings of hardened steel were shrunk upon them, and turned to proper form. This was a very difficult piece of work on account of the extreme accuracy of figure which was required.

There were besides numerous small pieces of work for the Observatory, and many repairs and minor alterations to field instruments for the Boundary and Geodetic Surveys, keeping two mechanics constantly employed.

The equipment of the shop has been increased by a second lathe, avoiding thereby a considerable loss of the men's time. The workshop, which is in the basement of the building, is insufficiently lighted for the fine work which we require. It is also rather inconveniently small.

The practice of opening the Observatory to the public every Saturday evening has been continued, and is much appreciated. An astronomer is always present on that evening to exhibit the large telescope. There are also many day-time visitors to the Observatory who have then an opportunity of seeing the other instruments.

The number of visitors registering in the book from April 1, 1908, to March 31, 1909, is 2,646.

In this connection may be mentioned the meetings of the Royal Astronomical Society of Canada which are held monthly during the winter in the Normal School Hall or in the Public Library, when lectures on astronomical subjects are presented. The majority of these lectures have been given by officers of the Observatory. Lectures are also given in the Observatory in the afternoon, alternating with the evening lectures in the city. These afternoon meetings serve a very useful purpose in the exchange of ideas among members of the staff.

TIME SERVICE.

The ordinary work in connection with the time service has consisted, as in the past, of the necessary attention to the up-town service, the sending out of time signals to the telegraph company, dropping of the time-ball on Parliament Hill, supplying of mean and sidereal time by telephone to those requiring it, occasional rating of chronometers, testing of aneroid barometers, &c., together with the maintenance of the clocks and apparatus at the Observatory. The city service has been extended by the installation of electric dials in the Mint and the Archives Building, which are operated by a master clock in the Mint controlled directly from the Observatory. The dials were started at noon on September 19, though the master clock was not put under control for some time subsequently. It was decided by the Public Works Department, contrary to the original intention, not to instal clocks in the Printing Bureau at present. There were also, as usual, changes and additions in the other Government Buildings. Below is a list of the number of clocks in operation:—

MINUTE DIALS.

	March 31, 1909.	March 31, 1908.
Parliament Building	49	46
East Block	36	35
West Block	63	61
Langevin Block	48	48
Post Office	20	20
Thistle Block	2	2
Ottawa Electric Company	1	1
Mint	16	..
Archives	7	..
Observatory	28	28
	270	241
Program clock	1	1
Seconds dials	3	2
Tower clocks	2	2
Total electrically driven clocks	276	246
Secondary master clocks	8	7
Primary clocks	4	4
Total	288	257

TRANSIT OBSERVATIONS.

Observations with the portable transits were taken on 142 nights, involving 281 determinations of clock error, as well as some observations for other purposes; on a number of nights two, and sometimes three, observers worked simultaneously, for determination of personal equation.

The relative personal equation of the Ottawa observers was in addition determined from the clock-curve, which was regular. The method of observation for clock-error was that described in last year's report, Appendix No. 3; the increase in accuracy over previous years was in the neighbourhood of 50 per cent. There were 156 exchanges for longitude, occupying 116 nights; exchanges were had irrespective of the weather at Ottawa, the clock error being when necessary interpolated from adjacent nights. An analysis was made of the rate of the Sidereal Standard as shown by the observations; the probable variation of daily rate appears to be between ·01 sec. and ·02 sec. per day; the advantage of having a completely uniform temperature is markedly shown. An approximate investigation was made, by observations suited to the purpose, of the causes underlying personal equation in micrometer observations. Mr. Stewart found in his own case a tendency to set the movable wire always to the same side (the left) of the star, by a quantity in the neighbourhood of a second of arc, depending on the magnitude of the star; north stars at upper culmination would thus be observed too soon, others too late. This affects the observed clock-error, and more markedly the azimuth. It was found that this would approximately explain the difference in personal equation of two of the observers, but not completely that of the third.

MERIDIAN CIRCLE.

The piers in the meridian circle room and the transit room have been rebuilt, their bases being sunk deeper into the earth and a system of drainage into a specially prepared cistern being installed, the cistern being pumped out from time to time. During wet periods there has proved to be a great accumulation of water in the cistern;

though the latter holds in the neighbourhood of 1,200 gallons it has on a number of occasions been filled to overflowing in a single night, apparently by surface water entering under the foundation walls of the building. This is very undesirable, as in that case the water becomes backed up around the footings of the piers. The only remedy would seem to be a proper drain surrounding the outside walls to carry off the surface water.

Provision has been made in the collimator piers for underground lenses to serve as permanent marks, over which may be adjusted the long-focus collimating lenses for the azimuth marks; pits have also been provided to allow access to the underground marks. The positions for the azimuth marks have been accurately determined and marked.

The mechanism for opening the roof shutters has been installed and works satisfactorily; the iron wall shutters have been replaced by wooden ones; wire frames have been made for the louvres in the walls to exclude snow, and have been in place during the past winter; the piers have been encased in felt and wood, with an air-space, to avoid sudden changes in temperature; an extension was made to the main instrument pier to provide for observations by reflection.

The meridian circle itself was in the beginning very unsatisfactory in almost all respects. When the graduated circles were received from the makers after having been repaired it was found that owing to irregularities in the bearings on axis and circles, the plane of the graduations was not perpendicular to the axis, nor was the distance from graduations to end of axis the same for both circles. While the adjustment of these errors was in progress it was found that the pivots were soft; it was therefore necessary to turn down the pivots and fasten upon them hardened steel bushings. Owing to the lack of lathes and grinders of the size requisite to handle the axis this proved a most arduous undertaking, but has at length been successfully accomplished. In this connection I wish to express my appreciation of the very great kindness of Mr. A. H. W. Cleave, of the Royal Mint, who was good enough to offer us the use of his workshop and even to have alterations made in his machines which made it possible to handle the work. Had it not been for his kindness the work could hardly have been done in Canada. There is still a great deal of work to be done on the instrument before it will be in a condition to do effective work. The counterpoises are unsatisfactory, and will require to be replaced by new ones; the bearings of the vertical circle require to be scraped and polished; alterations are necessary in the micrometers of the circle microscopes; the double spider lines in right ascension and declination micrometers and circle microscopes are at unsuitable and varying distances; in addition there is a multitude of small details that require alterations. When these have all been completed, however, the instrument will probably do efficient work. It is hoped that it may be ready for systematic work in both right ascension and declination by the beginning of the year.

For further details reference may be had to Mr. R. M. Stewart's report, in Appendix No. 3.

WORK OF THE ASTROPHYSICAL DIVISION.

The principal work in this division has been observation by the spectroscope of the radial velocities of spectroscopic binaries for the determination of the elements of their orbits. Five orbits have been thus determined: η Bootis, θ Aquilæ, α Coronæ Borealis, ϵ Herculis, β Orionis. In only the first of these have the observations been well satisfied by a velocity curve due to simple elliptic orbits. In two of the others irregularities show which are explained fairly well on the hypothesis of the presence of a third body. Four stars with early type spectra δ Herculis, γ Aquarii, ι Andromedæ, and ξ Persei, have been examined and their velocities found to be variable, but not enough observations have been made to determine the law of variation. Twelve other binary systems are under observation.

Considerable time has been spent in testing and adjusting the instruments and in experimenting on the best methods of observation. Mr. Plaskett investigated the fields given by different types of camera objectives for spectrographs, and the effect of increased slit width upon the accuracy of radial velocity work. Dr. DeLury examined the errors of the plane grating of the spectrograph of the coelostat. Mr Motherwell investigated the aberration of the eight-inch doublet of the stellar camera, and proved that the halos which the lens gives around the images of stars are due to spherical aberration, which may be corrected by slight refiguring of the lens.

Other work in this division has been micrometric measurements of double stars, comet photographs, observations of occultations of stars, and solar photography. This work as well as all the other astronomical work has greatly suffered from the dense smoke from forest fires which prevailed during a great part of last summer.

Fuller details of this work will be found in Mr. Plaskett's report, Appendix No. 2.

DIVISION OF GEOPHYSICS.

Continuous records have been obtained by the Bosch seismograph of earth movements. Some forty-nine earthquakes were recorded during the twelve months from April 1, 1908, to April 1, 1909, including five of some severity. Ordinarily the record of an earthquake shows that waves of three kinds are received. These are called the first preliminary, the second preliminary, and the long waves. They are distinguished from one another on the seismograph sheet by differences in form and amplitude, and the times of first arrival of the waves of each type may be measured off from the sheet very nearly.

It is supposed that the three waves have their origin at the same instant of time at the centre of disturbance, and that the difference in time of arrival is due to a difference in the mode of transmission through the earth's crust, whether by longitudinal or transverse vibrations through the depths of the earth, or near the surface, and that corresponding to the different modes or paths of transmission are different but definite velocities.

These velocities have been found by many observations within pretty close limits. Hence the difference of time between the first arrival of the different waves gives immediately the distance of the origin of disturbance. The actual position of the origin may often be determined by drawing a circle on a terrestrial globe with centre at the place of observation and radius equal to the distance of the origin. Where this circle passes through a region of known seismic activity, the probable origin of the disturbance may be placed.

Besides the records of earthquakes, numerous minor tremors, called microseisms, have been registered. An account of these, with an inquiry into their probable causes will be found in the report of Dr. Klotz, which forms Appendix No. 1 to this report.

Dr. Klotz concludes that the microseismic vibrations of the pendulums of the seismograph are closely connected with the gradients of barometric pressure, and that their amplitudes increase with the steepness of the gradient.

Microseisms are not due to the dynamical effect of the movement across the continent of areas of high or low pressure, nor to the direct dynamical effect of winds.

Microseisms registered at Ottawa almost invariably co-exist with 'lows' over the Gulf of St. Lawrence with steep gradients over the St. Lawrence valley.

They arise from movements of large areas of the earth's crust, and are related to the geological structure by which probably their period is determined.

The meteorological conditions on which they appear to depend are not local; the variations of local barometric pressure shown by the micro-barograph cause local bendings of the earth's crust which are exhibited on the seismograms by deflection of the zero of the instrument, but the irregularities thus caused are easily distinguished by their irregularity from the real microseisms.

It has been suggested that the fact that the period of most of the microseisms nearly agrees with that of the pendulums, indicates that the record is due to air currents within the instrument or to other instrumental cause. This explanation, however, cannot stand, in view of the evidence adduced by Dr. Klotz, of co-incident occurrence with the 'lows' on the eastern coast.

AUXILIARY BUILDINGS OF THE OBSERVATORY.

During the past year the coelostat house has been completed, and the coelostat installed, with its spectrograph. As stated above a careful examination has been made of the plane grating of this instrument, by which certain defects have been indicated. The making of this necessary examination has delayed the making of the observations on the sun which were contemplated.

The building for the standardizing of tapes and other measures of length has been completed, but the apparatus for making comparisons has not yet been installed. Means will be provided for tests of measures up to 50 metres in length.

Ground was broken for the residence of the Chief Astronomer about the middle of March last. This building will stand a short distance to the east of the Observatory.

Work was begun last summer on the grading of the grounds surrounding the Observatory, a much needed improvement. Owing to the excessive dryness of the latter part of the summer it was not thought advisable to do any sodding, which has been postponed until this season.

FIELD ASTRONOMICAL WORK.

Latitudes and longitudes were determined at twenty-seven stations during the season of 1908.

Two stations on the southern boundary of British Columbia, one near the southern boundary of Manitoba in the neighbourhood of Lake of the Woods, and three on the Ontario-Minnesota border, were observed for purposes of the boundary surveys. The other points were observed for geographical purposes, and comprise three points in Ontario, eight in Quebec, eight in New Brunswick, and two in Nova Scotia. The longitudes of the two most westerly stations were determined by telegraphic signals from Seattle, a point of known longitude; that of the others by signals from this Observatory.

Observations of the magnetic elements were made at seventeen points in British Columbia and at Winnipeg, Ottawa and Agincourt. The instruments used were the Tesdorpf magnetometer and the Dover dip-circle.

INTERNATIONAL BOUNDARY SURVEYS.

On June 3, 1908, a treaty between His Majesty and the United States was ratified, which provides for the survey of the whole of the boundary line from the Atlantic to the Pacific.

The treaty divides the boundary line into eight sections, and prescribes the manner in which the survey of each section shall be carried out, and placed the carrying out of the work, except as regards the fourth section, in the hands of two commissioners who shall be 'expert geographers or surveyors.'

The several sections are as follows:—

1. In Passamaquoddy bay, from the open waters of the Bay of Fundy to the mouth of St. Croix river (at Joe's Point near St. Andrews, N.B.).

By the treaty of 1783, the boundaries of the United States were defined as beginning at the mouth of St. Croix river and ascending that river to its source. Then the description proceeds with the northeastern, northern, western and southern boundaries of the United States, terminating on the Atlantic ocean at the northern boundary of Florida. The territory of the United States was also to include 'all the islands within twenty leagues of the coast except such as have heretofore belonged to His Majesty's province of Nova Scotia.' ('Nova Scotia' then included the present province of New Brunswick.)

Soon afterwards question arose as to which river was the St. Croix, mentioned in the treaty; it appears that three or more rivers bore that name. Commissioners were appointed under a special provision by treaty (1794) to decide which river was intended and to determine its mouth and its source.

The Commissioners in due course reported (1798) their decision identifying the St. Croix river of the treaty with the river which now bears the name, and placed its mouth opposite Joe's Point, the point at the southwestern extremity of St Andrews peninsula, opposite to the town of Robbinston, in Maine.

South and east of this point lies Passamaquoddy bay, being the western part of the Bay of Fundy, and including an extensive archipelago.

It will be observed that the decision of the Commissioners, placing the mouth of St. Croix river at Joe's Point, left the jurisdiction over the islands of this archipelago, which are within twenty leagues of the United States shores, to be determined by the fact whether they had previously belonged to the United States or to Nova Scotia.

Under the fourth article of the treaty of Ghent, 1814, Commissioners were appointed to determine to which of the High Contracting Parties the several islands belonged. These Commissioners rendered their decision in 1817 to the effect that Moose, Dudley and Frederick islands belonged to the United States, and that all the other islands in Passamaquoddy bay, and the island of Grand Manan, in the Bay of Fundy, belonged to His Britannic Majesty. This decision, however, did not determine the locality of the boundary line in the narrow waters between Campobello island and the islands allotted to the United States, and subsequently difficulties arose in regard both to smuggling and to fishery rights.

It was not until 1892 that provision was made by treaty for the determination of the boundary line in these waters, and commissioners were appointed to determine and mark the line.

This the Commissioners did in part but not wholly, since they failed to agree as regards the ownership of a certain island and of certain fishing grounds.

By the treaty of 1908, provision was made for the preparation on the behalf of each government of a 'case' to be submitted to the other, and in the event of their not arriving at an agreement within one year of the date of ratification of the treaty, for a reference of the question to arbitration. The cases of the two governments were duly presented on December 3 last, six months after ratification of the treaty.

These negotiations, or the arbitration which will result, if they do not result in an agreement, have reference only to the two specific points on which the Commissioners of 1892 differed. Their marking of other parts of the line is confirmed by the treaty. The present Commissioners are to renew the marks when necessary, and to lay out the remainder of the line when a decision of the disputed questions has been arrived at. Pending such decision no work has yet been done on this section.

2. The second section of the line is that along St. Croix river from its mouth to its source.

As already stated the Commissioners of 1798 determined the source of this river as well as its mouth. This was sufficient to obviate disputes involving any large extent of territory, and no serious question is known ever to have risen. For this reason doubtless no survey of the river as an international boundary has been made, or indeed provided for, by any previous treaty. In its course the river expands into several large lakes in which as well as in the river itself islands exist, which may become of importance in the future. The treaty provides that the boundary line shall follow the thalweg, or middle of the main channel as naturally existing, except where such would conflict with the recognized national character of an island. The boundary line is to be marked where possible by permanent monuments, and is to be shown by the Commissioners on accurate modern charts. Like provisions apply to all the sections of the boundary line.

It is proposed to send out two survey parties, an American and a Canadian party this summer to make the preliminary survey necessary for the setting out of the permanent reference marks. They will operate in the navigable part of the river below the international bridge connecting St. Stephen and Calais.

3. The third section extends from the source of the St. Croix to the St. Lawrence river. An approximate description of this section of the boundary line is: along the meridian of the source of St. Croix river to St. John river, up the latter and one of its branches, St. Francis river, to a certain point; in a straight line to the southwest branch of St. John river; up the last to its source in the highlands (of the St. Lawrence); along the highlands to the source of Hall's stream (a branch of Connecticut river); down the last to the 45th parallel; and along the 45th parallel to the St. Lawrence.

By the treaty of 1783, the boundary line was to follow the due north line from the source of St. Croix river to the highlands dividing the waters flowing into the St. Lawrence from those flowing into the Atlantic ocean, and thence to follow the highlands to the source of Connecticut river; and follow the river to the 45th parallel, and the parallel as far as the St. Lawrence.

Dispute arising as to the location of these highlands, this section of the boundary line remained undetermined for many years, the question about the year 1840 assuming a very serious phase, though more than one attempt had previously been made to settle it. By the treaty of 1842 the matter was finally disposed of, the definition adopted for the boundary, being a compromise between widely differing claims. The line was surveyed and marked with cast-iron monuments in the years 1843 to 1846, by a joint Commission.

For brevity in the above description of the boundary line, I have spoken of the meridian line of the source of the St. Croix and of the 45th parallel. The boundary line does not accurately follow these astronomical lines, but follows the lines of old surveys, originally intended to coincide with them, but which show in places very large deviations from them. The perpetuating in this manner of the errors of the old surveys was dictated by reasons of convenience arising out of the fact that in many instances the country had been settled on either side up to the old survey, and the lands were in private hands.

As a result of complaints which had from time to time been received, that some of the original monuments had been destroyed and that there was difficulty in places in finding the line, in 1890 an inspection, jointly with representatives of the state of New York was made of the line from Richelieu river to the St. Lawrence. This inspection indicated that it was necessary to renew the original monuments, as well as to place new ones where the line had been in the first instance insufficiently marked.

Nothing, however, was done until 1902, when an agreement for co-operation in the work of renewal was made with the government of the state of New York with the concurrence of the Washington government and a joint re-survey of the line was made, and new monuments of granite were erected.

In 1906 an agreement was made with the United States government for a joint re-survey of the rest of the line from Richelieu river to the St. Croix, and the work has since been actively prosecuted. The re-survey and renewal of monuments has been completed from Richelieu river to Hall's stream (covering the northern boundary of the state of Vermont) and along the meridian of the St. Croix river to the St. John. This has been done by a joint survey party representing both governments. The work so done will of course be available for the use of the Commissioners appointed under the new treaty.

It is proposed this year to proceed with the survey along the River St. John.

4. The fourth section covers the River St. Lawrence, the Great Lakes and their connecting waters, from the intersection of the 45th parallel by the River St. Lawrence to the mouth of Pigeon river in Lake Superior.

A general and rather vague description of this part of the line was contained in the treaty of 1783. The sixth article of the treaty of Ghent, 1814, provided for the appointment of Commissioners to determine the actual course of the line through the rivers and lakes, from the initial point in the St. Lawrence as far as the water communication between Lake Huron and Lake Superior. The seventh article of the treaty provided that the same Commissioners should determine the line from the said water communication to the North West Angle of the Lake of the Woods.

The Commissioners made the necessary surveys and laid down the line on their maps, reporting in 1822 their agreement so far as their work under the sixth article of the treaty was concerned. They, however, were unable to come to a full agreement under the seventh article, and that part of the line remained undetermined until settled by the treaty of 1842.

Owing to the imperfections of the maps upon which the Commissioners under the treaty of Ghent drew their line, difficulty is found in accurately transferring it to modern charts. The present treaty provides for the ascertainment and accurate re-establishment of the line, for the laying of it down on modern charts, and for the marking so far as practicable of the course of the line by buoys, monuments and range marks.

The carrying out of these provisions with respect to the fourth section of the boundary line is placed in the hands of the International Waterways Commission, which is composed of three Commissioners on the part of the Dominion of Canada and three Commissioners on the part of the United States.

5. The fifth section extends from the mouth of Pigeon river, up that river and through various lakes and rivers to the North West Angle of the Lake of the Woods.

The North West Angle of the Lake of the Woods was one of the governing points in the description of the boundaries of the United States in the treaty of 1783. Its location was ascertained without difficulty, but from the want of good maps when the treaty of 1783 was framed the line between the Lake of the Woods and Lake Superior was so vaguely defined as to leave room for widely different interpretations. Thus one contention was that the boundary line should ascend the St. Louis river at the head of Lake Superior, where Duluth now stands; another, that it should ascend the Kaministikwia. The Commissioners under the treaty of Ghent narrowed the question down to a choice between two water routes, both leading from Pigeon river to Rainy lake, and thence by Rainy river to Lake of the Woods. These two routes diverged a short distance up Pigeon river, passing one north and the other south of a considerable area almost surrounded by a series of lakes and rivers, now known as Hunter's island. By the treaty of 1842 the southern route was adopted.

No survey of the international boundary has been made along this section of the line. The Commissioners under the treaty of Ghent prepared maps to illustrate their report, but their surveys were imperfect.

The Commissioners under the present treaty having the duty of exhibiting the boundary line on modern charts will have to make a topographical survey over the whole distance.

6. From the North West Angle of the Lake of the Woods to the Rocky Mountains.

The treaty of 1783 described the northern boundary of the United States after reaching the North West Angle as proceeding thence west along the 49th parallel of north latitude to the Mississippi river.

It was afterwards ascertained, however, that the North West Angle lay about twenty-five miles north of the 49th parallel, and that the Mississippi river did not extend so far north as the parallel by a considerably greater distance.

The treaty of 1818 provided that the boundary line should follow the 49th parallel west to the Rocky Mountains. To provide for the difficulty as to the latitude of the North West Angle, it was agreed that the boundary line should be drawn due south from the angle of the lake to the 49th parallel. Thus occurred the peculiar 'jog' which the maps show in the boundary line at Lake of the Woods.

An interesting point in this connection is that the Commissioners who surveyed the meridian south from the North West Angle in 1872 found that their line starting from the old monument marking the North West Angle crossed the line of boundary which had been drawn by the Commissioners under the treaty of Ghent along the inlet of the lake at the head of which the monument stands.

This meridian line and the 49th parallel west as far as the Rocky Mountains were surveyed by a joint Commission in the years 1872 to 1874. The line was marked by iron posts one mile apart so far as the old boundary of the province of Manitoba extended (from longitude 96° to longitude 99°). On the remainder of the line the monuments were farther apart, averaging about three miles, and consisted of large mounds of earth or stones.

The re-survey of the line has the purpose of re-locating and repairing lost or damaged monuments, and establishing additional monuments wherever necessary to meet the requirements of modern conditions.

The doing of this was provided for in an administrative agreement between the governments, entered into in 1902. This agreement provided for a survey of the whole line from Lake Superior to the Gulf of Georgia, on the Pacific coast, but the completion of the portion west of the Rocky Mountains being more immediately pressing, operations were begun at that end, and the section east of the Rocky Mountains was not reached until last year. A Canadian party under Mr. J. J. McArthur began operations at Coutts, Alberta, which lies about one hundred miles east of the Rocky Mountains. The operations of the survey during the season covered one hundred miles east from Coutts, the section west of that place being left to an American party, under an agreement between the Commissioners by which the line was divided into alternate sections of one hundred miles.

7. From the Rocky Mountains to the Gulf of Georgia.

By the treaty of 1846, the boundary line here also lies on the 49th parallel. It was surveyed and monumented by a joint Commission in the years 1859 to 1863. The monuments generally consisted of mounds of stones, though along a certain part of the line cast-iron monuments were placed. Owing to the exceedingly mountainous character of the country the survey was not a continuous one; the position of the parallel was determined by astronomical observation in some of the principal valleys, and the line was cut out east and west from the astronomical stations as far as possible in the circumstances.

The survey made under the agreement of 1902 is continuous, from the summit of the mountains to Point Roberts in the Gulf of Georgia. Monuments of alluminium bronze, set in concrete bases, have been placed at average distances of two miles along the whole length of the line, and a wide vista has been cut through the forest from monument to monument. The field work was completed in 1907, with the exception of a short piece of triangulation in the Cascade Mountains, which was finished last year. The plans and other records of the survey have yet to be put into final shape for publication.

8. The eighth section is the water boundary from the 49th parallel to the Pacific ocean.

By the treaty of 1846 the boundary line was to follow the 49th parallel to the middle of the strait between Vancouver island and the mainland, and of the strait of Fuca to the Pacific ocean.

East of the southern extremity of Vancouver island and lying between it and the mainland lies an archipelago of considerable extent. Not many years after the treaty of 1846 the question arose to which country these islands belonged.

The principal island in the group is the island of San Juan, and the question which arose is commonly referred to as the San Juan question. The group is separated from Vancouver island and the islands adjacent thereto by Haro strait, and is separated from the Washington shore and its adjacent islands by Rosario strait. Both countries claimed ownership of the group of islands between these straits and for several years there was joint occupation of San Juan island by military forces.

By the treaty of Washington, 1871, it was agreed to refer the question to the decision of the Emperor of Germany, who decided in favour of the United States, that the boundary line should follow Haro strait.

In 1873 at a conference held at Washington by representatives of both countries an agreement was reached as to the actual course of the line, in accordance with the Emperor's decision, and the boundary line was defined by a line drawn upon a chart, accompanied by a written description.

The present treaty in providing for the survey of this line follows accurately the wording of the protocol of the conference of 1873, excepting at one point only, where a short curved line is replaced by a straight line.

It is proposed during the present season to send two survey parties to make the necessary surveys for the placing of reference monuments to perpetuate the points named in the treaty.

Mr. O. H. Tittmann, Superintendent of the United States Coast and Geodetic Survey, and the writer were appointed in June last commissioners, representing respectively the United States and His Majesty, for the carrying out of this treaty (excepting as regards the fourth section of the line).

Canada-Alaska Boundary Line

This boundary is in two sections, the most northerly following the 141st meridian of west longitude from a point near the summit of Mt. St. Elias to the Arctic ocean, the other starting from Cape Muzon on Prince of Wales island in about latitude 54° 40′, crossing the sea to the entrance of Portland channel, ascending the channel to a certain point, and then following certain mountains.

This boundary was first defined by the treaty of 1825, between Great Britain and Russia. The treaty described the line from its point of commencement, the southernmost point of Prince of Wales island, up Portland canal, and thence in a direction generally parallel to the coast to the 141st meridian of longitude west from Greenwich; thence along that meridian to the Arctic ocean. This definition of the boundary was of course not affected by the transfer of Alaska to the United States in 1867.

No demarcation had been attempted during the Russian occupation, but a few years after the transfer attention became directed to the boundary question. It was seen that the interpretation of the treaty as regards the southern part of the boundary, from Prince of Wales island to the 141st meridian, presented great difficulties, while the description of the remaining portion, following a definite astronomical line, the 141st meridian, was clear and unambiguous, and has never been the subject of controversy.

Hence in subsequent discussions the boundary line has been divided into two parts, which have been dealt with separately.

It is not my intention here to go into detail concerning the points of the controversy over the line from Prince of Wales to the 141st meridian. In 1892 a treaty was entered into between Great Britain and the United States, the first article of which provided for the appointment of commissioners to make a survey of the region adjacent to the line with a view to the ascertainment of the facts and data necessary for the permanent delimitation of the line in accordance with the spirit and intent of the then existing treaties.

The Commissioners made extensive topographical surveys of the mountains adjacent to the coast, and rendered a joint report to the two governments on December 31, 1895.

Although the treaty provided for the consideration of the boundary question, as soon as the report of the Commissioners had been received, the matter was not taken up until three years later, when it was discussed by the Joint High Commission, but without any action being determined upon.

In 1903, by treaty, the matter was referred in the form of five questions to a tribunal of six jurists, who held their sittings in London in September and October, 1903.

By their decision the line was to be drawn from Cape Muzon, on Prince of Wales island, in a straight line to a certain point off the mouth of Portland canal; up the canal to a certain point; then following certain mountain summits (which they marked out on the maps prepared by the survey made under the treaty of 1892) to Mt. St. Elias, which is near the 141st meridian.

The series of mountain summits selected by the tribunal was incomplete, in that between a certain summit north of Frederick sound and another north of Taku inlet a gap was left, some 120 miles in extent. In this gap the tribunal found the available topographical information not sufficiently complete to enable them to decide which were the mountains referred to in the treaty of 1825, and the line as regards that portion was left undetermined.

In the following year a conference between the Commissioners charged with the duty of the demarcation was held, at which a recommendation was made as to the course which the line should follow across the gap, and in March, 1905, this recommendation was formally approved by both governments.

By this agreement the line follows southward from the peak north of Taku inlet, from summit to summit of seven intervisible mountains, till a point near Whiting river is reached. Another peak was selected near the southern end of the gap. These eight peaks lie nearly in a straight line between the two terminal peaks of the Award. Between the seventh and eighth of them a gap remains about 50 miles in length in which the agreement leaves the selection of peaks in the hands of the Commissioners, after necessary surveys are made, the peaks selected to be intervisible and none of them more than 2,500 metres distant from the straight line joining the terminal peaks.

Survey of the Boundary of the Coast Strip of Alaska.

The demarcation of the Award line was begun in 1904 and has been continued since as rapidly as possible.

The work of the season of 1908 comprised the marking of the line at Alsek river, on the southern branch of the Iskut river (a tributary of the Stikine) and on the Unuk river and its tributaries, besides the topographical survey necessary for the carrying out of the agreement of 1905.

The Iskut work was carried on by Mr. J. D. Craig, D.L.S., and that of the topographical survey by Mr. W. F. Ratz, D.L.S., while Mr. White-Fraser, D.T.S., and Mr. F. H. Mackie, D.L.S., worked on the Alsek and Unuk rivers respectively, in conjunction with American parties.

The topographical survey of the region between the peak above referred to near Whiting river and the mountains north of Frederick sound was begun by Mr Ratz in 1907, and completed by him last year, so that the Commissioners have been able to make a selection of summits which accord with the conditions of the agreement of 1905, and it is hoped that the demarcation of this part of the line will be completed during the coming summer.

When this has been done little of the boundary of the coast strip of Alaska will be left for demarcation except a fifty-mile stretch near Mt. St. Elias and two or three uncompleted portions of a few miles each.

I regret to have to record the death of Mr. Ratz which occurred in Ottawa on February 6. Mr. Ratz had been employed on the Alaska survey since 1905. He carried out the demarcation of the line at Salmon river (Chilkat district), and in part between Taku inlet and Whiting river. During the last two years he was engaged, as already stated, on the topographical survey between Whiting and Stikine rivers, not the least difficult section of a very difficult survey. His success in carrying this to completion in a relatively short time is a testimony of his capability as a surveyor as well as to his personal energy. His death, at the early age of 25, is a serious loss to the profession and to the public service.

Survey of the 141st Meridian.

This survey and demarcation is carried on in pursuance of the treaty of 1906.

This treaty does not alter in any way the boundary line as defined by the treaty of 1825, but provides for the manner of making the survey and the demarcation merely.

Operations were begun in 1906 by ascertaining the position of the meridian at the crossing of the Yukon river by astronomical observations for longitude, using the telegraph for comparison of time.

The survey of the line south from the Yukon crossing was begun in 1907, and in 1908 continued southward to a point south of White river, a distance from the Yukon crossing of 225 miles. The placing of the permanent monuments on the line made good progress, as also the triangulation and topographical survey which is being made along the line.

Mr. A. J. Brabazon, D.L.S., was in charge of the Canadian parties engaged in this work.

THE GEODETIC SURVEY OF CANADA.

The work accomplished by the Geodetic Survey staff during the season of 1908 is briefly as follows:—

Two observing parties, measuring horizontal angles, were in the field during the whole season, but on account of the prevalence of dense smoke very little work was accomplished. The district covered lies between Brockville and Toronto.

Reconnaissance surveys were conducted in the maritime provinces, in the province of Quebec, in western Ontario and along the international boundary west of Lake Superior. This latter reconnaissance was for the purpose of making a primary triangulation to control the survey of the international boundary along Pigeon river. The reconnaissance in the province of Quebec, which embraced all of that part of the province lying southeast of the St. Lawrence river from Montreal to a point some thirty miles below the city of Quebec, and also one row of triangulation stations to the northwest of the St. Lawrence river a sufficient distance back therefrom to secure high enough points to control the country to the southeast was most gratifying in its results; it was successful in securing an excellent system of quadrilaterals and large five and six sided figures with central points.

The work of signal building was continued west of Toronto as far as Woodstock or thereabouts. In the maritime provinces reconnaissance has been satisfactory. The stations for a tringulation extend from Chamcook mountain in the southwest corner n New Brunswick, to the northerly extremity of Cape Breton island, embracing a district about fifty miles wide between those points, including the easterly portion of Prince Edward island. Chamcook mountain is one of the primary triangulation stations of the United States Coast and Geodetic Survey and in conjunction with Trescott Rock—another primary station of the same survey—direct connection is made with the Geodetic Survey of the United States.

In 1908 two Geodetic levelling parties were employed and a line of levels was carried from Coteau Junction—thirty-eight miles southwest of Montreal—to Fort Erie via Hamilton, and also from Hamilton to London. The computations are now in progress and are sufficiently advanced to show that the results are of a high order of precision. The work has been carried on by a double line of levels running forward and backward directions, the forward and backward levelling being independent of each other in every respect, and when possible, performed under different atmospheric conditions. The standard of accuracy adopted requires that the backward levelling shall correspond with the forward levelling within $0'{\cdot}017\ \sqrt{M}$, '*M*' being the distance in miles covered by the section. The dense smoke, so prevalent during the season of 1908 and which interfered so materially with the trigonometrical work, was found to be an assistance in precise levelling, inasmuch as the usual steadiness of the atmosphere—no doubt caused by smoke—made the observing of the graduations on the levelling rod much easier than in former seasons.

Consequent upon a discussion in parliament, in which was apparent a concurrence of opinion that an accurate survey of the better settled parts of Canada would be of practical benefit, the government, by order in council of April 20 last, formally instituted the 'Geodetic Survey of Canada,' and appointed the writer superintendent.

The following appendices are attached to this report:—

Appendix 1.—Report by Otto Klotz, LL.D., on seismological and magnetic work.
Appendix 2.—Report by J. S. Plaskett, B.A., on the astrophysical work.
Appendix 3.—Report by R. M. Stewart, M.A., on meridian work and time service.
Appendix 4.—Report on observations for latitude and longitude by J. Macara.

I have the honour to be, sir,
Your obedient servant,

W. F. KING,
Chief Astronomer and Boundary Commissioner.

APPENDIX 1.

REPORT OF THE CHIEF ASTRONOMER, 1909.

SEISMOLOGY, TERRESTRIAL MAGNETISM AND GRAVITY

BY

OTTO KLOTZ, LL.D.

CONTENTS.

ILLUSTRATIONS.

APPENDIX I.

SEISMOLOGY, TERRESTRIAL MAGNETISM AND GRAVITY, BY OTTO KLOTZ, LL.D.

OTTAWA, ONT., July 1, 1909.

W. F. KING, LL.D., C.M.G.,
Chief Astronomer,
Department of the Interior,
Ottawa.

SIR,—I have the honour to make the following report of the work carried out under my charge, and which is classified under the three headings—Seismology, Terrestrial Magnetism and Gravity.

SEISMOLOGY.

Instruments.—The instruments which are in service are: two Bosch photographic seismographs, described in the report for 1906; a Callendar electric recorder; a Negretti and Zambra barograph; a Shaw-Dines micro-barograph, besides wet and dry bulb thermometers.

The Callendar electric recorder is from the Cambridge Scientific Instrument Company, England. It was installed in August 10, 1908, and has given satisfaction. It records the outside temperature. It is similar to the one used in connection with our standard sidereal Riefler clock for temperature control. In the report for 1907 Mr. R. M. Stewart gives an illustration of the recorder, together with a detailed description, so it is unnecessary to describe the other one. It may be mentioned, however, that the extreme possible range of outside temperature is confined within the range of the galvanometer wire along which the sliding contact balances the resistance of the platinum wire thermometer, wound on a mica frame. The thermometer is housed in a louvred shelter 2 feet 6 inches by 1 foot 8 inches and 2 feet 6 inches high with slanting double top, the whole being painted white; it is mounted on four posts and the bottom is 4 feet above the ground in an open space with free circulation of air. It is 46 feet from the northwest corner of the transit house of the observatory. The lead-covered double leads are led from the thermometer in an iron ¾-inch pipe under ground, then through the wall of the Observatory and finally into my room to the recorder. The range of resistance on the galvanometer wire and covering the sheet which is daily renewed, is equivalent to 100°, that is, the readings extend from − 50°C. to + 50°C. or from − 58°F. to + 122°F., and this is represented in linear measure on the sheet by 20 cm., so that 1°C. is equivalent to 2mm. The temperature records are very satisfactory, and the rapid oscillations of temperature on bright cloudless days is very marked. These fluctuations amount to several degrees within a few minutes, showing that the atmosphere is far from being homogeneous as far as temperature is concerned, but instead is permeated by thermal and density 'schlieren,' continuously shifting. The scale of the bridge-wire was determined by readings of several standard mercurial thermometers placed within the thermometer shelter.

Last March another platinum wire thermometer was installed; it is in the well at the bottom of the south collimator pier of the meridian circle. The leads of this thermometer are led to a special switch beside the recorder, and every morning before taking off the sheet a reading is taken of this latter thermometer, which is subject, of course, to a very slow change of temperature.

Of the aneroid barograph with its weekly recording sheet nothing further need be said. Beside it hangs the Greene standard mercurial barometer and by which the readings of the former are checked.

In connection with the study of the seismograms, especially of the microseisms and other records, such as movements of the position of the pendulum zero not attributable to earthquakes, a Shaw-Dines micro-barograph was installed last July (1908), also a Richard Frères statoscope. Although the latter works very well, its time-scale is too large (one revolution of the cylinder in less than an hour) for continuous use. The former is 'an apparatus designed to magnify and record the minor and sudden fluctuations of the atmosphere as opposed to the general atmospheric surges. It records the small variations on a scale magnified twenty fold, the general surges being practically obliterated through the operation of a small leak. It thus records comparatively rapid oscillations, and no others. The instrument consists of a small, closed vessel containing air, which communicates with a mahogany box containing mercury, on the surface of which floats, mouth downwards, a light hollow cylindrical bell. The air is enclosed in a large japanned metal chamber, the space between the two being filled with a non-conducting material. The movements of the bell are transmitted to the chart by means of a delicate system of leverage. The chart is wound round a drum actuated by clock-work, and making one revolution in twenty-four hours.'

This instrument (micro-barograph) has given efficient service for the purpose for which it was desired, viz., in the first place to give a record of very rapid barometric fluctuations with the accompanying gusty winds, and secondly to enable one to make a comparison of such record with the seismogram to determine the relationship, if any, between the micro-barogram and seismogram. This has now been clearly and unequivocally established by simple ocular demonstrations. Whenever a closely serrated line with amplitudes of a sixteenth to quarter of an inch (about the maximum for very rapid oscillations) is found on the micro-barogram, the seismogram will show for the same time invariably an irregular record, not microseisms, which appear as a combination of tilting and horizontal movements, probably vertical movements too. They can never be mistaken for any phase of earthquake effects nor for microseisms, about which more will be said hereafter. The service of this instrument has been wholly confined to interpretation of some of the disturbances recorded by the seismograph and not for other meteorological purposes, as that is outside of our field.

The electric light 16 c.p., 104 v., continues to serve for the seismograph, and is efficient although slightly reduced in brightness when the machinery using the motor, and the lights of the observatory are on. A 'detector' was installed in my room, on the wall opposite to my desk. The object is to show when, by accident, the filament of the seismograph lamp should break, or otherwise the light circuit be interrupted. This is effected by having two small 1-candle power lamps in series, with the main lamp in the basement, and being themselves in parallel. The idea of having the two small lamps in parallel is that if one of them should give out, the circuit would not be interrupted, but would show by the other small lamp burning much brighter. The scheme works very well.

In last year's report I spoke of the trouble that some of the electric lamps, necessarily with single filament, gave by the vibrations set up in the filament and produced by the electric current alone. This has been nearly eliminated by the use of new lamps with shorter filaments. Occasionally spots of a widened line are shown on the seismogram when the filament has oscillated for a few seconds. It is a rather peculiar phenomenon and was discussed in detail last year.

The two horizontal pendulums have remained in their respective positions N.-S. and E.-W. during the year. The steel point of the N.-S. pendulum bearing against the lower support was found to have become somewhat blunted, so it was replaced by a spare point supplied by Bosch when the instrument was purchased. The effect of this was well shown in the record of microseisms whose amplitude although always small was distinctly increased by the decrease of friction at the point of lower support. For this same pendulum, as noted last year, the air-damping had been replaced by oil-damping, in the belief that the oil would be very much more efficient for the purpose of damping. Neither the damping by the oil nor the surface tension manifested themselves as conspicuously as anticipated. The experimental test was made with an immersion of 3mm. by the aluminum vane of the aluminum rod which extends from the 'bob,' or mass. The damping co-efficient was practically the same as with the air damping. The oil used was ordinary bicycle oil with some clock oil.

As in previous years a record has been kept of the hygrometric condition immediately without and within the seismograph room. The humidity although subject to small oscillations is in general dependent upon the season and the artificial heating of the building during the colder months. The least humidity is during the winter, and the greatest during the summer, ranging from an average of 36 per cent in January to 75 per cent in July. Since the construction of an additional drain below the seismograph cement floor there has been no occasion to use chloride of calcium for the absorption of moisture. The following are the bi-monthly means:—

Months.	Humidity.		Months.	Humidity.	
	Basement.	Seismograph Room.		Basement.	Seismograph Room.
1908					
April 1 to 15	48·6	45·7	October 1 to 15	61·7	57·9
" 16 to end	49·2	47·2	" 16 to end	72·2	54·7
May 1 to 15	58·7	60·7	November 1 to 15	81·3	48·2
" 16 to end	72·4	73·4	" 16 to end	44·5	43·2
June 1 to 15	69·3	72·5	December 1 to 15	40·9	38·6
" 16 to end	76·5	74·7	" 16 to end	37·7	36·0
			1909		
July 1 to 15	65·1	73·3	January 1 to 15	39·0	36·3
" 16 to end	71·2	75·6	" 16 to end	38·2	37·0
Aug. 1 to 15	67·9	73·8	February 1 to 15	37·5	38·1
" 16 to end	64·5	71·8	" 16 to end	36·1	34·0
Sept. 1 to 15	60·9	71·4	March 1 to 15	38·0	33·5
" 16 to end	67·6	71·5	" 16 to end	40·7	38·2

During the construction of the large dam across the Ottawa river above the Chaudière falls considerable blasting was done for the foundation in the limestone rock. It was desired to ascertain whether the shocks would be recorded by the seismograph. By request the engineer-in-charge, Mr. J. B. McCrae, kindly noted the time of discharge as given below:—

	h.	m.	s.	No. of holes.	Dynamite Sticks.
No. 1	12	15	00	3	3
2	12	17	30	5	5
3	12	24	30	4	4
4	12	29	00	11	11
5	12	48	00	8	8
6	12	52	30	16	16

The holes were 3 feet apart and about 15 inches deep; one stick of dynamite per hole, and the dynamite 50 per cent. The firing was electric. The nature of the limestone rock is more or less shaly. The distance from the Observatory to the dam is in round numbers 10,000 feet, or 3,050 km. The seismogram for the noon hour was carefully examined for any effect of the above blasts, but it failed to reveal the slightest trace. If there was any it was masked by the very small microseisms that were present on that day. Beside the presence of the minute microseisms two other causes militated against obtaining a record; one, the lack of compactness of the rock over that distance, and the other the very rapid oscillations that would be set up to which the seismograph could not well respond.

EARTHQUAKES RECORDED.

In the following table are given the earthquakes recorded here from January 1, 1908, to March 31, 1909, the end of the fiscal year. On April 1, 1909, began the publication of monthly bulletins of earthquakes and the Göttinger nomenclature adopted by most earthquake stations was also adopted. The preceding three months for 1908 are added in order to have a complete list for that year. Before the adoption of the above nomenclature fewer data were taken from the seismograms than subsequently, which is obvious in the table.

Göttinger Nomenclature or Designations.

Character of the earthquake—

I = noticeable. II = conspicuous. III = strong.
d = (terræ motus domesticus) = local earthquake (sensible or felt).
v = (" " vicinus) = near " (under 1000 km.)
r = (" " remotus) = distant " (1000 to 5000 km.)
u = (" " ultimus) = very distant earthquake (over 5000 km.)

Phases—

P = (undæ primæ) first preliminary tremors.
S = (" secundæ) second preliminary tremors.
L = (" longæ) long waves (principal portion).
M = (" maximæ) greatest motion in principal portion.
C = (coda) = trailers.
F = (finis) = end of visible disturbance.

Nature of the motion—

i = (impetus) = beginning.
e = (emersio) = appearance.
T = period = twice time of oscillation.
A = amplitude of earth movement, reckoned from zero line.
A_E = E-W component of A } measured in microns (μ).
A_N = N-S " A }

Record of the Earthquake Station, Dominion Astronomical Observatory, Ottawa, Canada. Latitude 45° 23′ 38″, Longitude 75° 42′ 57″ or $5^h\ 02^m\ 51^s.8$ W. Greenwich. Elev. 83^m. Time: Mean Greenwich, midnight to midnight. Instruments: Two Bosch photographic horizontal pendulums. Nomenclature: Göttinger. From January 1, 1908, to March 31, 1909.

No.	Date.	Char.	Phase.	Time.	Period.	Amplitude. A_E	Amplitude. A_N	Remarks.
	1908		—	h. m. s.	s	μ.	μ.	—
1	Feb. 1. ...	*I*	*P*	23 25 20				
			L	23 33 16				
			F	24 09				
2	" 9. ..	*I*	*P*	3 28 12				
			L	3 35				
			F	4 06				
3	" 9...	*I*	*P*	9 15 08				
			L	9 27				
			F	9 42				
4	" 11 ..	*I*	*P*	13 09 48				
			F	13 25				
5	" 14 . ..	*I*	*P*	9 01 04				
			S	9 08 18				
			L	9 14				
			F	9 40				
6	" 14	*I*	*P*	11 44 28				
			S	11 47 08				
			F	12 00				
7	Mar. 3....	*I*	*P*	23 47 48				
			F	24 10				
8	" 5 ...	*I*	*P*	2 36 48				
			L	3 20	20			
			F	4 00				
9	" 5.....	*I*	*e*	14 46				
			F	15 03				
10	" 25.. ..	*I*	*P*	17 02 00				
			S	17 07 34				
			L	17 15				
			F	18 17				
11	" 26 . ..	*II*	*P*	23 10 12				
			S	23 15 50	.....	..	.....	Chilapa, Mexico, destroyed
			M_E	23 28 40	.....		175	
			M_N	23 29 40	....	87		
	" 27...		*F*	2 55				
12	" 27. ..	*II*	*P*	3 54 12				
			S	3 59 44	..	....	......	Same epicentre as above.
			L	4 05 28				
			M	4 11	....	70	83	
			F	6 00				
13	April 19 ...	*I*	*eP*	8-16-09	5	...	5	Well-marked microseisms mask the *P*.
			iS	8-24-14	8	25	10	
			F	9-00-..	....	....	...	
14	April 23 ...	*I*	*S?*	0-07-36	8	7	2	Microseisms mask the *P*.
			eL	0-52-..	20	... ..	.... ..	
			F	2-16-..	......	....	... ..	
15	May 3 .	*I*	*S*	1-11-20	8	3	2	*P* unrecognizable in the small microseisms. The *L* of 22^s continue for 10 min.
			L	1-35-..	22	... ..	.....	
			F	2-30-.	... .	....	..	

RECORD of the Earthquake Station, Dominion Astronomical Observatory, Ottawa, Canada. Latitude 45° 23′ 38″. Longitude 75° 42′ 57″ or $5^h\ 02^m\ 51^s.8$ W. Greenwich. Elev. 83m. Time: Mean Greenwich, midnight to midnight. Instruments: Two Bosch photographic horizontal pendulums. Nomenclature: Göttinger. From January 1, 1908, to March 31, 1909—*Con.*

No.	Date.	Char.	Phase	Time.	Period.	Amplitude. A_E	Amplitude. A_N	Remarks,
	1908.			h. m. s.	s.	μ	μ	
16	May 5....	*I*	*P*	6-40 14	5	6	8	Microseisms throughout sheet. *L* not conspicuous till $7^h\ 19^m$ and continue then for 15 minutes.
			L	7-19-..	27	..	....	
			F	8-30-..	....	..	....	
17	May 15........	*IIr*	*iP*	8-39-22	12	3	2	On N-S. component for *iP* period 3^s to 4^s.
			Pr	8-41-00	10	....	....	
			iS	8-45-32	10	....	..	
			eL	8-50-48	33	....	.	Shorter periods of $5^s{\cdot}5$ superimposed on *L* of 33^s.
			M	8-53-30	......	140	110	
			F	11-10-..	....	....	...	Epicentral distance 4400 km.
18	June 14 ...	*I*	*eN*	6-07-36	2·6	....	6	Phases unrecognizable.
			eE	6-09-38	7	8	......	
			F	6-33-..	....	.	....	
19	June 16........	*Id*	*e*	20-41-52	2	8	8	Some windows rattled. Felt in the Observatory and in many places in the city.
			F	20 42-04	....	.....	.....	
20	June 18	*I*	*iP*	10-46-38	4·8	2	2	Epicentral distance 3800 km.
			iS	10-52-16	6·6	4	4	
			L	11-01-28	8·5	....	....	
			M	11-08-..	....	6	7	
			F	12-00-..	....	.....	...	
21	June 30.	*I*	*e*	17-51-30	6	..	..	
			M	17-57-.	11	8	6	
			F	18-20-.	....	.....	...	
22	July 2... ..	*I*	*e*	13-07-22	....	..	..	
			M_E	13-15-..	5	2	....	
			M_N	13-16-..	8	....	4	
			F	13-28-..	......	.....	.	
23	July 8	*I*	*P*	12-58-16	6	.....	.....	*L* not well marked. Distance of epicentre 4900 km.
			S	13-04-52	10	...	....	
			M	13-20-..	10	12	4	
			F	14-11-..	....	.....	.....	
24	July 16........	I*u*	*P*	17-00-30	5	.....	...	Epicentre 6800 km. Severe earthquake reported from Arica, Chile, but no time stated.
			S	17-08-52	7	....	.....	
			M	17-11-..	....	7	2	
			M_2	17-54-..	6	....	10	
			F	18-00-..	....	.....	.....	
25	July 19.... ..	*I*	*e*	14-13-40	5·3	.....	.....	
			F	14-19-..	....	.....	.....	
26	July 26.... .	...	....	....	....	...	.....	The first well-marked "sawtooth" microseisms, period $5^s.2$, since May 10.
27	August 14. .	*II*	*iP*	0-49-48	5·7	2	2	
			iS	0-55-40	8	10	6	
			iL	1-00-08	......	....	....	
			L	1-02-16	22	.....	...	Superimposed by shorter period waves.
			M_N	1-03-54	.....	......	41	
			M_E	1-08-16	....	71	....	
			C	....	7·6	......	...	Distance to epicentre 3900 km.
			F	2-25-.	....	...	...	
28	Aug. 17 ...	II	*iP*	10-56-00	4·6	....	...	
			iS	11-03-07	7	...	...	
			L	11-12-..	....	....		
			M	11-12-12	...	8	10	
			L_E	11-30-..	32	..	...	L_N L_L well-marked undulatory.
			L_N	11-36-..	29	....	.....	
			L_E	11-37-.	20	......	8	
			L_N	11-41-..	21	8	...	Distance to epicentre 5400 km.
			F	13-30-..	......	...	...	

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No.	Date.	Char.	Phase	Time.	Period.	Amplitude. A_E	Amplitude. A_N	Remarks.
	1908.			h. m. s.	s.	μ	μ	
29	Aug. 18	*I*	*e*	11 – 16 – 08	...	...	...	Press despatches report an earthquake at Eureka, California,
			M	11 – 20 – 40	7	4	..	at about 11^h =3 a.m. Pacific
			F	11 – 40 – ..	...	...	...	Standard, for which the adjoining is apparently the record
								Distance to Eureka 3800 km.
30	Aug. 19	*I*	*eP?*	23 – 42 – ..	6	...	...	
			eS?	23 – 47 – ..	8	...	...	
			M	23 – 47 – 48	...	7	6	
			F	24 – 00 – ..	...	...	...	
31	Aug. 20	*I*	*e*	10 – 21 – ..	...	...	...	Phases not distinguishable.
			L	10 – 43 – ..	16–20	4	2	E–W component the better
			F	11 – 33 – ..	...	...	...	shown.
32	Aug. 22	*I*	*e*	19 – 31 – ..	...	...	...	
			S?	19 – 36 – 22	...	...	...	
			M	19 – 42 – 00	8	6	...	
			F	20 – 15 – ..	...	...	...	
33	Aug. 23	*I*	*e*	19 – 22 – 28	5 7	...	...	
			F	19 – 26 – ..	...	...	...	
34	Aug. 29	*I*	*e*	18 – 15 – 18	5–6	...	...	
			M	18 – 24 – 10	...	6	...	
			L	18 – 25 – ..	20	...	...	
			F	19 – 00 – ..	...	...	...	
35	Sept. 21	I_u	*e*	6 – 43 – ?	...	...	...	The microseisms mask the *P* and
			S	6 – 55 – 47	8	...	8	interfere with the other phases.
			L_N	7 – 07 – 40	10	...	...	
			M_{1N}	7 – 09 – 32	10	...	16	
			M_{2N}	. – 12 – 16	9·5	...	16	
			M_{3N}	.. – 14 – 44	8	...	12	
			M_{1E}	.. – 14 – 40	10	50	...	
			M_{2E}	.. – 16 – 08	8	37	...	
			M_{3E}	.. – 18 – 14	8	25	...	
			F	9 – 00 – ..	...	...	...	
36	Sept. 24	*I*	*e*	1 – 05 – .	...	...	...	
			eL	1 – 09 – 40	16	3	2	
			F	1 – 21 – ..	...	...	...	
37	Oct. 13	*I*	*iP*	5 – 13 – 26	...	...	...	*iL* uncertain.
			iS	5 – 19 – 02	8.5	29	14	
			M_N	5 – 35 – 50	8	...	35	Epicentre 3700 km.
			M_E	5 – 38 – 00	8·3	50	...	
			e	6 – 52 – 38	8	12	6	A second shock appeared before
			M_E	7 – 03 – 52	...	14	...	the other had wholly died out.
			"	.. – 6 – 24	...	...	...	
			"	.. – 9 – 24	...	...	...	
			"	.. – 12 – 40	...	...	...	
			F	8 – 00 – ..	...	...	...	
38	Nov. 2	*I*	*P*	5 – 37 – 56	...	...	...	N.-S. component unreadable due
			S	.. – .. – ..	...	...	...	to stray microseisms.
			L	5 – 54 – 20	20	6	...	Some *L* of 32^s
			M	6 – 43 – .	20	14	...	Epicentre 6300 km.
			F	7 – 40 – .	...	...	...	
39	Nov. 4	*I*	*e*	8 – 54 –	12	...	...	
			F	9 – 20 – ..	...	...	...	
40	Nov. 6	*I*	*P*	7 – 31 – 50	6	14	7	Strong microseisms prevailed
			S?	7 – 38 – 16	...	...	...	and partly mask N-S compon-
			L	7 – 46 – 35	20	...	...	ent.
			M	8 – 02 – 20	16	29	12	
			F	10 – 30 – ..	...	...	...	Epicentre 5900 km.

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No.	Date.	Char.	Phase	Time.	Period.	Amplitude. A_E	Amplitude. A_N	Remarks.
	1908.			h. m. s.	s.	μ	μ	
41	Nov. 6	*I*	*e*	23 - 02 ?	....	....	....	Very strong microseisms prevailed, 10 μ, and almost mask N-S component.
			L	23 - 14 ?	....	....	....	
			M_E	23 - 16 - 50	10	17	....	
			M_N	23 - 16 - 50	6	....	10	
			F	23 - 45 - ..	....	....	....	
42	Nov. 9	*I*	*iP*	15 27 00	9	6	..	Small microseisms mask N-S component except *P*. No *M* distinguishable. Epicentre probably 6,500 km.
			L	15 44 ?	19	....		
			F	17 00 ..	....	....	....	
43	Nov. 11	*I*	*e*	13 - 39 - 10	5	...	2	
			L ?	13 - 44 - 40	....	..	....	
			M	13 - 56 - .	14	7	....	
			F	15 - 25 - ..	....	....	....	
44	Nov. 12	*I*	*e*	13 - 51 - .	4·3	1	....	Very weak: phases unrecognizable.
			F	15 - 00 ..	....	....	....	
45	Nov. 19	*I*	*e*	5 - 46 - ..	15	....	....	No phases recognizable.
			M_E	....	15	6	....	
			F	6 - 26 - .	....	....	....	
46	Nov. 22	*I*	*e*	6 - 45 - 36	8	1	..	Not recognizable in N-S component.
			L	6 - 55 - 12	16	2	..	
			L	8 - 09 - 24	20	2	....	
			F	8 - 30 - .	....	....	....	
47	Nov. 23	*I*	*e*	13 - 04 - 20	6	2	.	
			M	13 - 54 - ..	22	6	....	
			F	15 - 00 - .	....	....	.	
48	Nov. 30	*I*	*P ?*	21 - 49 - 48	....	....	...	
			L	21 - 56 ..	....	....	....	
			M_N	21 - 57 - 30	6	. .	75	
			M_E	21 - 59 - 30	10	125	....	
			F	23 - 30 - ..	....	....	....	
49	Dec. 12	*I*	*eL*	13 - 43 - 40	....	....	....	Microseisms present.
			L_E	13 - 46 - ..	32	4	....	
			L	13 - 57 - ..	20	4	4	
			F	14—26 - .	....	...	....	
50	Dec. 28	*I*	*iP*	4 - 31 - 04	5-6	8	4	Strong microseisms, but materially decreased after quake.
			L	4 - 39 - 42	20	...	....	
			M_N	4 - 56 - 30	16	...	10	
			M_E	5 - 00 - ..	16	18	...	Epicentre 7,100 km.
			F_N	6 - 10 ..	....	....	....	Postscripts:
			F_N	9—20 - ..	....	..	...	Calabrian quake. 7,300 km
	Dec. 28	*I*	*P*	23 - 22 - 05	....	...	6	No other phases recognizable. E-W component not recorded.
	1909.		*F*	24 - 00 - ..	....	....		
51	Jan. 12	*I*	*P*	0 - 04 - 36	4	3	4	Earthquake reported from Vancouver, B.C.
			F	0 - 22 ..	....	...	....	
52	Jan. 12	*I*	*e*	10 - 26 - ..	....	...	....	
			F	10 - 37 - .	....	....	...	
53	Jan. 12	*I*	*e*	12 - 30 - ..	....	....	....	
			M	12 - 35 - ..	12-16	4	2	
			F	12 - 55 - ..	....	..	....	
54	Jan. 21	*I*	*e*	21 - 43 - ..	....	....	....	No phases recognizable.
			M_N	21 - 47 - 30	6·1	...	5	
			M_E	21 - 48 - 40	6·7	6	...	
			F	22 - 05 - ..	....	....	....	

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No.	Date.	Char.	Phase	Time.	Period.	Amplitude. A_N	Amplitude. A_E	Remarks.
	1909.			h. m. s.	s.	μ.	μ.	—
55	Jan. 23....... ..	*I*	*P*	3-01-13	....	. . ..	.... ..	
			S	3-11-42	....	...	.. ..	Epicentre estimated at 9,400 km.
			L	3-28 ?	... ..	... ...	......	
			L	3-32-..	24	.. .	.... ..	
			M_N	3-35-..	24	......	6	
			M_E	3-37-..	22	8	....	
			F	4-50-..	....	.. ..	..	
56	Feb. 9.	*I*	*e*	12-01-..	. ...	.....	....	Well-marked microseisms prevail.
			L	12-06-..	20	..	.	
			F	12-21-..	....	....	....	
57	Feb. 16........	*I*	*P*	16-31-20?	....	...	......	
			L	16-54-20	6	...	.....	
			M_N	16-55-00	6	.....	30	Epicentre 8,400 km.
			M_E	16-55-40	7	40	....	
			F	17-35-..	. .....	.....	... .	
58	Feb. 22 ...	*I*	*P*	9-40-00	....	....	.. ...	Microseisms present.
			S	9-45-06	....	......	......	
			L_E	9-48-29	7	... ..	.. ...	Epicentre 3,500 km.
			M	9-52-40?	7	20	. ..	
			F	11-20-..	....	.....	.....	
59	Feb. 26..	*I*	*P*	16-53-35	. .....	....	...	Well-marked microseisms.
			S	16-59-16	... ...	... ..	.. ..	
			L	17-01-23	....	... ..	... .	Epicentre 3,900 km.
			M	17-05-12	12	50	.....	
			F	17-38-..	... ..	......	.....	
60	Mar. 12} 13} ...	*I*	*e*	23-42-..	.....	.....	. ...	
			L	0-07-..	. .. ...	... .	.. ..	
			M_E	0-14-.	20	6	.....	
			F	1-38-..	. .....	... ..	.....	
61	Mar. 13.........	*I*	*P*	14-42-20	....	.....	.... .	
			S	14-52-40	......	. .. .	.... .	
			L	15-16-32	20	......	.....	
			M	15-19-30	27	6	..	
			F	17-00-..	....	.....	....	
62	Mar. 18........	*I*	*eL*	0-03-40	24	..	......	
			F	0-20-..	....	... ..	....	Irregularities due to winds and microseisms mask the phases.

During this period of fifteen months sixty-two earthquakes were recorded and but one of them of Canadian origin, and that one in the vicinity of Ottawa. Popularly the severity of an earthquake is measured by the destruction of life and property, which is however by no means the criterion for the seismologist when considering it as a tectonic movement. There were three earthquakes by which much destruction was done: the two shocks of March 26-27 by which Chilapa, on the Pacific slope of Mexico was destroyed; then the great disaster of Messina, also spoken of as the Calabrian earthquake; and the Persian one of January 23, 1909.

Most of the other quakes probably occurred at sea and hence give us no evidence from the epicentre or central area of disturbance unless it be through the breaking of submarine cables. However, with the great improvement of earthquake instruments in recent years, with increased sensitiveness and more accurate time-scale, it will now be possible to locate with a fair degree of accuracy every earthquake that is recorded at a number of widely separated stations. There is yet room for improvement in sensitiveness, especially for recording the first preliminary tremors, and also in the time record; the clock correction, if any, should be within a second of time. The time-scale on our photographic seismogram is made by a shutter, actuated electrically by our normal standard mean time clock, and so far has never required a correction of a second. The light is cut off every minute for two seconds and the 60th minute is omitted in order to identify the hour.

With well marked phases on a seismogram and good time-scale, the distance to the epicentre of a tectonic quake can be obtained within say 100 km. or 60 miles. The direction of the seat of disturbance, however, can not be so well deduced. Were the matter through which the earthquake waves are propagated homogeneous, then the components of the two pendulums placed generally in the N.-S. E.-W. directions at each station would furnish some indication of the direction sought, and thus enable each station to obtain at least an approximate position for the epicentre. The complete analysis of the seismograms is yet remote.

That the velocity of the first and second preliminary tremors or longitudinal and transverse waves respectively is a function of the distance is well illustrated in the accompanying table which has been compiled of the Messina earthquake. Time of occurrence at Messina is taken as $4^h 20^m$ Greenwich mean time (Professor Rizzo). The seismogram records were obtained from the various subjoined stations, and the distances were directly taken from our 30-inch globe with a flexible steel tape especially graduated to represent 10,000 km. for the quadrant. A globe of this size with such a graduated tape is of great service in the study of earthquakes and their epicentres.

P, S, L. represent respectively the time of arrival of the first preliminary, the second preliminary, and the long waves.

MESSINA EARTHQUAKE.

Place.	Distance.	Middle ordinate to Chord.	*P*	*S*	*L*	Velocity per Minute. *P*	Velocity per Minute. *S*	Velocity per Minute. *L*	$\frac{S}{P}$
	km.	km.	h m s	h m s	h m s	km.	km.	km.	
Ottawa	7200	992	4 31 04	4 39 42	.. .. ..	651	365	... ...	·56
Washington	7650	1116	4 31 23	4 40 30	.. .. ..	672	373	....	·56
Tiflis	2550	128	4 25 33	4 29 50	4 35 20	458	259	166	·57
Cartuja	1700	56	4 23 35	4 26 40	4 27 50	474	255	217	·54
Sarajevo	700	10	4 21 51	4 23 09	4 23 54	378	222	180	·59
Belgrade	850	14	4 22 09	4 23 11	4 24 12	395	267	202	·68
Laibach	900	16	4 22 18	4 23 33	4 24 16	391	254	211	·65
Vienna	1100	24	4 22 55	4 25 17	4 26 16	377	208	175	·55
Cracow	1400	38	4 23 23	4 25 59	4 26 48	413	234	206	·56
Hamburg	1750	60	4 24 16	4 27 18	4 28 12	410	240	213	·58
Aachen	1600	50	4 23 53	4 26 38	.. .. ..	412	241	....	·58
Toronto	7500	1073	4 31 12	4 39 48	5 00 00	670	379	187	·57
Victoria	9550	1709	4 33 12	4 43 36	5 06 36	723	405	205	·56
						Mean		196·2	
						Per second		3·27	

The ratio $\frac{S}{P}$ is pretty constant, with the exception of the three stations, Sarajevo, Belgrade and Laibach, which are all less than 1,000 km. from the epicentre, and for which the ordinates to the chords are small, from 10 to 16 km., not reaching to the supposed layer of isostatic adjustment.

The degree of accuracy of the time element in the records for deducing velocities is of far more consequence for close stations than for very distant ones. However in the above, which comprise all the data available at the time, there does not appear to be any serious discrepancy in the reading of the various seismograms. The *L* waves show themselves conspicuously as being propagated over the same medium for all stations, that is, along the surface, by having the same velocity. Thus the velocity from origin to Cracow is the same as to Victoria, seven times as distant. Although there are some variations in the velocity of the surface waves, they are wholly independent of the distance, and most likely attributable to the difficulty of sometimes identifying the arrival of the long waves in the medley of the other waves and their reflections which precede.

As the time of the occurrence of the severe earthquake in Persia of January 23, 1909, was not reported, and the time service in those regions is in any case probably very unsatisfactory with reference to Standard or Greenwich time, an attempt has been made to determine the time of the occurrence at the epicentre, based on the press despatch that the epicentre was at Bahrein, and on the times of arrival of the first and second preliminary tremors (*P* and *S*) at various stations of which the records had been received. The geographical position of Bahrein is taken from Stieler's *Hand Atlas*, $\varphi = 33° \ 30'$, $\lambda = 49° \ 30'$ E. Greenwich. The distances are taken from our 30-inch globe.

In the following table the computed transmission times V_1, V_2 for the *P* and *S* are interpolated from the Wiechert-Zœppritz values compounded from the Indian earthquake of 1905, the Calabrian one of 1905, and the San Francisco one of 1906. For *L* the velocity is taken at 4 km. per second.

EARTHQUAKE OF JANUARY 23, 1909.

BAHREIN, PERSIA.

$\phi = 33° \ 30'$, $\lambda = 49° \ 30'$ E. OF GR.

GREENWICH TIME.

Station.	Distance.	Ordinate.	Seismograms.			Computed.			Deduced time at Epicentre.		
	km.	km.	*P*	*S*	*L*	V_1	V_2	*B*	P-V_1	S-V_2	*L*-*B*
			h m s	h m s	h m s	m s	m s	m s	h m s	h m s	h m s
Ottawa	9750	1778	3 01 13	3 11 42	3 28 ..	12 54	23 38	40 37	2 48 19	2 48 04	2 47 23
Hamburg	3830	287	2 55 14	3 00 36	3 03 12	7 07	12 40	15 57	.. 48 07	.. 47 56	.. 47 15
Aachen	4020	315	2 55 33	3 01 05	3 04 56	7 21	13 06	16 45	. 48 12	.. 47 59	.. 48 11
Trieste	3330	217	2 54 42	2 59 42	3 04 41	6 22	11 22	13 52	.. 48 20	.. 48 20	.. 50 49
*Sarajevo	2920	168	2 55 30	3 00 09	3 03 36	5 52	10 24	12 10	.. 48 38	.. 48 45	.. 50 26
Cracow	3060	183	2 54 08	2 58 59	.. .. ..	6 00	10 43	.. ..	.. 48 08	.. 48 16	.. ..
Vienna	3200	200	2 54 18	2 59 10	3 00 56	6 13	11 07	13 20	.. 48 05	.. 48 03	.. 47 36
Tiflis	1030	21	2 50 40	.. .. ..	.. .. ..	2 19	4 04	.. ..	.. 48 21	.. .. ..	.. .. ..
Strassburg	3850	290	2 55 09	3 00 26	3 05 26	7 09	12 40	16 02	.. 48 00	.. 47 46	.. 49 24
Laibach	3300	213	2 54 20	2 59 15	3 04 17	6 21	11 16	13 45	. 47 59	.. 47 59	.. 50 32
Belgrade	2650	137	2 53 26	2 57 53	3 01 42	5 27	9 42	11 02	.. 47 59	.. 48 11	.. 50 40
Cartuja	4820	450	2 56 33	3 03 05	3 07 30	8 20	14 48	20 05	. 48 13	.. 48 17	.. 47 25
Washington	10300	1972	3 01 22	3 12 05	3 30 ..	13 18	24 28	42 55	.. 48 04	.. 47 37	.. 47 05
						Mean.			2 48 11	2 48 06	2 48 48

It will be observed from the above table that the mean time deduced from the *P* agrees within 5 seconds of the mean of the deduced time from the *S*, so that one feels justified in giving for the time of the occurrence of the quake in Persia $2^h \ 48^m \ 8^s$

* Times evidently one minute too late.

Greenwich time. The agreement between the two independent values $P - V_1$ and $S - V_2$ for any station is satisfactory too; in several cases the times are absolutely co-incident. However, we cannot always be sure of individual seconds in reading P and S on the seismogram.

A greater difficulty we encounter when trying to read on the seismogram the arrival of the long waves, L, and this is manifested in the last column, which in the ideal condition we should expect to agree with the other two. The discordances in the last column of individual values from the general mean (2^h 48^m 08^s) of the other two columns is not attributable to the assumption of 4 km. as the velocity of the long waves per second, but rather to the reading of the various seismograms. For, taking $T = 2^h$ 48^m 08^s as the time of the occurrence of the quake and solving by least squares for the velocity of the long waves we get 238 km. per minute, which is practically the same as 4 km. per second, the quantity used.

If we arrange $L - T$ in the order of magnitude and divide the resulting time into the respective distance of the station from the epicentre it will be found that there is a tendency for the greater distance to give the greater velocity; the extreme values being Hamburg 4·24 km., and Belgrade 3·26 km. per second.

We may recall the table of the Calabrian or Messina quake, which gave for Belgrade 3·36 km., and for Hamburg 3·55 km., and the general mean 3·27 km. In no case for that quake was a velocity obtained as high as 4 km., the highest being for Cartuja 3·61 km. per second.

Judging from our seismograms here, it is believed that the discordances obtained for the velocity of the long waves are mostly or wholly attributable to the uncertainty of identifying, midst the complexity of longitudinal and transverse waves and their reflections which precede, the arrival of the surface or long waves.

Some of the stations on this continent failed to get a record of the first preliminary tremors, due to lack of sensitiveness of the instrument. For distant quakes not only the diminished force of the longitudinal impulse comes into play, but also the horizontal component of that impulse, so that distance very materially militates against the recording of the first preliminary tremors.

The following table is a compilation of the two preceding ones, and arranged in order of distance with the corresponding middle ordinate to the chord, and the mean velocity of the first preliminary tremors, P, or longitudinal waves in kilometres per minute.

FOR MESSINA AND BAHREIN EARTHQUAKES.

Place.	Distance.	Ordinate.	Velocity P.	Place.	Distance.	Ordinate.	Velocity P.
	km.	km.	km.		km.	km.	km.
Sarajevo	700	10	378	Vienna........	3,200	200	519
Belgrade . ..	850	14	395	Laibach........	3,300	213	532
Laibach...	900	16	391	Trieste........ ..	3,330	217	507
Tiflis...... ..	1,030	21	407	Hamburg.... .	3,830	287	540
Vienna	1,100	24	377	Strassburg.. ..	3,850	290	519
Cracow	1,400	38	413	Aachen..	4,020	315	542
Aachen.... .. .	1,600	50	412	Cartuja.........	4,820	450	573
Cartuja.. . ..	1,700	56	474	Ottawa.........	7,200	992	651
Hamburg. ...	1,750	60	410	Toronto	7,500	1,073	670
Tiflis.	2,550	128	458	Washington.....	7,650	1,116	672
Belgrade.. ...	2,650	137	500	Victoria... .. .	9,550	1,709	723
Sarajevo.	2,920	168	396	Ottawa...... ...	9,750	1,778	745
Cracow	3,060	183	510	Washington..	10,300	1,972	778

There are some discrepancies in the table, notably the one for Sarajevo. From information received it would appear that it is mostly due to an error or inaccuracy in time scale. If the phenomenal progress that seismology has made in recent years continues, such discrepancies will disappear and data of a high order of precision will be obtained, upon which a permanent structure can be raised.

There are now some 200 earthquake stations distributed over the earth, and the seismograms furnished by them are far from homogeneous, and are far from equal merit and value for studying the geophysical problems for which they are obtained. The first order of precision to be aimed at is that of time. Seismology demands now that the time recorded should be accurate within at least one second. As standard time is now so widely distributed by telegraph, there seems no reason why the time of every earthquake station should not be controlled by the time from some astronomical observatory. In order to be able to read to one second on the seismogram the time scale should be about 90cm. to the hour, or 15mm. to the minute; *i.e.,* 1mm. would represent 4 seconds. There is a limit to the speed of the revolving cylinder, for if it is too great, although the time could then be more accurately read, yet, waves with small amplitudes would become so flattened as to be scarcely recognizable. A further demand for precision, is that the instrument be highly sensitive in order that the first impulse of the first preliminary tremors is recorded, and that damping co-efficient should approach the limit of aperiodicity for the pendulum, in order that the seismogram may represent fairly well the earth movements and free from those of the pendulum itself.

CANADIAN EARTHQUAKES.

Looking at a geological map of Canada one is immediately impressed with the fact that the greater part of the Dominion, running from the Gulf of St. Lawrence past Hudson bay and on to Great Bear lake and the Arctic ocean, is composed essentially of archæan rock, that is, of the oldest formation on the earth. This is probably the largest area of archæan rock on the earth, being closely followed by the Scandinavian peninsula and Finland. As earthquakes are intimately associated with the age of rock formation, the more recent being more subject to disturbances than the older ones, we may say that broadly speaking the vast area above referred to will always be fairly free from earthquakes, for its compact and more or less homogeneous nature is not so well adapted to the adjustment of the strains of the earth's crust, which is the cause of earthquakes, as the newer formations are, which are intersected by dikes and faults, and which exhibit stratification and folding with, consequently, lines and surfaces of weakness.

In the St. Lawrence valley, westward from Quebec to Lake Huron, we have formations of the Palæozoic age, and also to the south of the St. Lawrence covering New Brunswick and Nova Scotia. In the whole of eastern Canada from Nova Scotia to near the mouth of the Mackenzie river, a distance of nearly 3,000 miles, no formations more recent than those of the Palæozoic age are found. In western Canada the newer formations occur; the Great Plains being represented by the Cretaceous and Tertiary eras. The mainland Pacific coast of British Columbia is almost wholly 'coast granite,' while the interior is largely represented by the Miocene period of the Tertiary era. The nature, composition and structure of the formation itself may, *per se,* directly lead through gravitational effect to earthquakes. While on the other hand such formation may lend itself to the adjustment of stresses imposed upon it from neighbouring regions, *e.g.* the sea or ocean. So much is obvious, that whatever reason we may assign as the contributory cause of an earthquake, where it occurs is necessarily the weak spot for the area under strain. From historic records and of late years from instrumental records the seismic areas of the earth are fairly well known, but why the degree of seismicity should vary in different regions is open to considerably more elucidation. The Indo-Pacific archipelago, including Sumatra, Java, New Guinea and the Philippines is the most seismic region of the earth for the larger quakes, while the eastern coast of Canada is fairly immune.

The more or less severe, but not destructive, earthquakes that have visited eastern Canada are all associated more or less directly with the 'Great Champlain and St. Lawrence fault,' running from the gulf up the river to Quebec and then curving southwesterly to Lake Champlain. Of these the quakes of 1663, 1791, 1860 and 1870 are the most noted. The first one has gained a certain celebrity from its exaggerated description. This earthquake, which lasted about six months, occurred during the French occupation. We may regard the record of this as the beginning of our literature on seismology, and hence give it a place here, although its scientific value is rather circumscribed.

From a manuscript in the Jesuits' College at Quebec the editor of 'Hochelaga Depicta' took the following account of this quake:—

'On the 5th of February, 1663, about half past five in the evening a great rushing noise was heard throughout the whole extent of Canada. This noise caused the people to run out of their houses into the streets, as if their habitations had been on fire; but instead of flames or smoke, they were surprised to see the walls reeling backwards and forwards, and the stones moving, as if they were detached from each other. The bells sounded by the repeated shocks. The roofs of the buildings bent down, first on one side and then on the other. The timbers, rafters and planks cracked. The earth trembled violently, and caused the stakes of the palisades and palings to dance in a manner that would have been incredible had we not actually seen it in many places. It was at this moment every one ran out of doors. There were to be seen animals flying in every direction, children crying and screaming in the streets; men and women seized with affright, stood horror-struck with the dreadful scene before them, unable to move, and ignorant where to fly for refuge from the tottering walls and trembling earth, which threatened every instant to crush them to death, or to sink them into a profound and unmeasurable abyss. Some threw themselves on their knees in the snow, crossing their breasts and calling on their saints to relieve them from the dangers with which they were surrounded. Others passed the rest of this dreadful night in prayer, for the earthquake ceased not, but continued at short intervals, with a certain undulating impulse, resembling the waves of the ocean, and the same qualmish sensations, or sickness of the stomach, was felt during the shocks as is experienced on a vessel at sea. . . . The violence of the earthquake was greatest in the forests, where it appeared as if there was a battle raging between the trees; for not only their branches were destroyed, but even their trunks are said to have been detached from their places and dashed against each other with inconceivable violence and confusion, so much so, that the Indians in their figurative manner of speaking, declared that all the forests were drunk. The war also seemed to be carried on between the mountains, some of which were torn from their beds and thrown upon others, leaving immense chasms in the places from whence they had issued, and the very trees with which they were covered sunk down, leaving only their tops above the surface of the earth; others were completely overturned, their branches buried in the earth and the roots only remained above ground. During this general wreck of nature the ice, upwards of six feet thick, was rent and thrown up in large pieces, and from the openings in many parts, there issued thick clouds of smoke, or fountains of dirt and mud, which spurted up to a very considerable height. The springs were either choked up or impregnated with sulphur,—many rivers were totally lost, others were diverted from their course and their waters entirely corrupted. Some of them became yellow, others red, and the great River of St. Lawrence appeared entirely white as far down as Tadousac. This extraordinary phenomenon must astonish those who know the size of the river, and the immense body of water in various parts, which must have required such an abundance of matter to whiten it. They write from Montreal that during the earthquake they plainly saw the stakes of the picketing or palisades jump up as if they had been dancing; and that of two doors in the same room, one opened and the other shut of their own accord; that the chimneys and tops of the houses bent like branches of trees agitated with the wind; that when they went to walk they felt the earth following them and rising at every step they took, sometimes sticking against the soles of their feet and other things in a very forcible and surprising manner. . . . From Three Rivers they write that the first shock was the most violent, and commenced with a noise resembling thunder. The houses were agitated in the same manner as the tops of trees during a tempest, with a noise as if fire was crackling in the garrets. The shock lasted half an hour, or rather better, though the greatest force was properly not more than a quarter of an hour; we believe there was not a single shock which did not cause the earth to open either more or less. As for the rest, we have remarked that, though this earthquake continued almost without intermission, yet it was not always of an equal violence. Sometimes it was like the pitching of a large vessel which dragged heavily at her anchors; and it was this motion that caused many to have a giddiness in their heads and qualmishness at their stomachs. At other times the motion was hurried and irregular, creating sudden jerks, some of which were extremely violent; but the most common was a slight tremulous motion, which occurred frequently with little noise. Many of the French inhabitants and Indians, who were eye-witnesses to the scene, state that a great way up the river of Trois Rivières, about 18 miles below Quebec, the hills which bordered the river on either side, and which were of a prodigious height, were torn from their foundations and plunged into the river, causing it to change its course and spread itself over a large tract of land recently cleared; the broken earth mixed with the waters, and for several months changed the colour of the great River St. Lawrence, into which that of Trois Rivières disembogues itself. In the course of this violent convulsion of nature, lakes appeared where none ever existed before; mountains were overthrown, swallowed up by the gaping, or precipitated into adjacent rivers, leaving in their places frightful chasms or level plains; falls and rapids were changed into gentle streams, and gentle streams into falls and rapids. Rivers in many parts of the country sought other beds or totally disappeared. The earth and the mountains were entirely split and rent in innumerable places, creating chasms and precipices whose depths have never yet been ascertained. Such devastation was also occasioned in the woods, that more than a thousand acres in one neighbourhood were completely overturned, and where but a short time before nothing met the eye but one immense forest of trees, now were to be seen extensive cleared lands apparently cut up by the plough . . At Tadousac, about 150 miles below Quebec on the north side, the effect of the earthquake was not less violent than at other places; and such a heavy shower of volcanic ashes fell in that neighbourhood, particularly in the River St. Lawrence, that the waters were as violently agitated as during a tempest. Near St. Paul's bay, about 50 miles below Quebec on the north side, a mountain about a quarter of a league in circumference, situated on the shore of the St. Lawrence, was precipitated into the river, but, as if it had only made a plunge, it rose from the bottom and became a small island, forming with the shore a convenient harbour, well sheltered from all winds. Lower down the river, towards Point Alouettes, an entire forest of considerable extent was loosened from the main bank and slid into the River St. Lawrence, where the trees took fresh root.

'There are three circumstances, however, which have rendered this extraordinary earthquake particularly remarkable: the first is its duration, it having continued from February to August, that is to say, more than six months almost without intermission. It is true, the shocks were not always equally violent. In several places, as towards the mountain behind Quebec, the thundering noise and trembling motion continued successively for a considerable time. In others, as towards Tadousac, the shock continued generally for two or three days at a time with much violence. . . . The second circumstance relates to the extent of this earthquake, which we believe was universal throughout the whole of New France, for we learn that it was felt from l'Isle Percée and Gaspé, which are situate at the mouth of the St. Lawrence to beyond Montreal, as also in New England, Acadia and other places more remote. As far as it has come to our knowledge, this earthquake extended more than 600 miles in length and about 300 in breadth. Hence 180,000 square miles of land were convulsed in the same day and at the same moment.

'The third circumstance, which appears the most remarkable of all, regards the extraordinary protection of Divine Providence which has been extended to us and our habitations; for we have seen near us the large openings and chasms which the earthquake occasioned, and the prodigious extent of country which has either been totally lost or hideously convulsed, without our losing either man, woman or child, or even having a hair of their heads touched.'

We might add a fourth circumstance, and that is, that the narrators of the above anticipated the sensationalism of our 'yellow' journals by two and a half centuries.

The following is a list of the slight local shocks occurring in Canada from January 1, 1908, to April 30, 1909. The items were gathered from the daily press:—

1908.

May 12.—A very perceptible shock of earthquake was felt in Yarmouth, N.S., and vicinity a few minutes before 12 on Wednesday night. Houses shook and trembled and there was a loud report as of heavy thunder. No damage has been reported. It was bright moonlight and calm at the time. It was likewise felt in Digby, Annapolis and Shelburne counties.

June 16.—A distinct shock occurred at Ottawa, and was recorded by the seismograph at 3^h 41^m 52^s p.m., the pulsations lasting 16 seconds. It was generally felt; windows rattled, and some heard a loud rumbling sound. On the Rossi-Forel scale the intensity would be designated by IV. It was felt over an area about 60 miles in diameter.

July 17.—Quite a distinct shock was felt at Arnprior at 2^h 10^m a.m. A great many citizens felt it. The quake was accompanied by a noise similar to that of a large building falling.

August 8.—Despatches from the up-river section of New Brunswick report earthquake shocks in several places this morning. At Hartland there were three shocks at 1, 4 and 7 a.m. Plaster fell from the ceiling in one building. In Fredericton and vicinity there was a shock felt about 7 o'clock. Thunder and lightning and very heavy rain were experienced during the night.

November 30.—An earthquake travelling apparently from north to south threw the inhabitants of the town of Skidegate, Queen Charlotte islands, into a state of nervous apprehension in the afternoon of November 30, according to news brought south by the fishing steamer *Celestial Empire,* which reached Vancouver yesterday morning (December 9) from the northern halibut banks. It was estimated that the shock lasted fully seven seconds. No other tremors were felt, greatly to the relief of the people of the town, who became somewhat alarmed on observing that two Indian shacks had been thrown to the ground. The buildings knocked down were old, half-tumbled-down affairs.

1909.

January 11.—Nearly all parts of southern British Columbia and Washington Territory, across the international boundary, were shaken by an earthquake at 3.45 p.m., Pacific standard time of January 11, the quake lasting from 10 to 20 seconds. No damage was done but the alarm was very great. Beyond the breaking of some crockery in a few homes in Victoria, there was little damage caused. Comox, Alberni, Pachena, Bamfield and other points report having felt the shock, Bamfield stating that two tremors were felt, while Estevan reports that no shock was experienced there. At Port Townsend, across the boundary line, in many places where water pipes lay in the frozen ground, the earthquake broke the pipes and flooded houses.

January 31-February 1.—Three distinct earthquake shocks were felt in Montreal last night. The first shock was felt at $11^h\ 30^m$ p.m., the second at $11^h\ 45^m$, and the third and most severe at $3^h\ 20^m$ a.m. People were awakened all over the city. The rattling of glassware and crockery was heard distinctly. A peculiar feature was the howling of dogs all over the city. Loud cracking as though houses were being severely strained was noticed everywhere. A number of houses are cracked as the result of the quakes, also some sidewalks.

February 3.—At about 4 a.m. quite a number of people in Montreal were aroused by an unusual sound and a slight sense of vibration, which lasted only a very short time and was not repeated. It was less severe than the preceding one of two days ago.

Examining the geological areas for the above places it is not difficult to understand that local shocks may occur there. The complexity of the formations; the differences in composition, in density, in elasticity; the many faults and dikes; the numerous surfaces of contact; the constant gravitational effect, all conspire towards the interruption of a continuous gradual adjustment of stresses and strains, so that at times these adjustments, though very minute, are abrupt and manifest themselves as local shocks. That these adjustments are very small is shown by the very small acceleration produced. Acceleration is the measure of intensity of an earthquake.

In the above local shocks there is only one, that for Ottawa, for which direct measures were obtained. We find from them that the acceleration produced was 2·4 millegals.

The unit of acceleration in the C. G. S system is called a 'gal', *i.e.*, the acceleration of 1cm per second, per second; hence for gravity at latitude 45° we have 980·60 gals. A millegal is the thousandth of a gal.

Small local shocks like the above may occur almost anywhere, at least in many localities over the southern part of Canada from Nova Scotia to British Columbia.

It may be remarked, however, that when we reach the Pacific coast we enter upon ground adapted to tectonic or the larger quakes. Vancouver island, Queen Charlotte islands and the smaller islands all lie in comparatively shallow water, but immediately to the west lies the deep trough of the Pacific, adapted for breeding seismic disturbances on a large scale.

MICROSEISMS.

In order to treat this subject as fully as the data and records here warrant, some of the matter published last year is here incorporated for the sake of completeness.

Under the designation microseisms, are included all pulsations not directly attributable to what are generally known as earthquakes, which give abrupt, more or less violent, and momentary movements of the earth's crust, the effect of which may, however, continue for some hours. Attempts have been made to classify these microseisms according to their cause, but so far without complete success. During the past year the writer has paid considerable attention to these disturbances, and in doing so has studied and compared the daily seismograms with our daily micro-barograms, our weekly aneroid barograms and also with the daily weather maps, which give the isobars at 8 a.m. for Canada and the United States, roughly between latitudes 25° and 55°, and the Atlantic and Pacific oceans. The micro-barogram exhibits particularly well very rapid fluctuations of pressure as manifested by local and often gusty winds, the counterpart of which is always represented on the seismogram by irregular movements and not by microseisms The average time of the beginning of the seismogram sheet is about 10 a.m., so that the above isobars and gradients dependent upon them are for a time preceding the former by two hours. From the examination of the local barogram alone not much information can be gathered as to the behaviour of the seismograph except when very rapid and marked fluctuations, say a millimetre or more, take place in the pressure, comparable with the 'pumping' of a mercurial barometer at sea. The barometer may show little or no change in pressure at a given place, yet areas of 'High' and 'Low' (barometer) may be rushing along to the north and south of it, setting up vibrations or pulsations of the earth's surface that may be markedly felt at a given place by the seismograph. Similarly from a large rise or fall of the barometer during 24 hours at a given place alone, we can draw no gradients to determine the atmospheric movements; the position of the isobars and 'Highs' and 'Lows' being unknown. We have simply the record of the vertical movement of pressure at one point. The isobars on the Weather Map are drawn at intervals of one-tenth inch difference of pressure. The normal to the isobars is called the gradient, and when spoken of, generally refers to the gradient between a 'High' and a 'Low' passing through Ottawa. An examination has been made during the year of the daily seismograms and the daily Weather Maps, including the isobars or position of 'Highs' or 'Lows' and the forecast for the Ottawa regions with reference to winds and storms. This examination furnishes the data upon which the conclusions depend. As the Observatory is not yet supplied with an anemometer and pressure gauge for comparison of the dynamical conditions, we are at present dependent upon the daily forecast.

It may be stated at the outset, before discussing the preceding data, that there is never a day in the year on which some trace of microseisms can not be seen on a seismogram from a Bosch photographic seismograph. It is all a matter of degree. That microseisms should be ever present is but natural, for the earth is in a continual state of stress and strain, many varied and different causes contributing thereto. The term microseisms as here used excludes any deviations of the vertical or movements of the zero position of the pendulum. Some writers have divided microseisms into 'earth tremors' or 'pulsations,' and 'earth pulsations' or 'pulsatory oscillations.' The writer, however, from the seismograms at this station sees no reason for this division, as it is not at all evident from them that the contributory causes, whatever they may be, manifest themselves in such a manner as clearly to differentiate themselves. Furthermore, from the examination of the seismograms the oscillations of the pendulum are excluded; on the one hand, from the frequent change of period on the same seismogram, which would be inadmissible for a pendulum, and on the other hand, if the pendulum were made to oscillate we should expect to see the damping effect in the decrease of amplitude, and a more or less sudden beginning, unless the oscillations of the earth particles themselves were of a period commensurable with that of the pendulum, which, of course, is sometimes the case. It is evident that a photographic registering apparatus with high magnification will record microseisms when a seismograph with mechanical registration will draw only a straight line.

Of the contributing causes to stresses and strains and manifesting themselves as microseisms, we may consider: secular cooling of the earth; unequal heating and the radiation during the day and night; statical effect of atmospheric pressure, areal or local; dynamical effect of atmospheric pressure, areal or local; precipitation, as rain or snow.

The vanishingly small effect of secular cooling, whatever its constants may be, becomes evident from the fact, that, although it is ever present, and its manifestations would be of a constant nature, the recorded microseisms are of the most fluctuating character both in time and magnitude, completely masking the effect of secular cooling. The daily alternations of unequal heating and radiation during the 24 hours are not shown by their effect on microseisms. The case of precipitation is similar in regard to microseisms to the preceding. It may be noted that the stresses set up over large areas, hundreds of miles in extent, by differential loading of rain, is small compared with that of barometric pressure. Taking an area, say of a thousand miles with a rainfall of an inch, which is a pretty heavy rain, and decreasingly distributed, we would have a maximum pressure of a little over one-thirtieth of a pound per square inch, and the rain-pressure diminishing to zero for the edge of the area. An average barometric gradient, on the other hand, over such an area would be several times as great, due to a differential atmospheric pressure equivalent to about three-tenths of an inch of the mercurial barometer. The rain-pressure may, however, make itself felt locally, as has been recorded at some stations. The result of a heavy rainfall soon fills the valleys and streams much beyond the direct precipation on them, so that this loading and bending of the surface may become a measurable quantity by an observing station in the neighbourhood. This effect is, however, one of tilting, of change of vertical or change of pendulum zero and not microseisms, the subject at the moment under discussion.

The effect of difference of atmospheric pressure and of change of atmospheric pressure may be manifested in two ways by the seismograph. We are here dealing with large areas, say 1,000 miles in extent, for local barometric conditions have little or nothing in common with microseisms. In the one case, considering the earth as having an elastic crust, the pier is tilted towards the area of greatest pressure, in consequence of which the pendulum will move in that direction, *i.e.*, its zero line will be displaced. Besides this effect of statical loading, there appears to be no doubt, based on the records here, that vibrations are set up by this statical loading, quite apart from the dynamical effect of change of pressure. In the other case, by change of pressure over a wide area vibrations are set up on the earth's surface, and these may be produced by two allied causes. The one of these is the passage of Highs' and 'Lows' over the surface, equivalent to the dragging of a weighted meniscus over the surface, and the other is the winds set up or resulting from the atmospheric gradient due to difference of pressure. The winds would operate more probably by frictional resistance along the surface of the earth rather than by impact or uneven surface or obstructions. In studying various phenomena collectively in an investigation for correlation, considerable restraint must be exercised not to draw conclusions as to cause and effect from a limited number of coincidences, for a conclusion once drawn is apt to become an obsession to the investigator, and he is more or less blinded to facts that do not fit his theory.

In examining the records of microseisms the first question that presents itself is whether the recorded motion is that of the ground or of the pendulum; in the first case the pendulum acts as a steady mass or point, while in the latter case it is set oscillating either by impulses from the ground or by an undulatory movement of the ground. Let us consider the case of microseismic record of the 'sawtooth' type, where we see regular and almost wholly uniform oscillations kept up for hours and longer. If in this case the pendulum actually oscillates it will do so with the period inherent to it. After receiving the first impulse or impact let us suppose it to oscillate. If no further impact were received the oscillations would soon die out and the amplitudes would decrease in the known ratio of the damping coefficient. When a second impulse is given the pendulum will continue its uniform swings, provided the time interval from the preceding impulse is that of the period of the pendulum or a multiple thereof. Were this not the case, interference would occur and would be shown on the record. But such interference is not present in the microseismic records referred to and we must conclude, even admitting that the diagram is a record of the oscillations of the pendulum, that it is in reality only a counterpart of the actual movements of the ground, that is, of horizontal to-and-fro motions of the earth particles. The pendulum can be kept swinging uniformly only by some force acting at intervals of the period of the pendulum. This may occur through the periodic oscillating movements of the earth particles; or the same effect may be produced by rythmic undulatory movements of the ground. Now, the period of microseisms recorded here lies usually between 5 and 6 seconds, which is also approximately the period of the two pendulums, and the period of the undulatory movements manifested in the 'principal portion' of tectonic earthquakes is 20 seconds or more, so that if we adopt the hypothesis that the microseismic motions are undulatory and not horizontal displacements, we have to explain a period only one-quarter of the general period of the earth's crust. The shorter period might perhaps be accounted for by the supposition that a thinner part of the crust of the earth is affected in the microseisms than is involved in the undulatory motion connected with macroseisms. As an analogy we may give the short period of the ripples in water from a breeze, and the much longer one of waves from a storm when a greater depth of water is involved in the motion.

This reasoning does not appear to furnish a conclusive reply to the question whether the microseisms are attributable to the horizontal or to the undulatory movements. However, the consideration of the simultaneous occurrence of microseisms, together with certain atmospheric or barometric conditions leads to the conclusion that microseisms are mostly attributable to horizontal displacements.

Having made daily comparisons with the seismograms, local barograms and weather maps, the following conclusions have been deduced:—It is believed that identical atmospheric conditions prevailing over different parts of the earth's surface will not necessarily produce similar microseisms, as these are affected by the elasticity of the particular area under consideration, also by the geological formation, the presence of well-marked dykes, faults, and by the proximity of large sheets of water or the ocean. One effect of the proximity of the ocean caused by barometric pressure is the change of the level of the water, quite apart from the tides, and this change through loading or unloading along the coast produces a displacement of the pendulum zero, referred to in another place. In the sea, then, we have the dual effect of the direct barometric pressure and the correlated one of displacement of the water, while on land we have only the former. Barometric gradients over the ocean necessarily produce a motion of the water, quite apart from that produced by the winds resulting from the gradients. However, the pressure effect on the ocean bottom remains constant, for any displacement of the water is exactly balanced by the change of atmospheric pressure. Different of course it is on land which suffers the change of barometric pressure.

The feature to strike one most in the above comparisons is that when marked microseisms are present we are almost certain to find that the daily weather map for the morning of the day of record gives for the following 24 hours an area of 'Low' about the Gulf of St. Lawrence. That is, the condition of 'Low' in the gulf precedes the record of marked microseisms. The greater part of the gulf is less than 150 fathoms deep. Through it runs a 'deep' from the mouth of the St. Lawrence (Matane) along the south of Anticosti, passing between Cape Breton and Newfoundland, reaching a depth of 250 fathoms before joining the Atlantic ocean. This deep is over the eastern part of the great St. Lawrence and Champlain Fault, shown on the geological maps, for nearly 700 miles. The waters about Nova Scotia and Newfoundland are all within the 150 fathom line, so that the 'Lows' over the gulf and Sable island are over waters, the greater part of which are less than 150 fathoms deep. The distance from Ottawa to the gulf is about 700 miles, direction east-north-east; and from Ottawa to the nearest broad waters of the Atlantic, off the state of Maine, 300 miles, direction east-south-east.

Next to the presence of a 'Low' in the gulf in importance as a phenomenon accompanying microseisms, we find the isobars which cut the valley of the St. Lawrence (in which lies the great fault) at right angles, so that the gradient is along the St. Lawrence valley, or in general parallel to the Atlantic coast, and to the line of the Alleghany mountains.

Furthermore, it is found that if a 'High' prevails along the south Atlantic coast, northward from Florida the microseisms are intensified.

The passing of 'Highs' and 'Lows' across the coast-line, *i.e.*, from land to water, is not found to be marked by the occurrence of microseisms. As the whole atmospheric movement is, for Canada and the United States, from west to east, it is uncommon for a 'High' or 'Low' to cross the coast-line *from* the Atlantic *to* the continent.

It appears that the reversal of the position of 'Low' and 'High' with reference to the gulf for the former is not so closely associated with the subsequent appearance of microseisms as obtains in the case first stated.

When there is a persistence of 'Low' in the gulf and 'High' on the Atlantic coast to the south as indicated, the microseisms set up in the first instance become intensified in amplitude, so that the maximum microseisms are not necessarily coincident with the greatest difference of pressure, or the steepest gradients. It appears that the difference of barometric pressure is in the first instance responsible for the microseisms, and when favourable conditions continue the microseisms will increase in amplitude, although the pressure difference may have decreased. Furthermore, another condition is that the line of 'High'-'Low' preserves its direction along the St. Lawrence valley.

When a 'Low' with even very steep gradients is to the west, say over the lakes, and 'High' on the lower St. Lawrence or gulf, microseisms are generally weak or even absent altogether, although there are exceptions. This is not the case when the 'Low' is to the east, especially when over the gulf. When the 'Low' with steep gradients moves up to Lake Erie by 8 a.m. of the day of the seismogram we may expect to see the beginning of marked microseisms, which increase as the 'Low' moves down the St. Lawrence towards the gulf. From the immediately preceding it is seen that the microseisms give no indication of the approach of a 'Low' or storm centre, but on the contrary, are the result of the passage of a 'Low' and especially of its presence in the gulf. Some investigators believe the microseisms may be the forerunner of coming weather conditions, and hope that this may assist in making forecasts. The seismograms examined here are not very encouraging on that point, the microseisms indicating rather 'that we have had weather, than that we are going to have weather.'

The preceding remarks refer to the microseisms and not to the effect of bending or displacement of the pendulum zero, brought about by unequal pressure over a large area. The writer is not as yet prepared to say whether the approach of a 'Low,' with the consequent lifting or rising of the earth's surface, is a distinctly measurable quantity as registered by our seismograph, for the measurements of the two components of the change of pendulum zero for the year have not yet been tabulated and critically compared with the movements of 'Highs' and 'Lows' in the eastern part of the continent.

By far the large majority of microseisms show themselves by a serrated record, 'sawtooth' type. as I designate them; more rarely are they of the 'spindle' type, where the oscillations or rather the amplitudes rise and fall, increase and decrease, with certain cadence, as in the vibrations of a string between two fixed points. The interval between the maximum amplitudes is very variable, varying from one to several minutes. The rate of increase and decrease of the amplitudes is less than that produced by the damping of the pendulum, so that we can scarcely attribute it to the latter on the supposition that the pendulum itself is set in motion and the oscillation dies down by damping, to be renewed by a fresh impulse. This, however, would preclude a gentle increase; instead there should be a more or less abrupt beginning, which is not the case. Intermittent rhythmic vibrations of the ground, nearly synchronizing with the period of the pendulum, setting the pendulum in motion could produce the phenomenon.

The validity of a supposed relationship between different phenomena, as cause and effect, is tested by predicting the effect when given the cause. This has been done with reference to the existence of a 'Low' in the gulf and a 'High' over the Atlantic coast to the south, or in general by taking the daily weather map with its isobars and from it predicting the resulting microseisms. The result has so far been satisfactory that in the large majority of cases the microseisms have fairly well answered in presence and magnitude the prediction. There are, however, still important out-standing differences that require further explanation. Just why the 'Low' about the gulf should have such an influence in the production of microseisms is by no means apparent. The two main physical features are the shallow gulf and the St. Lawrence valley in which lies the great St. Lawrence and Champlain Fault, 700 miles long, already referred to. Also there is the generally parallel trend of the Atlantic coast, and that of the Alleghany mountains.

On frequent occasions there is a 'Low' over the gulf, another 'Low' over Arkansas, while one 'High' rests north of Lake Superior and another over Bermuda. When these conditions obtain with steep gradients we are pretty sure to have marked microseisms. The line joining the 'Lows,' then, lies in the St. Lawrence valley, while that of the 'Highs' is at right angles to the former. In this case the maximum strain is along the valley of the St. Lawrence, along the Great Fault, so that from *a priori* reasoning marked microseisms might be expected.

In concluding the present investigation of the well-marked microseisms recorded here, we will repeat, that the presence of a 'Low' over the gulf surrounded by steep or fairly steep gradients on a given morning is indicative of more or less well-marked microseisms following at Ottawa that day.

It has already been stated that the large majority of microseisms have a period of about 5^s with small fluctuations. The cause of the fluctuations is by no means apparent unless it be the varying depth of the earth's surface involved.

On some occasions the period changes to one of about one-half, or about 3^s, showing, however, a transition time during which there is an irregularity and interference, so that their period is unrecognizable. At present no explanation can be offered for this change. When the period is so short, the amplitudes are very minute, although visible on the sheet to the naked eye.

It is found that, broadly speaking, the microseisms are more numerous during the colder season than during the warmer one, and some have sought therein a relationship of cause and effect. In our climate here we have a large range of temperature, during the year 1907-1908, of 127°F. (96° and − 31°F.). During February, when the thermometer reached its lowest and we had some continuously very cold weather, the seismograph showed no evidence thereof. More frequent microseisms might be expected during winter from the fact that the frozen ground better transmits pulsations, and that the act of freezing itself sets up stresses and consequent oscillations. From extreme cold it does not necessarily follow that the ground is frozen to any great depth. During the past winter there was very little frost in the ground, because an early and heavy snowfall, subsequently accumulating to many feet, covered the earth with a mantle that cold could not penetrate.

From examination it is found that the strongest and most numerous microseisms were recorded during the months of January and February last (1909), while during the period September, 1907, to April, 1908, October had the strongest, and the fewest and weakest were during the summer months of July and August, when the atmospheric barometric gradients were very long.

We are led to conclude that strong winds have little effect in causing microseisms by setting up pulsations over large areas of the earth's surface or crust, *i.e.*, the dynamical effect by friction or impact is not the governing factor in the production of microseisms. We are dealing here with the larger effect of strong winds upon large areas and not the local effect upon buildings, which, as is well known, are set in oscillation, and these in turn are communicated to the ground. When the building within which the seismograph is housed is large, the oscillations of the former will be recorded.

When we compare the occurrence of microseisms with the predicted strong winds of the daily forecasts, we find little or no connection between the two phenomena. Considering the two phenomena as independent events, we see that the probability of the simultaneous occurrence of the two events is as great as the actual happening, *i.e.*, as far as the observations go there is very little to show any causal relationship between the two.

On the other hand we do find that the winds recorded here by the micro-barograph invariably show themselves on the seismograms, not by microseisms, but by irregular movements, including deviations of the zero line. Microseisms and these latter movements can never be mistaken for earthquake records.

Record of Microseisms for the period January 1, 1908, to March 31, 1909. Two Bosch photographic seismographs, mounted N.-S., E.-W. Magnification, 120. Sheet put on each day at about 10. a.m. Standard Time = 15^h G.M.T.

Date.	N-S. Comp.		E-W. Comp.		Remarks.
	Period.	Max. Amp.	Period.	Max. Amp.	
1908.	s.	μ	s.	μ	——
Jan. 1	5·7	8	5·8	8	Decreasing towards following morning.
" 2					Almost wholly quiescent.
" 3					Almost quiescent.
" 4					" "
" 5	5·5	7	5·4	8	Increase gradually, reach a maximum about midnight, then decrease.
" 6	5·5	4	5·5	4	
" 7	5·5	4	5·5	4	Maximum about 8 a. m., Jan. 8.
" 8	5·5	4	5·5	4	
" 9	5·5	4	5·5	4	
" 10	5·6		5·6		Small.
" 11	5·5	2	5·5	2	
" 12	5·5	4	5·5	4	
" 13	5·5	3	5·5	4	
" 14	5·5	4	5·1	4	Increase about midnight.
" 15					Present but weak.
" 16					Slight microseisms scattered throughout.
" 17		2		2	
" 18					Scarcely any.
" 19					" "
" 20	5·5	2	5·5	2	
" 21	5·5	2	5·5	2	
" 22	3·0				
" 23	5·3	4	5·5	4	
" 24	5·5	7	5·5	7	Two hours at beginning and end of sheet weakest.
" 25	5·5		5·7		Decreasing.
" 26					Small, of usual saw-tooth type, not so well expressed by N-S component.
" 27	5·5	4	5·5	4	
" 28					Present throughout.
" 29					" "
" 30		2		2	
" 31					Slight throughout.
Feb. 1		6		6	Earthquake occurs, microseisms after quake.
" 2	5·7	6	6·3	6	
" 3					Not so strong as yesterday.
" 4					Scarcely any.
" 5					Weak.
" 6					"
" 7	5·5	2	6·0	2	
" 8					Small.
" 9					Very slight.
" 10					Scarcely any.
" 11					" "
" 12					Very few and weak.
" 13					Small and fairly evenly distributed.
" 14					Very few.
" 15	5·4	3	6·3	4	
" 16	5·3	3	6·6	5	
" 17	5·5	3	6·3	3	
" 18					Scarcely any.

RECORD of Microseisms for the period January 1, 1908, to March 31, 1909. Two Bosch photographic seismographs, mounted N.-S., E.-W. Magnification, 120. Sheet put on each day at about 10 a.m. Standard Time = 15ʰ G.M.T.—*Con.*

Date.	N-S Comp.		E-W. Comp.		Remarks.
	Period.	Max. Amp.	Period.	Max. Amp.	
1908.	s.	μ	s.	μ	
Feb. 19					Very minute, increase after 3 a. m.
" 20	5·7		6·4	4	Fairly strong by E-W component.
" 21	6·0		6·8	6	
" 22	6·0	3	6·5	4	
" 23					Very weak.
" 24					Weak.
" 25					Practically quiescent.
" 26					Very minute.
" 27					Small.
" 28					Very weak.
" 29					Slight traces.
March 1					" "
" 2					Very slight traces.
" 3	3·0		3·0		Very weak.
" 4					Apparently quiescent.
" 5					Almost perfectly quiescent.
" 6	5·5	3	6·0	5	Decrease after 6 p.m.
" 7					Very slight.
" 8					" "
" 9					Almost quiescent till about 3 a.m., when micros- set in, reading 3μ.
" 10	5·7	1	6·9	4	
" 11		1		2	
" 12		1		1	
" 13					Very slight.
" 14					" "
" 15					" "
" 16					Practically quiescent.
" 17					Quiescent.
" 18					Very minute.
" 19					" "
" 20					Minute.
" 21	5·7	2	6·3	2	Small.
" 22					Very slight.
" 23					" "
" 24					Small.
" 25		4		4	Decrease after 7 p.m.
" 26					Small. Continue between the two earthquake records of Chilapa, Mexico.
" 27					Very minute.
" 28		2		2	Minute.
" 29					"
" 30	4·0	2			
" 31				3	Strongest during night.
April 1	4·6	4	4·8	2	Increase after 6 p.m.
" 2					Less strong.
" 3	5·2	5	5·0	5	
" 4	5·7	6	7·5	6	
" 5		3		3	Gradually decreasing.
" 6					Minute.
" 7					Very minute.
" 8					Minute.
" 9	3–5	2	3–5	2	
" 10	5·2	4	6·3	2	
" 11	5·5	4	5·0	3	
" 12	5·7	6	6·2	4	
" 13	5·7	7	6·0	5	
" 14	5·3	4	6·0	3	Decreasing.
" 15	5·3		7·5		By following morning period for both 3ˢ.7.
" 16	4·2	3	4·1	2	Decrease.
" 17	5·5	4	5·5	4	
" 18	6·0	4	7·3	5	

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Record of Microseisms for the period January 1, 1908, to March 31, 1909. Two Bosch photographic seismographs, mounted N.-S., E.-W. Magnification, 120. Sheet put on each day at about 10 am. Standard Time = 15^h G.M.T.—*Con.*

Date.	N.-S. Comp. Period.	N.-S. Comp. Max. Amp.	E.-W. Comp. Period.	E.-W. Comp. Max. Amp.	Remarks.
1908.	s.	μ	s.	μ	
Apr. 19					Minute, increase after 6 a.m.
" 20		4		3	
" 21	5·3	4	5·4	3	
" 22	5·2	3	5·7	2	
" 23	5·5		5·5		Very minute, and decreasing.
" 24	5·0	2	5·0	2	Quiescent after noon.
" 25					Almost quiescent.
" 26		1		1	Small.
" 27		2		2	Stronger after 6 a. m.
" 28	6·3	4	7·5	5	
" 29	6·6	5	7·5	6	
" 30		2		3	
May 1		2		2	
" 2	5·3	3	6·0	2	
" 3	5·3	5	6·3	4	
" 4		5		4	Strongest during night.
" 5	5·7	6	6·0	5	Decrease after 1 a. m.
" 6	5·5	2	6·0	2	
" 7	5·5	3	6·0	2	
" 8	4·3		5·0		Minute.
" 9	5·5	3	6·0	2	
" 10	5·5	4	5·7	3	
" 11		2		1	Decreasing.
" 12	3–5	1	7·0	4	
" 13	4·0				Very minute.
" 14	4·3				"
" 15					"
" 16	5·2	1			Very small.
" 17					Almost quiescent.
" 18					" "
" 19					" "
" 20					" "
" 21					Almost wholly quiescent.
" 22					Practically quiescent.
" 23			7·0		Almost quiescent.
" 24					Quiescent.
" 25					Almost quiescent.
" 26					Quiescent.
" 27					Slight traces.
" 28					Quiescent.
" 29	2·7		4·6		Very minute.
" 30	2·7		4·3		"
" 31					Apparently quiescent, but shows very minute and rapid oscillations
June 1					" " "
" 2					Practically quiescent.
" 3			7·0	2	
" 4					Very small.
" 5					Practically quiescent.
" 6					" "
" 7					Faintest traces.
" 8					"
" 9					"
" 10					Practically quiescent.
" 11					Perfectly quiescent.
" 12					Quiescent.
" 13					Practically quiescent.
" 14					Quiescent.
" 15					Small, scattered.
" 16					Small.
" 17					Very minute.
" 18	5·5	1			Decrease after midnight.

RECORD of Microseisms for the period January 1, 1908, to March 31, 1909. Two Bosch photographic seismographs, mounted N.-S., E.-W. Magnification, 120. Sheet put on each day at about 10 a.m. Standard Time = 15^h G.M.T.—*Con.*

Date.	N-S. Comp.		E-W. Comp.		Remarks.
	Period.	Max. Amp.	Period.	Max. Amp.	
1908.	s.	μ	s.	μ	
June 19					Small.
" 20					Nearly quiescent.
" 21					Very minute.
" 22					A few very minute shown by N-S component.
" 23					A few scattered shown by N-S component.
" 24	4·4	1			Strongest about 4 p. m.
" 25					Practically quiescent.
" 26					" "
" 27					" "
" 28					Practically quiescent.
" 29					" "
" 30					Very minute by N-S component.
July 1					Practically quiescent.
" 2					" "
" 3					Quiescent.
" 4					"
" 5					Minute.
" 6					Quiescent.
" 7					Almost quiescent, some minute between 2 and 4 a.m. (July 8).
" 8					Quiescent.
" 9					Very minute, mostly shown by N-S component.
" 10					Practically quiescent.
" 11					Quiescent.
" 12					"
" 13					"
" 14					"
" 15					"
" 16					" , a few very minute.
" 17					Very minute throughout, more distinct by N-S component.
" 18					Very minute.
" 19					Practically quiescent.
" 20					Quiescent.
" 21					"
" 22					"
" 23					"
" 24					"
" 25					" until about 8 a. m. (July 26) when minute micros. appear and increase.
" 26	5·2	4	5·2	4	First typical "sawtooth" micros. for months. Strongest between 9 p.m. and 3 a.m. Period N-S component pendulum $6^s.1$, E-W component pendulum $10^s·1$.
" 27	5·5	3	6·0	3	Decrease, disappear after 12 p.m.
" 28					Practically quiescent.
" 29					Quiescent.
" 30		1		1	Very minute.
" 31					Almost quiescent.
Aug. 1	5·0	4	5·0	4	Low moving up Atlantic coast from Hatteras.
" 2	5·0	4	5·0	4	Little stronger than yesterday. Maximum about midnight.
" 3	5·0	3	5·0	3	
" 4		2		2	
" 5					Practically quiescent.
" 6					Quiescent.
" 7					"
" 8					"
" 9		1		1	Very minute.
" 10					"
" 11					" , shown best by N-S. component.

RECORD of Microseisms for the period January 1, 1908, to March 31, 1909. Two Bosch photographic seismographs, mounted N.-S., E.-W. Magnification, 120. Sheet put on each day at about 10 a.m. Standard Time = 15ʰ G.M.T.—*Con.*

Date.	N-S. Comp. Period.	N-S. Comp. Max. Amp.	E-W Comp. Period.	E-W Comp. Max. Amp.	Remarks.
1908.	s.	μ	s.	μ	
Aug. 12					Practically quiescent.
" 13					Quiescent.
" 14					"
" 15		1		1	
" 16		1		1	Not continuous.
" 17					Almost quiescent.
" 18	4·5				Very minute.
" 19					"
" 20		1		1	
" 21		2		2	
" 22		2		2	Strongest in forenoon.
" 23		2		2	" about 3 a.m. (Aug. 24).
" 24					Very small.
" 25					Minute.
" 26	3·7	1	3·7	1	Quiescent till about 2 a.m. (Aug. 27), then small, Low moving up Atlantic coast from Hatteras.
" 27	5 1	5	5·1	4	Decrease after 8 p.m.
" 28	5 0	1	5·0	1	
" 29					Very minute, and decrease.
" 30					Practically quiescent.
" 31					" "
Sep. 1					Almost quiescent.
" 2	3·8	1	3·8	1	Minute.
" 3	5·0		5·0		A little stronger than yesterday.
" 4					Practically quiescent.
" 5					" "
" 6					Practically quiescent, save for fluctuations, not micros. caused by gusty wind.
" 7	5·5	2	6·0	1	
" 8	5·0		5·0		
" 9	5·0	1	5·0	1	Decreasing after midnight.
" 10	5 0	1	5·0	1	
" 11	5·0		5·0		Very small.
" 12	6·0	1	7·5	2	Towards evening micros. appear, increase to midnight, then decrease.
" 13					Minute.
" 14	4·7	1	4·9	1	Minute, increase.
" 15	5·5	2	5·5	2	
" 16	5·6	3	6·4	4	Maximum about 10 p.m.
" 17	4–5	2	5–8	3	
" 18	5·7	3	6·3	4	
" 19	5·9	4	6·6	5	
" 20	4 7	3	5·5	4	
" 21	5·4	2	6·8	3	
" 22	6·1	1	6·8	2	
" 23	5·0	1	5·7	1	
" 24			7·5	1	Almost wholly quiescent, here and there micros.
" 25			7·0	1	
" 26	5–6	1	7·5	1	
" 27	5·5		5·7		Small; N-S component the stronger, being reverse of what it has been lately.
" 28	5·5	1	5·7	1	
" 29	5 0	2	5·0	1	
" 30	5·1	2	6·2	1	
Oct. 1	5·3	1	5·1	1	
" 2	4 0	1	4–10	3	After 1 a.m. (Oct. 3) periods lengthen, and intensity increases.
" 3	4·5	4	7·5 4 7	4	Increase after 9 p.m. Period of E-W component becomes shorter.
" 4	5 3	3	5·5	2	Decreasing.
" 5	5·4	2	5·5	1	
" 6					Minute.

RECORD of Microseisms for the period January 1, 1908, to March 31, 1909. Two Bosch photographic seismographs, mounted N.-S., E.-W. Magnification, 120. Sheet put on each day at about 10 a.m. Standard Time = 15[h] G.M.T.—*Con.*

Date.	N-S. Comp. Period.	N-S. Comp. Max. Amp.	E-W. Comp. Period.	E-W. Comp. Max. Amp.	Remarks.
1908.	s.	μ	s.	μ	
Oct. 7	4·9	1	4·9	1	
" 8	4·8	2	5·1	2	Strongest about 8 p.m.
" 9	5·2	2	5·4	2	Strongest about midnight.
" 10	5·3	2	5·8	2	Strongest between 8 p.m. and 2 a.m.
" 11	4·6	....	5·0	....	Very small, better expressed by N-S component.
" 12	.....	....	.....	.....	Small and well marked.
" 13	5·3	2	5·2	2	
" 14	5·6	3	5·7	3	Strongest about 9 p.m.
" 15	5·2	1	6·8	1	Almost disappear by following morning.
" 16	.....	....	.....	....	Almost quiescent.
" 17	6·4	1	6·7	2	Almost quiescent till about 9 p.m. then become pretty well marked.
" 18	6·5	1	7·0	1	
" 19	.....	.....	....	.....	Very minute.
" 20	4·9	1	6·7	1	Almost quiescent.
" 21	6·0	3	6·6	4	Minute till 9 p.m., then increase.
" 22	6·3	3	6·8	5	Decrease after 8 p.m.
" 23	5·1	1	7·8	1	
" 24	5·1	2	6·9	2	
" 25	5·4	2	5·5	2	
" 26	5·3	1	5·6	1	Decrease after 2 a.m., (Oct. 27).
" 27	5·4	1	6·1	1	
" 28	5·1	1	6·0	1	Scattered throughout, not continuous.
" 29	4·6	4	4·3	3	Increase after 2 a.m., (Oct. 30).
" 30	4·7	3	4·5	2	
" 31	5·4	6	5·4	3	Begin small. After 5 a.m., (Nov. 1st), become very marked.
Nov. 1	5·6	6	5·8	4	"Sawtooth" type, very few of spindle form.
" 2	5·5	4	5·4	3	
" 3	5·4	5	5·8	3	
" 4	5·4	4	5·5	2	
" 5	5·0	4	4·9	2	Strongest during the night.
" 6	5·8	10	6·6	6	
" 7	5·8	6	5·9	4	
" 8	5·7	3	5·8	2	
" 9	5·3	2	5·3	1	
" 10	5·0	1	5·9	1	
" 11	4·8	1	6·9	1	
" 12	4·9	5	5·4	3	Fairly quiescent till midnight, when micros set in and increase in intensity.
" 13	5·2	5	5·7	4	
" 14	5·4	2	5·8	2	After 2 a.m., period changes markedly by decreasing to 4[s].
" 15	4·8	2	4·6	2	
" 16	4·8	3	5·3	2	
" 17	4·5	1	5·5	1	
" 18	4·8	4	5·0	3	Increase after 7 p.m.
" 19	4·3	4	4·4	3	Maximum about 7 p.m.
" 20	5·0	2	8·3	1	
" 21	5·0	2	5·0	1	
" 22	4·0	2	4·0	1	
" 23	......	.....	.....	......	Scarcely a trace.
" 24	5·0	1	....	....	Almost quiescent.
" 25	5·0	1	......	....	"
" 26	5·7	1	7·0	1	
" 27	5·2	2	7·2	1	
" 28	5·0	3	5·0	2	
" 29	5·6	3	5·6	2	Decrease.
" 30	5·2	2	5·3	1	
Dec. 1	....	......	....	....	Very windy, shown by irregularity of zero line. New steel point for E-W component.
" 2	5·1	3	4·5	3	Begin small, become well-marked by following morning.

RECORD of Microseisms for the period January 1, 1908, to March 31, 1909. Two Bosch photographic seismographs, mounted N.-S., E.-W. Magnification, 120. Sheet put on each day at about 10 a.m. Standard Time = 15^h G.M.T.—*Con.*

Date.	N-S. Comp. Period.	N-S. Comp. Max. Amp.	E-W. Comp. Period.	E-W. Comp. Max. Amp.	Remarks.
1908.	s.	μ	s.	μ	
Dec. 3	5·4	3	4·3	4	
" 4	5 1	2	4·5	2	
" 5	5·1	3	4·5	5	Begin small.
" 6	5·1	4	4·5	6	
" 7	5·1	3	4 3	8	
" 8	5·2	5	4·6	9	
" 9	5·1	3	4·3	4	
" 10	5·3	3	4·6	4	
" 11	5·8	3	4·5	4	Strongest about 7 p.m.
" 12	5·6	4	4·6	5	
" 13	5·5	5	4 4	5	
" 14	5·3	3	4 6	5	
" 15	5·6	4	4 7	4	
" 16	5·3	3	4·6	4	
" 17	5·3	3	4 5	5	
" 18	5·1	3	4 4	5	
" 19	5·2	3	6·5	6	
" 20	6·2	2	6·6	5	
" 21	4·9	1	6·6	2	
" 22	5·1	1	5·6	4	
" 23	5·5	4	6·6	7	
" 24	5·6	2	6·3	4	
" 25	5·6	1	6·3	3	
" 26	5·5	4	6·8	7	Strongest between 5 and 12 p.m.
" 27	5·4	4	6 1	7	
" 28	5·6	4	6·2	5	No difference of micros. before and after the earthquake (Messina).
" 29	4 3	2	4·7	4	
" 30	5·4	1	6·4	2	
" 31	....	....	....	....	Small to minute.
1909.					
Jan. 1	5·5	2	5·9	3	
" 2	5·1	1	5·8	2	
" 3	5·0	1	5 4	1	Almost quiescent.
" 4	5·0	1	6·3	1	" "
" 5	5·3	1	6·5	2	
" 6	5·3	2	6·0	3	Increasing.
" 7	4 9	2	6·6	4	
" 8	4 9	–	6 4	1	Almost quiescent.
" 9	....	....	....	....	" perfectly quiescent.
" 10	5 3	1	6·5	2	
" 11	5·0	1	6·5	2	
" 12	5-3	1	8·6	2	
" 13	5·1	1	6 6	2	
" 14	5·4	....	6 6	..	Almost perfectly quiescent.
" 15	4·7	1	5·7	2	
" 16	5·3	2	6·7	5	
" 17	....	....	7·0	5	Wind effect shown by irregularities of zero line. N-S component off.
" 18	..	....	6·6	8	Maximum between 5 and 9 a.m. (January 19). N-S component off.
" 19	6·0	7	6·4	12	Strongest in a long time.
" 20	5·9	4	6·9	7	
" 21	5·4	2	6 0	3	Almost cease after 5 p.m.
" 22	5·8	1	6·7	1	Fairly quiescent.
" 23	5·7	1	5·9	1	Scattered, not continuous.
" 24	6·0	2	6·1	2	
" 25	6·0	1	6 0	1	Wind makes zero line irregular.
" 26	4-5	3	4 5	3	
" 27	5·6	5	6·5	6	

RECORD of Microseisms for the period January 1, 1908, to March 31, 1909. Two Bosch photographic seismographs, mounted N.-S., E.-W. Magnification, 120. Sheet put on each day at about 10 a.m. Standard Time = 15h G.M.T.—*Con.*

Date.	N-S. Comp. Period.	N-S. Comp. Max. Amp.	E-W. Comp. Period.	E-W. Comp. Max. Amp.	Remarks.
1909.	s.	μ	s.	μ	
Jan. 28	5·8	5	6·8	7	
" 29	6·6	5	6·8	8	
" 30	6·0	5	6·7	6	
" 31	5·3	2	6·6	3	
Feb. 1	5·5	2	6·4	4	
" 2	5·4	1	6·2	2	Decreasing.
" 3	5·2	1	5·8	1	Almost quiescent.
" 4	5·2	1	5·2	1	" "
" 5	5·2	1	5·4	1	Minute.
" 6	3–5	1	4–6	1	
" 7	5·1	2	5·1	2	
" 8	5·4	5	5·6	5	Decrease after 8 p.m.
" 9	5·5	6	6·2	8	Increasing.
" 10	......	......	......	......	No light.
" 11	5·7	2	6·7	2	Small.
" 12	5·4	1	5·9	1	
" 13	4–5	1	4–5	1	Minute.
" 14	4–5	1	4–5	1	Very small.
" 15	6·2	1	6·8	2	Decreasing.
" 16	3·7	1	3·7	1	Periods decrease after 7 p. m.
" 17	4·4	2	6·6	2	
" 18	5·4	2	6·5	3	Begin small, but increase, particularly after 5 a. m. (Feb. 19).
" 19	5·9	3	6·8	5	
" 20	5·1	2	6·4	3	
" 21	5·7	2	6·4	4	In general not as strong as yesterday.
" 22	5·7	2	6·2	3	
" 23	5·6	1	6·2	1	Small.
" 24	5·3	1	6·2	1	Wind effect shown by irregularity of zero line.
" 25	5·6	5	6·3	6	Wind effect shown by irregularity of zero line. After 4 30 p. m., micros. well-marked.
" 26	5·8	5	6·7	7	
" 27	6·1	4	6·9	8	Decrease after 6 p. m.
" 28	5·6	2	6·3	3	Decreasing.
March 1	5·3	1	5·9	2	
" 2	5·5	1	6·5	2	
" 3	4·8	6	4·6	4	Small but after 5 a. m. (March 4) strong set in.
" 4	4·9	4	5·0	3	
" 5	5·4	4	5·7	4	
" 6	5·4	2	6·2	2	Gradual decrease.
" 7	5·8	2	6·4	4	" increase.
" 8	5·7	3	6·3	6	
" 9	5·8	2	6·3	4	Decrease to small and minute.
" 10	5·3	1	5·5	1	
" 11	5·2	1	5·8	1	Wind effect shown as heretofore.
" 12	5·6	1	6·0	1	
" 13	5·3	1	6·2	1	
" 14	5·2	1	6·4	1	
" 15	5·2	1	6·4	1	
" 16	5·4	2	6·1	2	
" 17	5·7	2	6·4	3	
" 18	5·5	3	6·6	5	Increases to well marked.
" 19	5·8	3	6·5	5	Maximum between 8 & 12 p. m.
" 20	5·9	4	7·0	6	Decreasing.
" 21	5·7	3	6·7	4	
" 22	5·8	3	6·6	5	
" 23	5·5	3	6·8	4	Strongest between 6 & 9 p. m.
" 24	5·3	2	6·4	2	
" 25	5·3	1	5·8	1	Snow storm shows irregularity of zero line.
" 26	5·4	2	6·6	3	
" 27	5·5	3	6·5	4	
" 28	5·4	3	6·5	3	
" 29	5·2	3	6·2	3	
" 30	5·3	2	6·2	2	
" 31	5·4	1	6·4	1	

A table was compiled for the official year April 1, 1908, to April 1, 1909, in which were given day by day for every twelve hours, 8 a.m. and 8 p.m eastern standard time, the position and pressure of the Low, as shown by the charts of the 'Tracks of Centres of Low Areas' published in the United States Monthly Weather Review. In an adjoining column was entered the occurrence and intensity of microseisms on the respective date. The object was to determine if possible the relationship between the existing Low at any particular time and place with the prevailing microseisms at Ottawa. Unfortunately for the purpose in hand the published track of Lows ends generally at the gulf, sometimes near its west coast, and less frequently in Newfoundland, so that the presence of a Low immediately east of the gulf, and which probably is the cause of many of the microseisms, is not noted, with the result that the Low in the west with which the microseisms are bracketed, being the only Low on the chart, is asked, so to speak, to account for the microseisms, when in reality they have nothing to do with it, but are due to the uncharted Low of the vicinity of the gulf or Newfoundland. The comparison between Lows and microseisms as above was consequently very misleading. It resulted in frequently having strong microseisms associated with a Low in the gulf, which is generally the case, but the next day the microseisms would probably persist, while the Low moved eastward beyond the sphere of the chart, yet they would in the table appear opposite to a Low far in the west, with which it could not possibly be related. I have therefore omitted this tabulation.

The following table has been compiled from the charts 'Tracks of centres of Low Areas,' published in the Washington 'Monthly Weather Review.' The object was to see whether the dynamical effect of the daily movement of the Lows across the continent was manifested by microseisms, that is, whether the apparent velocity of translation of the Low produced microseisms, and whether the intensity of the latter was a function of the velocity. The consideration here is independent of the steepness of gradients accompanying a Low. We may have a Low persistent or stationary for some time and this would hence not belong to the above investigation. That same Low may however be surrounded by steep gradients, which, in turn, as shown elsewhere, will be conducive to the appearance of microseisms. The rapidity with which a Low travels across the continent, from west to east, is quite independent of the gradients or isobars that accompany it. In the table, the first column gives the number of the Low for the respective month; the next column headed 'Beginning' gives the day of the month, forenoon—a—(at 8 a.m.) or afternoon—p—(8 p.m.) with barometer reading, when the Low began its course; the third column 'Ending' gives the date, forenoon or afternoon, with pressure when the Low ended or rather left the continent. The fourth column, 'Duration,' is the difference between the second and third, expressed in days. The fifth column, 'Distance,' gives the length of the track or path followed by the Low, and was obtained by following on the map with a graduated measuring wheel, adapted for the purpose, the path of the Low from beginning to end across the continent. The odd miles in the distances must not be taken too seriously, they simply show the multiplication of a constant factor by the revolutions and part of a revolution of the wheel measuring the track. The sixth column which gives the division of 'Distance' by 'Duration,' expresses the apparent average daily velocity of the Low across the continent. Finally, the last column shows where the Low was lost to observation or ended as far as the continent is concerned. 'Gulf' refers to the waters and surroundings of the Gulf of St. Lawrence, while 'Atlantic' refers to the ocean along the continent from Maine to Florida. 'Interior' indicates that either the Low disappeared as such in the interior, or was lost to observation in northeastern Canada:—

APRIL, 1908.

No.	Beginning.		Ending.		Duration	Distance.	Apparent average daily velocity.	Disappearance.
		in.		in.	days.	miles.	miles.	
I	1a	29.70	3a	29.04	2.0	1,700	850	Gulf.
II	3a	29.32	6a	29.64	3.0	2,480	827	"
III	6p	29 56	9a	29.18	2.5	2,340	936	"
IV	8p	29 60	12a	28.88	3.5	2,340	668	"
V	13a	29 64	16a	29.58	3.0	2,560	853	"
VI	15p	29.68	19p	29 14	4 0	3,024	756	"
VII	17a	29 44	19p	29.14	2.5	2,832	1,133	"
VIII	20p	29 58	29a	29.72	8 5	4,576	538	"
IX	21p	29.46	29a	29.72	7.5	4,016	535	"
X	21p	29.90	23p	29.78	2.0	896	448	Atlantic.
XI	25p	29.42	29a	29.72	3.5	2,128	608	Gulf.
XII	25p	29.36	29a	29.72	3.5	2,048	586	"
XIII	27p	29.70	30p	29.24	3.0	2,704	901	Atlantic.
						Mean ..	742	

MAY, 1908.

No.	Beginning.		Ending.		Duration	Distance.	Apparent average daily velocity.	Disappearance.
I	1a	29.08	1p	29 40	0.5	160	320	Gulf.
II	1a	29.64	3a	29.36	2.0	1,168	584	"
III	2a	29.35	10a	29.32	8.0	3,536	442	"
IV	6p	29.54	9a	29.80	2.5	656	262	Interior.
V	7a	29.60	8p	29.60	1.5	976	651	Gulf.
VI	8a	29.53	13a	29.62	5.0	3,840	768	"
VII	9p	29.66	13a	29.62	3.5	2,784	795	"
VIII	11a	29.64	18a	29.92	7.0	3,376	482	"
IX	14p	29.66	20p	29.76	6.0	2,960	493	Atlantic.
X	18a	29.46	19a	29.58	1.0	880	880	Interior.
XI	19a	29.56	24a	29·98	5.0	3,264	653	Gulf.
XII	23p	29.64	25a	29.74	1 5	928	619	Interior.
XIII	24a	29.92	31a	29.44	7.0	2,128	304	Gulf.
XIV	24p	29.58	27a	29 64	2.5	2,144	858	"
XV	25a	29.78	31a	29.44	6.0	3,104	517	"
XVI	25a	29 70	27p	29.54	2.5	976	390	Interior.
						Mean .	564	

JUNE, 1908.

No.	Beginning.		Ending.		Duration	Distance.	Apparent average daily velocity.	Disappearance.
I	1a	29·76	3a	....	2 0	992	496	Gulf.
II	2a	29·48	4p	29·52	2·5	1,450	580	Interior.
III	4a	29·54	11p	29·86	7 5	3,392	452	Gulf.
IV	8p	29 70	17a	....	8·5	2,720	320	"
V	17a	29·52	22a	29 70	5·0	3,200	640	"
VI	22p	29 56	26a	29·66	3·5	3,120	891	"
VII	24p	29·68	27p	29·62	3·0	1,680	560	Interior.
VIII	27p	29·62	30a	29 82	2·5	1,840	736	Gulf.
						Mean...	584	

JULY, 1908.

No.	Beginning.		Ending.		Duration.	Distance.	Apparent average daily velocity.	Disappearance.
		in.		in.	days.	miles.	miles.	
I	2p	29·72	9a	..	6 5	2,880	443	Gulf.
II	7p	29·78	12p	.	5.0	2,720	544	"
III	9a	29·88	11a		2 0	496	248	Atlantic.
IV	12a	29·88	15p	29·56	3·5	2,704	772	Gulf.
V	14a	29·80	20a	....	6 0	3,232	539	Atlantic.
VI	18p	29 86	23a	......	4·5	2.784	619	Gulf.
VII	19p	29·90	22a	30·04	2·5	1,408	563	Atlantic.
VIII	23a	29·68	26p	29 88	3·5	1,216	347	Interior.
IX	29p	....	31p	29·32	2·0	688	344	Atlantic.
X	27a	29·84	30a	30·02	3.0	1,456	485	
						Mean...	491	

AUGUST, 1908.

No.	Beginning.		Ending.		Duration.	Distance.	Apparent average daily velocity.	Disappearance.
I	1a	29·66	3a	....	2·0	960	480	Gulf.
II	1p	29 44	10a	29·80	8·5	2,928	344	"
III	10p	29·56	14p	29·80	4 0	2,240	560	"
IV	15a	29·80	19a	29 60	4·0	2,528	632	"
V	20a	29·70	24a	29·98	4·0	2,440	610	"
						Mean...	525	

SEPTEMBER, 1908.

No.	Beginning.		Ending.		Duration.	Distance.	Apparent average daily velocity.	Disappearance.
I	1a	29·90	3a	....	2·0	1,424	712	Gulf.
II	4p	....	7a	....	2·5	1,960	784	"
III	6a	29·84	7a	......	1·0	1,024	1,024	"
IV	8a	29 86	9a	29 02	1·0	736	736	Interior.
V	11a	....	18a	....	7·0	2,320	331	Gulf.
VI	14p	29·66	19a	29·78	4·5	2,080	462	Interior.
VII	23a	29·82	29a	.....	6 0	3,040	507	Gulf.
VIII	28p	....	30p	29 68	2 0	1,680	840	Interior.
						Mean...	674	

OCTOBER, 1908.

No.	Beginning.		Ending.		Duration.	Distance.	Apparent average daily velocity.	Disappearance.
I	1p	29·90	2p	.....	1·0	704	704	Gulf.
II	2a	29·28	3p	29·56	1·5	560	373	Interior.
III	8a	....	11p	29·68	3 5	2,240	640	Gulf.
IV	8p	29·72	11p	29·68	3·0	2,544	848	"
V	14a	29·36	15a	29·30	1·0	1,200	1,200	Interior.
VI	14p	29·56	17p	..	3·0	1,888	629	"
VII	15p	29·46	17p	29·90	2·0	960	480	"
VIII	17p	29·68	21p	....	4·0	2,099	525	"
IX	20p	29·58	27a	29·90	6·5	2,144	329	"
X	26a	......	27p	....	1·5	1,056	704	Gulf.
XI	27p	....	30p	29 06	3·0	2,120	707	"
						Mean....	649	

NOVEMBER, 1908.

No.	Beginning.		Ending.		Duration	Distance.	Apparent average daily velocity.	Disappearance.
		in.		in.	days.	miles.	miles.	
I	1p	29·66	4p	29·20	3·0	2,944	981	Gulf.
II	5a	29·72	6p	29·16	1·5	1,480	987	„
III	8p	29·66	12a	29·46	3·5	2,400	686	„
IV	14a	29·96	15a	29·60	1·0	1,480	1,480	„
V	16p	29·54	18p	29·60	2·0	2,304	1,152	„
VI	17p	29·50	20a	29·88	2·5	2,336	934	„
VII	21a	29·88	25a	29·52	4·0	1,424	356	Interior.
VIII	23a	29·64	25a	29·52	2·0	1,000	500	„
IX	23p	29·70	26a	29·06	2·5	2,048	819	„
X	27a	29·84	30p	29·04	3·5	1,936	553	„
XI	28a	29·90	30p	29·04	2·5	1,984	793	„
XII	29a	29·52	30p	29·04	1·5	1,408	938	„
						Mean.....	848	

DECEMBER, 1908.

No.	Beginning.		Ending.		Duration	Distance.	Apparent average daily velocity.	Disappearance.
I	2p	30·06	4p	29·62	2·0	2,176	1,088	Gulf.
IIa	5a	29.82	7a	29·86	2·0	2,128	1,064	„
IIb	5a	29·82	7p	29·28	2·5	2,656	1,062	„
III	9a	29·68	12p	29·04	3·5	2,640	754	„
IV	11a	29·50	14a	29·48	3·0	2,720	907	„
V	12p	29·06	16a	29·72	3·5	2,944	841	„
VI	14a	29·72	17p	......	3·5	640	183	Interior.
VII	16a	......	18p	29·42	2·5	1,504	602	Atlantic.
VIII	18a	29·86	19a	29·94	1·0	1,280	1,280	„
IX	21a	30·00	23a	......	2·0	1,520	760	„
X	23a	29·78	26a	29·28	3·0	2,240	747	Gulf.
XI	25a	29·62	28a	29·66	3·0	2,880	960	„
XII	28a	29·40	31a	29·58	3·0	2,560	853	„
						Mean.....	854	

JANUARY, 1909.

No.	Beginning.		Ending.		Duration	Distance.	Apparent average daily velocity.	Disappearance.
I	2a	29·70	6a	29·36	4·0	2,000	500	Gulf.
II	3a	29·60	5p	29·84	2·5	1,824	730	Interior.
III	3p	29·58	6a	29·36	2·5	3,008	1,203	Gulf.
IV	7a	29·66	10p	29·86	3·5	1,328	379	Interior.
V	10a	29·92	11a	29·80	1·0	1,088	1,088	Gulf.
VI	12p	29·60	15a	29·66	2·5	2,944	1,177	„
VII	15a	30·00	18a	29·70	3·0	2,608	869	„
VIII	19a	29·18	21a	29·70	2·0	1,640	820	Interior.
IX	21p	28·90	26a	29·56	4·5	3,344	743	Gulf.
X	25p	29·74	27p	29·30	2·0	2,016	1,008	„
XI	27p	29·72	31a	29·12	3·5	2,240	640	„
						Mean.....	832	

FEBRUARY, 1909.

No.	Beginning.		Ending.		Duration.	Distance	Apparent average daily velocity.	Disappearance
		in.		in.	days.	miles.	miles.	
I	3a	29·64	6p	28·98	3·5	2,528	722	Gulf.
II	4a	29·48	6p	28·98	2·5	2,208	883	"
III	5a	29·36	7p	29·70	2·5	2,600	1,040	Atlantic.
IV	5p	29·60	7p	29·70	2·0	1,800	900	"
V	7a	29·42	10p	29·30	3·5	2,760	789	Interior.
VI	11p	29·68	17a	29·40	5·5	3,059	556	Gulf.
VII	13a	29·58	17a	29.40	4·0	3,136	784	"
VIII	16p	29·44	20p	28·94	4·0	3,536	884	"
IX	20a	29·66	25p	29·02	5·5	4,200	764	"
X	24a	29·66	27p	29·58	3·5	3,168	905	"
						Mean.....	825	

MARCH, 1909.

No.	Beginning.		Ending.		Duration.	Distance	Apparent average daily velocity.	Disappearance
I	28p Feb...	....	2p	29·78	2·0	1,664	832	Atlantic.
II	28p Feb.....	......	2p	29·74	2·0	1,664	832	"
III	1a	29·38	5a	29·00	4·0	3,744	936	Gulf.
IV	4p	29·60	7p	29·62	3·0	2,880	960	"
V	5a	29·65	7p	29·62	2·5	2,016	806	"
VI	5p	29·78	10p	29·42	5·0	3,840	768	"
VII	12a	29·98	14p	29·62	2·5	2,560	1,024	"
VIII	15a	30·22	18a	29·48	3·0	1,920	640	Atlantic.
IX	16a	29·88	20a	29·58	4·0	3,040	760	"
X	18a	29·64	21p	29·72	3·5	2,240	640	"
XI	19p	29·72	22a	29·92	2·5	1,216	486	Interior.
XII	22p	29·76	26a	29·10	3·5	2,720	777	"
XIII	22p	29·68	26a	29·10	3·5	2,624	750	"
XIV	24p	29·54	29a	29·08	4·5	2,432	540	Gulf.
XV	26a	29·70	29a	29·08	3·0	2,720	907	"
						Mean	777	

The result of the comparison of the preceding table with the microseisms prevailing at corresponding dates may be briefly stated. There is a general relationship between the movements of Lows and microseisms, that is, that during the winter months when the average movement is greater than during the summer months, the microseisms are more frequent and stronger during the former period than during the latter, but when we look for an increase of microseisms with an increase of movement of Lows, we find that the two phenomena are by no means always synchronous. We are therefore obliged to deny the relationship of cause and effect between these two phenomena.

As is shown elsewhere the true relationship lies between the isobars and gradients, their geographic position, the ocean and the microseisms.

MAREOGRAMS.

Very recently through the kindness of Dr. W. Bell Dawson, Superintendent of the Tidal Survey, I had an opportunity of examining the mareograms of St. Paul island for the year 1904, and those for May-December, 1908, the latter, the latest received.

St. Paul is a small rocky island in Cabot strait, the main entrance to the Gulf of St. Lawrence, between Cape North in Cape Breton Island and Cape Ray in Newfoundland, but near to the former. It is almost surrounded by the 100-fathom (183 meters) line and lies just outside and westward of the St. Lawrence Deep running from the Atlantic ocean (1,000-fathom-line) to the mouth of the St. Lawrence, opposite Matane, a distance of about 630 miles (1,014km.). Cabot strait, 65 miles wide, 250 fathoms deep, is the main entrance to the gulf; the other, the Strait of Belle Isle, is only 11 miles wide at its narrowest part and has less than 50 fathoms of water. The gulf itself is about 450 miles long in a N.W.-S.E. direction, and 350 miles in a N.E.-S.W. direction. The greater part of the gulf is less than 100 fathoms deep.

The object of the scrutiny of these mareograms was to examine the secondary oscillations, which are superposed on the regular tidal movements, and to see if any relationship exists between the occurrence and intensity of these secondary oscillations and the microseisms registered at Ottawa. For the study of the oscillations in the gulf, the mareograms of St. Paul seemed the most suitable.

Secondary oscillations have received considerable attention by various investigators, but so far without conclusive proof of their cause. Last year the Earthquake Investigation Committee of Japan issued a report on 'The secondary oscillations of Ocean Tides.' In the investigation 'Professor Omori was led to the conclusion that the bays or inlets oscillate like fluid pendulums with periods peculiar to their own.'

Records were obtained from many bays about the Japanese coast by specially designed portable tide-gauges and the results tabulated. The period of oscillation was computed by the formula $t = \frac{4l}{\sqrt{gh}}$ where $l =$ length of bay, $h =$ mean depth, and $g =$ acceleration. The denominator represents the velocity of the long waves.

The observed and calculated periods, although ranging for different bays very widely, from 9^m to 363^m, agree pretty well throughout. This part of the investigation seems to show conclusively that each bay has its own inherent period or note like a tuning fork, and will oscillate with its own period 'if it be excited by waves in the external sea having the synchronizing component.' From this it would follow that we can get little or no information about the period of the microseisms as dependent upon the periods of the bays, for microseisms with the same period obtain or prevail over very large areas, tens or hundreds of thousands of square kilometres in extent. However, 'as to the cause of the long waves which manifest themselves as secondary undulations,' the above report says, 'we may mention the wind, the cyclone, the earthquake, &c.' In short, the report does not show that the change of atmospheric pressure is the direct cause of these secondary oscillations and is indicated by them.

Coming now to the mareograms of St. Paul island, it is found that:

(1) Secondary oscillations are always present throughout the year.

(2) The range or double amplitude varies, being greater in winter than in summer. The range running from 1cm. to 30cm.

(3) The period is practically constant throughout the year and years (1904 and 1908), being about 4·6 min., deviating from this by only one or two-tenths of a minute, and this deviation may be partly due to difficulty in measuring the period accurately.

(4) Small oscillations in amplitude show less interference phenomena than do the larger ones.

(5) There is a fair correspondence between the occurrence of Lows with steep gradients in or about the gulf and large amplitudes for the secondary oscillations; but this coincidence is not nearly so well marked as in the relation between such Lows and microseisms.

(6) The cause of these secondary oscillations is in the main due to changes of barometric pressure.

(7) As the period of the oscillations is practically constant, and the disturbing cause variable, the period must be a function of the topography and hydrography, that is, the depth of water and extent of basin.

Although the 100-fathom line almost surrounds the island, yet one would not be justified in using its dimensions for computing the period for the oscillations there. Such would give about 31 minutes.

The following table gives the period and range (double amplitude) of mareograms at St. Paul island. The dates are taken more or less at random, but always of such records where the pencil tracings were still clear, as in some cases they were somewhat obliterated by inking in a smooth tidal curve:—

SECONDARY OSCILLATIONS on mareograms recorded at St. Paul island, Cabot strait. The tide-sheets cover alternately 3 and 4 days. Time scale, $1^h = \frac{3}{4}$ inch. Vertical scale, 1 in. = 1 ft.

Date.	Period.	Range Units of 1/20 ft.	Date.	Period.	Range Units of 1/20 ft.	Date.	Period.	Range Units of 1/20 ft.
1904.	min.		1908.	min.		1908.	min.	
Jan. 3	4·0	15	May 18	4·5	4	Sept. 11	4·6	12
" 9	4·0	20	" 29	4·8	11	" 18	4·8	5
" 14	3·2	17	June 2	5·0	2	" 21	4·5	3
" 27	4·0	5	" 7	4·6	2	" 25	4·8	3
Feb. 7	4·5	4	" 17	4·6	7	" 29	4·8	2
Mar. 4	4·6	6	" 21	4·6	4	Oct. 2	4·6	6
" 23	4·3	9	" 23	4·5	4	" 6	4·8	2
" 24	4·3	3	" 26	4·6	3	" 9	4·5	3
Apl. 16	4·5	7	" 30	4·5	2	" 14	4·3	3
" 18	4·4	9	July 3	4·6	1	" 20	4·5	4
May 2	4·8	3	" 7	4·5	2	" 24	4·8	3
" 8	4·6	2	" 12	4·6	3	" 26	4·6	2
" 18	4·6	2	" 14	4·5	2	" 31	4·6	7
June 30	4·6	2	" 17	4·6	2	Nov. 9	4·6	3
July 3	4·3	2	" 20	4·8	2	" 12	4·8	8
" 7	4·3	3	" 24	5·0	2	" 16	4·5	7
Aug. 8	4·6	2	" 31	4·6	2	" 19	4·6	8
" 26	4·8	4	Aug. 3	4·4	2	" 24	4·6	5
Sept. 1	4·3	5	" 7	4·6	2	" 27	4·4	5
" 12	4·6	3	" 14	4·3	2	Dec. 1	4·6	5
Oct. 1	4·3	5	" 22	4·6	2	" 3	4·6	8
" 8	4·3	3	" 26	4·3	2			
Nov. 13	4·5	4	" 29	4·6	8			
" 15	4·3	8	Sept. 1	4·3	2			
" 25	4·5	5	" 4	4·5	2			

Another examination of mareograms was made, and that for Trepassey, near Cape Race, Newfoundland, the extreme point jutting into the broad Atlantic It showed very marked secondary oscillations, exceeding both in period and in amplitude those of St. Paul island greatly. While the mean period of the latter is 4·6 minutes, that of the former is 67·6 minutes, about 15 times as large; and the range reaches over three and a half feet, while for the other it seldom reaches half a foot. The distance apart of these two stations is about 300 miles, but the tidal movement coming from the southeast reaches them about simultaneously. The general movement of the atmosphere or areas of Lows and Highs is easterly, and the barometric conditions prevailing at the two stations are, allowing for time interval in passing from one to the other, fairly similar, yet we find these great differences in the secondary oscillations. We must hence again conclude that their period as well as amplitude must be dependent upon surroundings of the station, *i.e.*, topography-hydrography, or depth of water and extent of basin. Land-locked basins, as shown by the mareograms of Halifax and other places, show little of secondary oscillations, and those shown are generally irregular, which is an experience quite different from that cited for the Japanese coast.

Taking the above two stations which are exposed to the Atlantic, and noting their very different periods, there does not appear to be any very obvious connection between them and the microseisms.

Some investigators believe that the breaking of the waves on the shore sets up tremors in the earth's crust, which may manifest themselves to great distances. To this I am not at present prepared to give assent. My investigations have established more or less synchronous phenomena, but how they are related—as cause and effect—is not yet fully determined.

The following table from the mareograms for Trepassey is similar to the preceding one for St. Paul island. It may be noted that at Trepassey there was at times a tertiary oscillation of a period of 2 minutes or less superimposed on the secondary oscillations. The selection of dates is more or less at random. The mean for each of the four months available is given, and it will be seen that the periods are about the same:—

Secondary Oscillations on mareograms recorded at Trepassey, Newfoundland. Time scale $1^h = \frac{1}{2}$ inch. Vertical scale 1 in. = 6 ft.

Date.	Period.	Range.	Date.	Period.	Range.
1902.	min.	ft.	1902.	min.	ft.
Aug. 22	64	3·	Oct. 9	68	3·0
" 25	77	2·5	" 13	71	3·5
" 26	74	3·	" 15	65	3·0
" 27	63	1·5	" 25	66	3·0
Mean	69·5	......	" 31	64	3·0
			Mean	66·8	......
Sept. 1	65	2·5			
" 2	65	3·0	Nov. 3	67	1·5
" 5	76	2·0	" 5	64	2·0
" 6	68	2·5	" 6	71	3·0
" 24	68	3·5	" 11	63	3·0
" 26	67	2·0	" 17	64	2·0
Mean	68·2	......	Mean	65·8	......
			Grand mean	67·6	......

After these various examinations we arrive at the following conclusions:—

(1) Microseisms are essentially due to meteorological phenomena, that is, to barometric pressure and the accompanying gradients.

(2) The amplitude of microseisms is largely a function of the steepness of the barometric gradient.

(3) Areas of low barometer with steep gradients, but west of Ottawa, have little effect in producing microseisms.

(4) Strong microseisms are almost invariably accompanied by steep gradients in the gulf, with the St. Lawrence valley, containing the Great Champlain fault, on a line of steep gradients.

(5) A well-marked Low sweeping up the Atlantic coast from Florida to Newfoundland is almost invariably accompanied by marked microseisms.

(6) Microseisms are but slightly, if at all, influenced by the movement of Lows across the continent.

(7) Microseisms are not produced by local winds, frictional excitation of the earth's surface.

(8) Microseisms represent movements in vast blocks of the earth's crust, covering tens of thousands of square miles; and the period is possibly dependent on or modified by marked geological configuration and depth.

(9) Microseisms once produced may continue for a day or two when the immediate cause has passed.

ACCELERATION.

The acceleration produced here by earthquakes for the period of the report, April 1, 1908, to March 31, 1909, has in all cases been small. The destructiveness of an earthquake is dependent upon the acceleration and this is measured by the absolute displacement of the earth particles and the period of the oscillation. The absolute displacement is obtained from the seismogram on which the magnified movement is read in terms of millimetres. This latter is converted into absolute measure by application of the magnification factor.

The general expression for the oscillation of a pendulum is $T_o = 2\pi\sqrt{\frac{L}{g}}$ where T_o = period, *i.e.*, the oscillation to and fro, L = length of the pendulum (in metres), g = acceleration for the particular latitude, being for latitude 45°, 9,806 metres, and $\pi = 3{\cdot}1416$, or the ratio of the semi-circumference of a circle to the radius.

If in a horizontal pendulum we have observed its period, T_o, without damping of the pendulum, the deduced L is called the 'equivalent length,' being that of a simple pendulum having the same period.

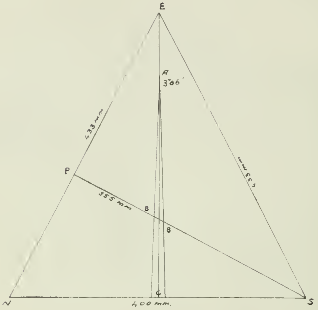
As the square root of g (9·81) is approximately the value of π, we obtain the approximate relation

$$T_o = 2\sqrt{L}, \text{ or } L = \left(\frac{T_o}{2}\right)^2$$

The magnification of the actual movement of the pendulum is effected in seismographs either by a system of levers or by means of a mirror attached to the pendulum. The former method is adopted where there is mechanical registration by a stylus on smoked paper, or by a light glass tube drawn to a fine point and filled with ink, and the latter method for photographic registration as is the case for our seismograph. The magnification in the latter case is simply double the ratio of the actual length of the pendulum to the distance of the recording cylinder from the axis of oscillation of the pendulum.

We may regard the magnification to be produced by the extension of our simple pendulum of the above length L to the length J, which is called the 'equivalent indicator length,' so that the magnification or $V = \frac{J}{L}$. The determination of V for our Bosch photographic seismograph was made directly from measurements of the parts composing the horizontal pendulum and therefrom computing the length of the simple pendulum that would have the same period as the horizontal pendulum when the latter swung in a vertical plane. This deduced length divided into twice the distance of the recording cylinder gave $V = 120$. Some of the heavy astatic Wiechert pendulums, weight 17,000 kgm. (ours is 200 gms.!) have a lever magnification of upwards of 2,000.

As stated in a previous report, the period of the horizontal pendulum is simply a matter of adjustment of the axis about which it swings with reference to the vertical. We may here give an investigation that I made during the past year for tilting and period of the east-west pendulum, *i.e.*, of the one giving the north-south component.



In the accompanying diagram *E, N, S* represent the three footscrews of the pendulum stand. *E, N* the axis of rotation with reference to tilting done by footscrew *S*.

A is the vertical projection of the lower point of pendulum support.

B is the vertical projection of the upper point of pendulum support, when arc on footscrew *S* reads 0°.

B' similarly when arc on footscrew *S* reads 90°.

(*Note.*—In linear measure the triangle *A, B, B'* is much exaggerated in scale; the angles are however to scale.)

The top of the base-plate is 92 mm. above the pier.
Lower support above top of base-plate, 27·5 mm.
Centre of bob above top of base-plate, 25 mm.
Distance between supports of pendulum, 166·7 mm.
Thread of footscrew very nearly 1/40 inch, say $\frac{5}{8}$ mm.

The tilting was done with the south footscrew by turning it through 90°. A special brass arm, graduated through 90° into half-degree spaces and attached concentrically with the footscrew, together with a fixed pointer, opposite the graduations, securely placed on the pier, were used in the experiments.

We have then in linear measure for 90° turn of the footscrew $\frac{1}{4} \times \frac{5}{8} = \frac{5}{32}$ mm., and the angular measure will be θ, where $\sin \theta = \frac{5}{32} \div 355 = \cdot 0004401$, hence $\theta = 90''\cdot 8$.

Four measurements of raising and lowering by a quarter turn, or 90°, by south footscrew gave displacements of image at cylinder by pendulum mirror over point of lower support, respectively: 1′ 4$\frac{3}{8}$″, 1′ 5″, 1′ 6″, 1′ 5$\frac{3}{8}$″, mean 1′ 5$\frac{1}{4}$″ = 438mm.

Distance of image from mirror, 4,060 mm. Hence angle swept over by image = a, and $\tan\frac{a}{2} = \frac{219}{4060} = \cdot 054$, $a = 6^{\circ}\ 12'$ and the angle swept over by the pendulum $= \frac{a}{2} = 3^{\circ}\ 06'$.

The upper point of support is 166·7 mm. vertically above the lower one. By the quarter turn of the footscrew we have an angular motion of 90″·8, hence the *relative* displacement of the upper point of support to the lower one will be x, where $\frac{x}{166\cdot 7} = \tan 90''\cdot 8$, therefore $x = \cdot 073382$mm. $= B\ B'$.

This displacement is in a plane, perpendicular to the axis of rotation $E\ N$. Reducing to the perpendicular of $A\ C$ this becomes ·06509 mm.

Remembering that $A\ C$ is the normal position of the pendulum, we have in the triangle formed by the two positions of the upper point of support and the lower one due to readings of 0° and 90° on the footscrew, the angle at the apex 3° 06′ from above, and the reduced opposite side ·06509 mm., hence the horizontal distance between the two points is d, where $\cdot 06509 \div d = \sin 3^{\circ}\ 06'$, therefore $d = 1\cdot 2036$mm.

It follows that the angle between the points of support and the vertical is γ, where $\tan\gamma = \frac{1\cdot 2036}{166\cdot 7} = 24'\ 49''\cdot 25$.

By previous determination we have the distance from the centre of oscillation to the axis of rotation of the pendulum 66·774 mm., hence the length of the equivalent pendulum is $L = \frac{66\cdot 774}{\sin 24'\ 49''\cdot 25} = 9248\cdot 4$ mm., therefore the period $= 2\pi\sqrt{\frac{L}{g}} = 6^{s}\cdot 10$ (g for 45° = 9806 mm.)

By direct observation on the day of the above investigation, the period was found to be $6^{s}\cdot 15$, being in satisfactory agreement with the above value.

The method of deflection of image is more accurate for the determination of the period than direct observation.

For the above adjustment of pendulum 1″ tilting was equivalent to a displacement of the image of 5·42 mm., or 1 mm. deflection of image = ″·184 tilting north-south. Similar experiments were carried out with the other pendulum, the N–S one, giving the east-west component. The instrument is identical with the other; it is mounted on the same pier, but its adjustment was different at the time.

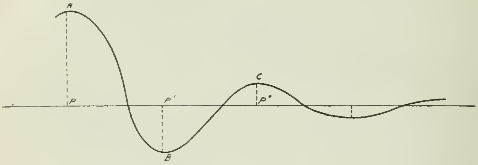
For it was found a period of $12^{s}\cdot 56$, and 1 mm. deflection of the image represented a tilt of ″·0444. As one can read to a tenth of a millimetre, we see that for the adjustment of the latter pendulum one can detect tilting of ″·0044, which is equivalent to about 1 inch in 710 miles.

Without damping, a horizontal pendulum set in motion would continue to oscillate for an indefinite time and with equal amplitudes, leaving out of consideration for the moment the effect of friction at the points of support. This latter would effect a reduction in amplitude in arithmetical progression.

As the principal function of the seismograph is to record the true movements of the earth, both in time and magnitude, it is essential that its own personality regarding swing should be obliterated as much as possible, that is, that it should subside unless acted on by the earth movements. This is effected to a greater or less degree by air, oil or electro-magnetic damping. In our Bosch instrument an air chamber forms a cushion within which a vane of the pendulum moves.

The effect of damping is to reduce the amplitudes in geometrical progression instead of arithmetical, as in the case with friction. Friction will ultimately stop a pendulum, but with damping the amplitude curve is asymptotic, and hence the time infinite.

The 'damping ratio' is understood to be the ratio of the amplitude of a swing from the zero line to the next amplitude on the opposite side, as shown by the accompanying diagram.



Damping ratio $= \frac{A\ P}{B\ P'} = \frac{B\ P'}{C\ P''} = 1 : f$; hence in time $\frac{T}{2}$, where T = period of damped pendulum we have the ratio $1 : f$.

In time $2\left(\frac{T}{2}\right)$ the ratio $1 : f^2$, and in general for $n\left(\frac{T}{2}\right)$ the ratio is $1 : f^n$.

If we call $x\left(\frac{T}{2}\right)$ the time in which the amplitude is reduced $\left(\frac{1}{e}\right)$ th of its value, where e is the base of the natural or Napierian logarithms, then for time $x\left(\frac{T}{2}\right)$ we have $1 : f^x = 1 : e^{-1}$.

Let $\tau = x\left(\frac{T}{2}\right)$, $\therefore x = \frac{2\tau}{T}$, hence $1 : f = 1 : e^{-\frac{1}{x}} = 1 : e^{-\frac{T}{2\tau}} = e^{\frac{T}{2\tau}} : 1$.

The quantity $e^{\frac{T}{2\tau}}$ is generally designated by ϵ.

The effect of damping changes the period of the pendulum when swinging freely, and the relation between the two is expressed by

$$T_o = \frac{T}{\sqrt{1 + \left(\frac{T}{2\pi\tau}\right)^2}}$$

in which T is the damped period.

The magnification of the earth movement of earthquakes, as recorded on the seismogram by the damped pendulum, is dependent upon the period of such earth movement, hence the magnification is not a constant quantity for interpreting the amplitudes. Professor Wiechert in his 'Theorie der automatischen Seismographen,' gives the following formula for the derivation of the magnification:—

$$\mathfrak{V} = \frac{V}{\sqrt{\left\{1 - \left(\frac{T_e}{T_o}\right)^2\right\}^2 + 4\left(\frac{T_o}{2\pi\tau}\right)^2\left(\frac{T_e}{T_o}\right)^2}}$$

From relations we have found before, this may be put in the form

$$\mu = \frac{V}{\sqrt{\left\{1 - \left(\frac{T_e}{T_o}\right)^2\right\}^2 + 4\,\frac{(\text{nat. log }\epsilon)^2}{\pi^2 + (\text{nat. log }\epsilon)^2}\left(\frac{T_e}{T_o}\right)^2}}$$

or using the common logarithms we have

$$\mu = \frac{V}{\sqrt{\left\{1 - \left(\frac{T_e}{T_o}\right)^2\right\}^2 + \frac{4\,(\cdot 733 \log \epsilon)^2}{1 + (\cdot 733 \log \epsilon)^2}\left(\frac{T_e}{T_o}\right)^2}}$$

in which T_e is the period of the earth particles; T_o is the period of undamped pendulum; and the other symbols as previously designated.

It will be observed that this gives wide variations in the magnification, dependent upon the relative values of T_e and T_o, and also upon the damping co-efficient. The value best suited for ϵ lies between 3 and 8.

We now come to the evaluation of the acceleration from the amplitude and period of the recorded earth movements. We have the general expression for normal acceleration $= \frac{v^2}{r}$, in which $v = \frac{2\pi r}{T_e}$, and r is the amplitude, or half range of the oscillation measured on the seismogram, and expressed in microns or 1/1000 millimetres. The value of r is obtained by dividing the linear measure on the seismogram by the appropriate μ for the particular period of T_e. The result is expressed in milligals, where 1 gal is the acceleration of 1 cm. = 10 mm. = 10,000 μ per second, per second, and a milligal is 1/1000 of a gal. Gravity would therefore be represented by 980·6 gal (for $\varphi = 45°$), so that approximately a milligal is the one millionth of gravity.

The acceleration Δg in milligals is given by the approximate formula $\Delta g = \frac{4\,A}{T_e^{\,2}}$, where A is the amplitude (½ range) expressed in microns, and T_e the period in seconds.

As Ottawa is several thousand miles from the nearest seismic area—the West Indies, Mexico or California—the acceleration produced here is always very small, and of course the destructive earthquakes which have occurred there in recent years were not felt here.

During the year, April 1, 1908, to March 31, 1909, the greatest acceleration was produced by the earthquake of November 30, where the period was 10^s, and the amplitude 125μ. This gives an acceleration of 4·9 milligals or about the 1/200,000 that of gravity.

For the disastrous Messina earthquake of last December the following accelerations have been computed. Most of the weekly or monthly earthquake reports received from other stations do not give sufficient data to compute the acceleration:—

—	Distance.	T_ϵ	A	Δg
	km.	s	μ	
Ottawa	7,200	16	18	·3
Granada	1,700	12	750	21
Graz	1,000	20	1,100	11
Jena	1,400	19	3,000	33

In closing this part of my report, on seismology, I desire to express the hope that at no distant day, quarters will be erected for the machine shop; for the operation of the machinery in the basement of the Observatory, as at present, is a menace to the satisfactory functioning of the seismograph.

TERRESTRIAL MAGNETISM.

In continuation of the systematic magnetic survey of Canada begun last year, stations were occupied during the past summer, mostly in British Columbia, and the observations were made by Mr. C. A. French. The stations occupied were: Ottawa, Agincourt, Winnipeg, Banff, Golden, Revelstoke, Sicamous, Clinton, Barkerville, Quesnel, Alexandria, Williams Lake, Bridge Creek, Ashcroft, Spence's Bridge, Nicola, North Bend, Agassiz, Vancouver, Victoria and Nanaimo. The magnetic observations were all made in a tent, carried along for the purpose. Instruments used were: Tesdorpf magnetometer 1977, Dover Dip circle 145, Dent Mean Time chronometer 511, and a six-inch Troughton-Simms theodolite for azimuth, latitude and time observations.

In order that the observations of the elements of terrestrial magnetism in different parts of the earth may be strictly inter-comparable, it is essential that the constants of the instruments employed be referred to standard instruments, preferably at basal stations. By such comparisons, repeated from time to time, say at the beginning and end of the season of field work, one is enabled to give a homogeneity and confidence to the results which would otherwise be lacking, and would militate against their value for incorporation in the general discussion of the difficult problems presented by terrestrial magnetism.

There are several departments of physical investigation in which little progress has been made during the last fifty years in getting at the fundamentals underlying the elements involved. One of them is terrestrial magnetism. In 1904 the Carnegie Institution of Washington undertook to attack the problem in a comprehensive manner, especially in supplying magnetic data for the accessible regions of the world not before occupied, and more particularly to make a systematic magnetic survey of the various oceans, for which purpose a specially built non-magnetic vessel, the *Carnegie,* has been built and which was recently launched at Brooklyn. This work, combined with the Solar Research at Mt. Wilson, also under the auspices of the Carnegie Institution, should in the near future unravel some of the mysteries that have hitherto enshrouded that subtle force or energy—Terrestrial Magnetism.

Toronto is and has been one of the principal magnetic stations in the world, although the location of the instruments now, is not where the original ones were mounted. This change in 1898 to Agincourt, some 10 miles distant, was necessitated through the introduction of the electric cars in Toronto. Since beginning our systematic magnetic survey of Canada complete sets of magnetic observations—declination, inclination and horizontal intensity—have always been made with our field instruments at Agincourt and compared with the results of the standard instruments there, thereby standardizing the former. A similar comparison was made with our Tesdorpf magnetometer 1977 through the kindness of Dr. L. A. Bauer, Director of the Department of Terrestrial Magnetism, Carnegie Institution, at Washington, in April, 1908, with results practically identical with those at Agincourt.

For further comparisons, and more particularly for the comparison of different magnetic instruments, there has been erected during the past year on the Observatory grounds here, a magnetic hut, an illustration No. 1, thereof, accompanying this report. Its dimensions are 10 x 15 feet. It is scarcely necessary to say that no iron or steel of any description was used in the construction. The nails are all copper; hinges, &c., of brass, all tested for non-magnetism before use. The two pillars for mounting the instruments are solid cedar posts surmounted by brass plates 11¼ inches in diameter, which are grooved with three diameters, dividing the surface into sectors of 60°, for the footscrews of the instruments. When observations are made at night, petroleum is used for illumination. There is a permanent azimuth mark about a quarter of a mile distant. The Observatory grounds are just outside of the city limits and the vicinity is fairly free from traffic. The nearest approach of an electric car line to the magnetic hut is 1,492 feet (455 m.). The cars run from 6 a.m. to 12 p.m. on this line. In order to test whether the current of the line exercised a magnetic influence at the hut, observations were made for three days during the 24 hours for declination. There was no effect noticeable during the day-time when the cars were running, and for different positions of the cars on the line with reference to the hut and power station; nor for the time after midnight. The change in declination for each 24 hours followed the general daily curve of eastern and western elongation. Further on will be found the record of these observations. In the future, observations will be made here with the field instruments at the beginning and close of the season's work.

The following 'Memorandum for Magnetic Observations, 1908,' was issued to the observer:—

'In the selection of new stations regard should be had for future occupation for the same points.

The vicinity of trolley lines should be avoided; the magnetic station should be at least a mile from the line.

The station selected is to be connected by linear measure with established corners of lots or intersections of streets, so that it may be accurately re-established at any future time. The azimuth of two or more well recognized objects from the station is to be obtained, either by observation on the sun at about 9 a.m. or 3 p.m., or on Polaris, the former by observing the altitude, circle right and circle left, and the latter by noting the sidereal time when sighting on Polaris, circle right and circle left.

The nature of the ground, whether there are any rock exposures, and surrounding topographic features are to be noted.

A sketch is to be made for each station, showing its relative position, and that of the astronomic meridian.

The order of the observations in general are:—

1. Azimuth.
2. Declination.
3. Dip.
4. Oscillation.
5. Deflection.
6. Deflection.
7. Oscillation.
8. Dip.
9. Declination.

Suspension of weight and removal of torsion for fibre declinometer require particular attention.

The mean of the times for dip, oscillations and deflections will be approximately the same when observing in the above order.

The observations are to be entered on the forms supplied.

Before leaving a station all the observations are to be reduced, with a sufficient degree of accuracy to ensure their reliability.

On your way west you will go via Toronto, and at Agincourt (the Magnetic Observatory) take a full set of observations with both the Tesdorpf and Dover, for the latter especially to obtain the value of A, not forgetting to note temperatures throughout all the observations. Particular attention will be paid to the determination of the declination and the constant of correction for the declination magnet. 10.

After all the observations have been satisfactorily made, you will proceed to Winnipeg and re-occupy the Carnegie Institution station in the park, the description of the station is hereto attached, also the former magnetic values. The azimuths given will be re-determined, and a full set of satisfactory magnetic observations taken.

Similarily Banff will be occupied, the necessary data are also attached.

The names of the other stations to be occupied are appended:—Golden, Revelstoke, Sicamous, Ashcroft, Clinton, Bridge Creek, Williams Lake, Alexandria, Quesnel, Barkerville, Spence's Bridge, Nicola, North Bend, Agassiz, Vancouver, Victoria, Nanaimo (Departure Bay).'

Description of Stations occupied.

Ottawa.—The station (not the magnetic hut) was situated in the southeastern part of the observatory grounds; it was 81 feet from the easterly limit and 53 feet from the southerly limit of the grounds. This station was occupied by the Carnegie Institution in October, 1906, and in 1907-1908 by our observers. It is now abandoned owing to the erection of the Director's house nearby. The reference object was the flag-staff on the central tower of the Parliament Buildings. True bearing, N. 16° 59′·0 W.

Agincourt.—The magnetic observatory.

Winnipeg.—Same station as occupied by the Carnegie Institution in 1906. It is in River Park, about half a mile east of park entrance, in the first cleared space beyond the grove of small trees that surround the entrance. It is about 15 paces from the top of the north bank of the Red river and in line of the fence bounding the buffalo pasture on the side adjacent to the river. It is about 330 feet southwest of the south corner of the pasture. Two grain elevators in the distance, and a small red barn in the pasture are seen nearly in line from the station. A red water tank is seen near the elevators aud a little to the west of the barn. The following true bearings were determined:—

Smokestack near International Elevator C.. ..	39° 18′·8 E. of N.
Pole on the red water tank..	23° 40′·0 E. of N.
West gable of a large white house..	47° 28′·6 E. of N.

Banff.—The station is the same as that occupied by the Carnegie Institution in 1907. It is in the grounds of the National Park Museum, 292 feet south-southwest of the southwest corner of the museum building, midway between, aud in line with, the two small spruce trees near the north bank of Bow river and nearest to a pen used at present for ducks. The point was marked by a round pine stake (about two inches in diameter and about eight inches long) driven flush with the surface. The stake is 67½ feet from the northeast corner of the duck pen and 93½ feet from the southeast corner, and is about 10 feet north of bank of river, aud furthermore about in line with the west side of a one-story building in the rear of the Canadian Pacific Railway Museum on the north bank of the Bow river. The bearings of the following objects were obtained:—

Meteorological Observatory, Sulphur Mt. anemometer pole, 8° 07′·2 W. of S.
Sanitarium hotel, bottom of flagstaff, east tower.. .. .. .. 27° 19′·2 E. of S.

Golden.—The station (1908) is on the property of Mr. Alexander, in a clearing on the south bank of the Kicking Horse river. It is about 200 feet east of the roadbed of the proposed Kootenay railway, and is midway between the ends of that portion of the bank along which is a breakwater consisting of a layer of small trees. From the station the top of the Columbia hotel is visible above the wooden bridge over the Kicking Horse river, and the front of the Queens hotel is seen to the east of the firehall.

The point is marked by a round wooden peg 2 inches in diameter, and projects about an inch above the ground. It is distant 190 feet 3 inches from the northeast corner of a vacant log house; 261 feet 9 inches northeast from the southeast corner of a lot, one side of which is on Calgary street and the other parallel to the Kootenay Railway road-bed, and 234 feet southeast from the northeast corner of a lot adjacent to the first mentioned one. True bearings of the following reference objects were obtained:—

Bottom of pole on C. P. R. water tank.	N. 36° 51′·1 W.
Bottom of flagpole on Columbia hotel.	N. 49° 35′·8 W.
Bottom of flagpole on Parson's store.	N. 80° 03′·9 W.

The magnetic observations were taken 13 feet 3 inches southeast from station and in line with pole on tank. The soil is gravel.

Revelstoke.—The station is located on the Athletic grounds in the southwest part of the town. It is about 45 paces east of the bank of the Columbia river. The top of the Catholic church may be seen a little to the left of the line joining the station with the Canadian Pacific Railway water tank. The station is marked by a peg 2″ x 1½″ driven flush with the ground, and is 71 feet 8 inches from the northeast corner of the grand stand and 68 feet from the southeast corner. The true bearings of the following reference objects were obtained:—

Bottom of pole on west water tank on mountain side.	N. 33° 28′·1 E.
Top of belfry on school.	N. 6° 03′·8 W.
Bottom of pole on Court House.	N. 18° 53′·7 W.

The magnetic observations were taken at a point 8 feet 3 inches southwest from station and in line with water tank.

Sicamous.—The station is located in a clearing on the south side of the Canadian Pacific Railway, and on the east side of the narrow part of Shuswap lake. The Canadian Pacific Railway hotel may be seen between the pump-house and the first telegraph pole to the west of the semaphore. It is almost directly in line with the north end of the Bellevue hotel. The spot is marked by a round post about 2 inches in diameter, driven so as to project 3 inches above ground. It is 18 feet 9 inches from a large poplar tree and southeast of it, and is 14 feet from another round post about 1½ inches in diameter, which is in line with the station and tree. It is 172 feet from the east end of the Canadian Pacific Railway bridge.

The true bearings of the following points were obtained:—

Top of pyramid over east bay window, C.P.R. hotel.	S. 67° 56′·7 W.
North end of peak of Bellevue hotel.	S. 39° 39′·0 W.

The magnetic observations were taken 9 feet southeast from station and in line with Canadian Pacific Railway hotel.

Clinton.—The station is in the southeast part of the town in a field owned by Mr. Smith. It is on a slight elevation about 30 paces to the south of the road leading to the cemetery. It is marked by a brass nail in a fir stake 2″ x 4″, driven 18 inches into the ground and projects 7 inches. It is 143½ feet northwest of the post which marks the northwest corner of the cemetery, and 144 feet southwest from the south large gate-post.

The true bearings of the following reference objects were obtained:—

Top of church tower, Indian reservation.	S. 70° 07′·3 W.
Pole on cottage, rear of Provincial Land Office. .	N. 88° 18′·7 W.
Pole on cottage (Dr. Sanson's).	N. 69° 30′·5 W.

The magnetic observations were taken 25 feet northeast from station and in line with spire on Catholic church.

Barkerville.—The station is in a small clearing on the west side of the road which leads from the south of the town. It is about 336 feet (by way of road) from the bridge which crosses the ditch constructed for conveying water used for mining purposes, which is about 45 paces from the south end of the bridge which crosses the river (now dug). The station is marked by a brass tack in the top of a fir post 3″ x 4″ which projects 3 inches above the ground. It is 39 feet from the middle of the road and 37 feet from a spruce tree which is to the south of it, and in line with a point slightly to the east of the Presbyterian church.

The following true bearings were determined:—

Pole on Fire Hall.	S. 72° 08′·7 W.
Pole on Masonic Hall.	N. 80° 32′·3 W.
West gable on belfry Presbyterian church.	N. 44° 59′·5 W.

The magnetic observations were taken 12 feet east from the station and in line with the pole on the Fire Hall.

Quesnel.—The station is on government property, north of the town. It is about 318 paces from the ferry cable, and is marked by a brass tack in a fir post 2″ x 4″, driven so as to project 8 inches above ground. It is 15 feet from the bank of the Fraser river, and 76 feet 8 inches northwest from the corner post of the fence around a small field which is adjacent to the post office property. There are three clumps of spruce trees about 75 feet south, and are so situated that the Catholic church and post office may be seen between the easterly pair; the pole of Reid's store between the westerly pair; and the grist mill to the right of the westernmost one.

The following true bearings of reference objects were obtained:—

Bottom of cross on church.	S. 28° 10′·7 E.
Gable of wing of post office.	S. 22° 54′·4 E.
Pole on Reid's store.	S. 14° 47′·4 E.
Gable of ventilator on grist mill.	S. 2° 06′·9 E.

The magnetic observations were taken 8 feet northwest from station and in line with pole on Reid's store.

Alexandria.—The station is on a waste piece of land in the northwest corner of a field belonging to Mr. Anders. The field is on the west side of the government road opposite the post office and farm buildings, and borders on the Fraser river. It is marked by a brass tack in a fir post 5 inches in diameter, which projects 8 inches above ground. It is about 95 feet northeast from the end of the trail which leads to the post office landing; 56 feet from the bank, and 57 feet southeast from a forked tree. The soil is a layer of sandy loam over gravel.

The following true bearings of reference objects were obtained:—

West chimney on Mr. Anders' house.	S. 73° 20′·7 E.
Spire, Catholic church, Indian reservation.	S. 3° 30′·0 W.

The magnetic observations were taken 12 feet northwest from station and in line with west chimney on Mr. Anders' house.

Williams Lake.—The station is southwest of the town on property belonging to the Cariboo Trading Company. The point is marked by a brass nail in a fir post 4″ x 4″, which projects 7 inches above ground. It is about 132 paces west of the Government Road, and a line joining it with the centre of the school passes over the entire length of a fairly large irrigation ditch. A telegraph pole obscures the lower part of the pole on the top of the school. The station is 87 feet from the point where the ditch branches into two, one taking a northwest direction and the other a southwest one. The ground is covered with stones and bowlders. The soil is of a soft, black nature.

The following true bearings of reference objects were obtained:—

Top of north chimney on large frame house. . .	S. 22° 12′·0 E.
Top of small pole on school.	N. 88° 20′·5 E.
Bottom of pole on ventilator C. T. Co.'s barn. . .	N. 7° 52′·5 E.
Bottom of pole over bay-window, white house W. of hotel.	N. 6° 38′·1 W.

The magnetic observations were taken 25 feet northwest from station and in line with chimney on large frame house.

Bridge Creek.—The station is located on property belonging to Stephenson Bros., and is on the south edge of a fir grove which is in a field to the northwest of the ranch buildings, being 145 feet from the point where the irrigation ditch passes under the fence adjacent to the Cariboo road, and about at right angles to it. It is marked by a brass nail in a fir post 4½″ x 4″, which projects 7 inches above ground.

The true bearings of the following reference objects were obtained:—

N.W. corner of chimney on N. of dwelling house. .	S. 28° 30′·1 E.
Gable of house situated to S.W. of dwelling house. .	S 14° 38′·9 E.
Chimney on machine shop in open field.	S. 14° 16′·4 W.

The magnetic observations were taken 12 feet northwest from station and in line with the central reference object.

Ashcroft.—The station is the same as that occupied by the Carnegie Institution in 1907. The station is in a field in the southern part of the town, owned by the British Columbia Express Company. It is 100 feet east of the bank of the Thompson river, about 1,000 feet from the Canadian Pacific Railway track, and about 500 feet from the nearest building. The station is marked by a brass screw in the top of a fir post 3½″ x 3½″ x 30″, set so as to project 11 inches above the ground.

The following true bearings were determined:—

Presbyterian church spire.	0° 17′·8 W. of N.
English church spire.	14° 36′·4 E. of N.
Corner of red house on hill.	45° 41′·5 E. of N.
Telegraph pole marked 48.	3° 19′·6 E. of S.
Vertical edge of rock pinnacle on opposite bank of river.	12° 50′·2 W. of S.

The magnetic observations were taken 14 feet west from the station and in line with the Presbyterian church spire.

Spence's Bridge.—The station is a little less than half a mile west of the railway station, in a field belonging to Mr. Clemes. It is marked by a brass nail in a fir post 4″ x 4″ projecting 12 inches above ground, and is 61 feet 5 inches from the north corner post of the cemetery and almost in line with the diagonally opposite post, and is 110 feet 7 inches from the east corner post and 115 feet from the west corner post. (The diagonals of the cemetery are almost N.-S. and E.-W.)

The following true bearings of reference objects were obtained:—

Corner of post of water tank on mountain side. .	N. 42° 21′·8 W.
Centre of circle on white cross (being headstone on grave in cemetery on opposite side of river.	N. 11° 27′·4 W.
Pole on C. P. R. water tank.	N. 64° 31′·6 E.
Bottom of post marked 'Yard Limit' on C.P.R.	S. 27° 47′·6 W.

The magnetic observations were taken at a point 25 feet west from station, and in line with pole on Canadian Pacific Railway water tank. Soil, loose sand and gravel.

Nicola.—The station is opposite the Canadian Pacific Railway station in a field owned by Mr. House. It is marked by a brass nail in a fir post 2" x 4", projecting 7 inches above ground. The point is about 165 paces southwest of the end of the 'Y.' 62 feet east of a small irrigation ditch and 22 feet north of a line joining the botton of the north row of stakes in the fence along the south boundary of the field.

The following true bearings of reference objects were obtained:—

Gable end C. P. R. station..	N. 33° 35'·7 E.
Gable end C. P. R. engine shed..	N. 49° 54'·4 E.
Vertical edge of large boulder on mountain side..	N. 86° 03'·0 E.
Chimney on south wing of house (this wing painted red)..	S. 2° 55'·8 W.
Gable of large red barn, about a mile distant..	S. 34° 30'·5 W.

The magnetic observations were taken 12 feet northeast from station, and in line with chimney on house. Soil, fine gravel.

North Bend.—The station is southwest of the town on the property of Mr. Phinister. It is on a waste piece of land beyond the first enclosure at the rear of the post office, and is about 650 feet from the Canadian Pacific Railway tracks. It is marked by a brass nail in a fir post 4" x 4", projecting 12 inches above ground. The point where the line through the station and the pole on the Canadian Pacific Railway water tank, intersects the continued line of the straight rail fence running northwesterly from the northwest corner of the post office is 38 feet from the station, and 86 feet from the end of the fence.

The following true bearings of reference objects were obtained:—

Pole on C. P. R. water tank..	N. 25° 46'·2 E.
Small pole on south end of Mountain View hotel.	N. 46° 39'·9 E.
Small pole on west end of C. P. R. hotel..	N. 58° 36'·9 E.
Bottom of cross on Catholic church..	N. 88° 57'·1 E.

The magnetic observations were taken 8 feet southwest from the station and in line with the pole on the water tank.

Agassiz.—The station is on the grounds of the Agassiz Agricultural Association. It is marked by a fir stake 2" x 4" driven flush with the ground. It is about 9 feet inside the race-track and is 165 feet 10 inches from the point in the east fence which is 167 feet from the northeast corner of the grounds, and 173 feet 10 inches from the point in the west fence which is 165 feet from the northwest corner of the grounds; the above distances to the east and west fences are in the same straight line.

The following true bearings of the reference objects were obtained:—

Gable of porch in front of Presbyterian church..	S. 27° 42'·0 W.
Gable of building in southwest corner of grounds.	S. 60° 49'·1 W.
Top of ventilator on hop barn..	N. 56° 17'·8 W.

The magnetic observations were taken 31 feet northeast from the station and in line with the Presbyterian church. Soil, sandy loam.

Vancouver—Brockton Point.—The station is on the Government Lighthouse Reserve, on which is also the small Dominion Astronomical Observatory, used as a reference station for longitudes in British Columbia. It is 43 feet southerly from the southwest corner of the observatory building (office part), and eight feet due west from the produced line of the west end of building.

The following true bearing of the distant reference object was obtained:—

Steeple Catholic Indian mission church, North Vancouver, N. 50° 22'·6 E.

The magnetic observations were taken at the above point.

Victoria.—The Coast and Geodetic Survey station of 1903, as described in the C. & G. S. report of 1903, p. 1003, is as follows:—'On the southeastern edge of the city, about 500 feet in a southwesterly direction from the flagpole in Dr. Millin's yard (Dallas road and Dallas ave.) and 12 feet from the edge of the bluff overlooking the beach, between Holland point and Finlayson point. The station is marked by a 2″ x 4″ fir stub set flush with the ground. The flagpole in Dr. Millin's yard bears 65° 03′·3 east of true north; Race Rocks lighthouse bears 43° 18′·8 west of true south.'

The following was received from the Carnegie Institution:—'L. A. Bauer, of the Carnegie Institution, re-occupied this station in August, 1907, having found a fir stub projecting about 2 inches in the locality described above. However, two sets of azimuth observations gave for the azimuth of the first mark 64° 53′·1 E. of N., and the second mark 43° 12′·3 W. of S. Apparently there are two stubs in close proximity which it will be well to investigate if the station is re-occupied.'

A stub or peg was found projecting slightly above ground, evidently the one found by Dr. Bauer, of the Carnegie Institution. This peg, being badly decayed and broken, was replaced by one 4″ x 4″, set flush with the ground.

The following true bearings of reference objects were obtained:—

Flagpole in Dr. Millin's yard..	N. 64° 51′·0 E.
Race Rocks lighthouse..	S. 43° 13′·7 W.
Buoy on Brotchy ledge..	S. 72° 20′·9 W.

The magnetic observations were taken 12 feet northeast from the station and in line with the lighthouse.

Nanaimo.—The station is on the side of Jesse island, which faces south and west. It is marked by a fir post which projects 18 inches above ground, and has a mound of earth and stones around it one foot in height. It is about 45 paces from the edge of the bank, and 160 paces from the cliff near the northwestern part of the island.

The following true bearings of reference objects were obtained:—

Pole on water tank at Brechin mine..	S. 8° 16′·7 W.
Chimney on west end of large white house at northwest part of bay..	S. 86° 01′·0 W.

The magnetic observations were taken 12 feet north from the station and in line with the pole on the water tank.

To occupy the stations between Ashcroft and Barkerville required a stage-drive of fully 500 miles.

On September 4, 1908, a magnetic storm manifested itself at Williams lake, as shown by the following readings for declination, magnet erect. The observations began at 16^h 30^m Pacific Standard Time; this would be equivalent to 0^h 30^m (a.m.) Greenwich Mean Time of September 5.

Vernier A.	Time.	Vernier A.	Time.	Remarks.
	h. m.		h. m.	
177° 04'.8	16 30	177° 22'.5	17 10	Reference object A = 307° 36'.1. B = 127° 36'.0.
6.3	32	26.3	12	
4.5	37	26.7	14	Azimuth R. O., S 22° 11' 2 E.
6.2	40	22.7	16	
6.7	41	14.7	24	
10.1	42	2.0	30	
10 2	44	176° 56'.6	32	
4.2	46	44.1	33	
0.5	48	38.0	34	
4.5	50	177° 10'.6	38	
8.9	52	176° 36'.1	43	
16.2	54	177° 00'.0	46	
16.2	56	176° 52'.8	50	
12.6	58	177° 10'.0	52	
6.2	17 00	8.0	18 00	
8.9	2	18.0	10	
12.0	4	.....	.....	
8 3	6	.....	.....	
14.0	8	.....	.....	

The needle was very unsteady also on the following day (5th). On September 11 and 12, while at Ashcroft, the needle showed unsteadiness. There was a fine auroral display on the evening and night of September 11.

The following readings of the declination magnet show the disturbances at Ashcroft on September 11, 1908.

Time—Pacific Standard—eight hours slow on Greenwich.

Vernier A.	Time.	Remarks.
	h. m.	
243° 24'.8	14 01	Reference object A = 215° 14'.3. B = 35° 14'.2.
28.5	3	
22.0	12	Az. of R. O. = N. 0° 17' 8 W.
28 0	16	
18.0	22	
14 3	28	
242° 54.6	43	
58.5	46	
243° 12.3	49	
22.3	54	
16 1	15 03	
10 4	07	

The range of declination at Williams lake on September 4, during the 1^h 40^m of observation, was 50'·6; and at Ashcroft on September 11, during 1^h 04^m, was 33'·9. On the afternoon of September 12, at Ashcroft, the magnet was quite steady. The observations at neither place were sufficiently continuous to obtain the extreme range, east and west, that the magnet attained.

The magnetic storms of those days were undoubtedly world-wide. Dr. C. Chree, of Kew, makes note of them in 'Nature,' of September 24, 1908. Referring to the declination, he says: 'The extreme easterly position was reached at about 2.53 a.m., and the extreme westerly position at about 5.14 a.m. on September 12, the total range of declination being about 1° 27′. The movements on September 12 were the most rapid. Between 1.24 a.m. and 1.46 a.m. there was a westerly movement of about 51′, followed in the course of the next eight minutes by an easterly movement of about 35′, while between 2.58 a.m. and 3.28 a.m. there was a westerly movement of about 53′. There were no large movements after 6 a.m.

TABLE I.

Stations occupied during 1908. The declinations are all reduced to 10.30 a.m. local time for the position of the average meridian for the day and place.

Place.	Latitude.	Longitude.	Year.	Month & Day.	Hour & Minute.	Declination.	Month & Day.	Hour & Minute.	Dip.	Month & Day.	Hor. intensity C.G.S. Units.
	° ′	° ′				° ′			° ′		
**Winnipeg, Man.	49 52	97 09	1908	July 16	10 30	13 61·2	July 16	10 30	....	July 16	·13128
				" 17		58·8	" 17		78 15·0	" 17	
				" 18		56·2	" 18		12·0	" 18	·13113
				" 20		57·1	" 20		11·9	" 20	
						13 58·6			78 13·0		·13121
Banff, Alta.	51 10	115 37	1908	July 22		26 6·8	July 22		....	July 22	·15922
				" 23		5·7	" 23		75 0·3	" 23	·15978
				" 24		4·2	" 24		74 55·9	" 24	·15966
						26 5·6			74 58·1		·15955
Golden, B.C.	51 18	116 57	1908	July 27		26 3·8	July 27		74 43·3	July 27	·16152
				" 28		7·4	" 28		....	" 28	
				" 29		1·6	" 29		74 42·2	" 29	·16167
				" 30		1·2	" 30		....	" 30	
						26 3·5			74 42·8		·16160
Revelstoke, B.C.	51 0	118 12	1908	....		....	Aug. 1		74 13·6	Aug. 1	·16499
				Aug. 3		25 48·6	" 3		17·5	" 3	·16521
				" 4		47·6	" 4		17·2	" 4	·16483
				" 5		49·5	" 5		....	" 5	
						25 48·6			74 16·1		·16501
Sicamous, B.C.	50 50	118 59	1908	Aug. 6		25 51·7	Aug. 6		73 51·0	Aug. 6	·16779
				" 7		55·3	" 7		52·0	" 7	
				" 8		54·7	" 8		52·0	" 8	

						" 9..		53·0	" 9.		....	" 9 ...	·16771
						" 10...		49·3	" 10 ...			" 10 ...	
							25	52·8		73	51·8		·16775
Clinton, B.C.	51		121	35	1908	Aug. 13.....	26	25·3	Aug. 13. ...		....	Aug. 13.. ..	
						" 14. ..	..	25·8	" 14	73	28·9	" 14.....	·17040
						" 15.....	..	28·0	" 15.....		26·3	" 15.....	·17043
						" 16.....	..	26·6	" 16....		....	" 16.....	
							26	26·4		73	27·6		·17042
Barkerville, B.C...	53	4	121	30	1908	Aug. 22.....	28	5·8	Aug. 22.. .	74	57·5	Aug. 22. ..	15707
						" 23.....		8·9	" 23.....		58·5	" 23.....	·15710
						" 24.....		7·3	" 24. ...		....	" 24. ..	
							28	7·3		74	58·0		·15708
Quesnel, B.C......... ..	52	59	122	32	1908	Aug. 26.....	28	18·1	Aug. 26.....	74	51·3	Aug. 26.....	·15869
						" 27....		19·1	" 27.....		50·8	" 27. ...	·15857
						" 28.....		19·9	" 28.....		....	" 28.....	
							28	19·0		74	51·1		·15863
Alexandria, B.C................	52	35	122	28	1908	Aug. 30...	28	15·5	Aug. 30.....	74	21·7	Aug. 30.....	·16401
						" 31.....		15·4	" 31.....		20·1	" 31. ..	·16375
						Sept. 1...		17·7	Sept. 1.. .		... ...	Sept. 1	
							28	16·2		74	20·9		16388
*Williams Lake, B.C......... ...	52	6	121	56	1908	Sept. 3.....	28	54·1	Sept. 3.. .	74	12·5	Sept. 3.. .	16524
						" 4......		50·3	" 4.. ..		....	" 4. ...	
						" 5.... ..		52·6	" 5....		12·1	" 5	·16515
						" 6.. .		54·2	" 6.....		....	" 6 ..	
							28	52·8		74	12·3		·16518
Bridge Creek, B.C.	51	39	121	27	1908	Sept. 8.....	26	49·0	Sept. 8.....	73	35·0	Sept. 8.....	·17202
						" 9 . ..		45·8	" 9.....		35·2	" 9.....	·17142
							26	47·4		73	35·1		·17172

* Magnetic storm on afternoon of Sept. 4th.
** Observations for Dip were taken with Dover Dip Circle 145. The standards on Tesdorpf Magnetometer 1977 prevented a reading being taken.

TABLE I—*Continued.*

Place.	Latitude.		Longitude.		Year.	Month & day.	Hour & minute.	Declination.		Month & day.	Hour & minute.	Dip.		Month & day.	Hor. Intensity C. G. S. Units.
	°	'	°	'				°	'			°	'		
*Ashcroft, B.C.	50	44	121	17	1908	Sept. 11	10 30	....	...	Sept. 11	10 30	73	{25·6 24·9	Sept. 11	....
						" 12		..	....	" 12			26·2	" 12	....
						" 14		27	46·8	" 14			{28·4 25·6	" 14	·17214
						" 15			47.0	" 15		.	....	" 15	·17229
								27	46·9			73	26·1		·17222
Spence's Bridge, B.C.	50	25	121	21	1908	Sept. 16		...	....	Sept. 16		.....	...	Sept. 16	·17379
						" 17		26	38·1	" 17		72	59·3	" 17	·17361
						" 18			40·6	" 18			58·5	" 18	... .
								26	39·4			72	58·9		·17270
Nicola, B.C.	50	9	120	40	1908	Sept. 19		25	1·4	Sept. 19		72	54·7	Sept. 19	·17546
						" 20			4·1	" 20			53 3	" 20	·17546
						" 21			3·4	" 21		...	......	" 21	....
								25	3·0			72	54·0		·17546
North Bend, B.C.	49	52	121	27	1908	Sept. 23		25	48·6	Sept. 23		72	33·4	Sept. 23	....
						" 24			48·9	" 24			31·1	" 24	·17964
						" 25			47·3	" 25			31·9	" 25	·17980
						" 26			47·2	" 26		....	......	" 26	....
								25	48·0			72	32·1		·17972
**Agassiz, B.C.	49	15	121	45	1908	Sept. 28		...	......	Sept. 28		71	34·9	Sept. 28	....
						Oct. 1		25	24·0	Oct. 1		..	34·9	Oct. 1	·18923
						" 2			23·2	" 2		.....	34·9	" 2	·18915
								25	23·6			71	34·9		·18919

Vancouver, (Brockton Point) B.C.	49	18	123	7	1908	Oct. 5	25	21·0	Oct. 5	...	...	Oct. 5	...
						" 6		23·3	" 6	71	39·5 / 41·4	" 6	...
						" 7		24·3	" 7		44·0	" 7	18782
						" 8		24·4	" 8		42·8 / 41·7	" 8	18781
							25	23·3		71	42·4		·18782
Victoria, B.C. (C.I.S.)	48	25	123	21	1908	Oct. 12	...	...	Oct. 12	71	18·3	Oct. 12	...
						" 13	24	34·0	" 13		19·8 / 20·0	" 13	·18757
						" 14		33·9	" 14		19·9 / 18·3	" 14	·18769
							24	34·0		71	19·3		·18763
Nanaimo, B.C (Jesse Island)	49	13	123	52	1908	Oct. 17	25	15·4	Oct. 17	71	19·3	Oct. 17	·18827
						" 18		15·1	" 18		20·9	...	...
							25	15·3		71	20·2		18827
Ottawa, Ont (C.I.S.)	45	24	75	43	1908	Nov. 2	12	49·1W	Nov. 2	75	41·9	Nov. 2	·15150
						" 5		47·5	...	...	...	" 5	·15169
						" 26		48·9	...	...	...	" 26	...
							12	48·5W		75	41·9		·15156
Ottawa, Ont (Hut.)	45	24	75	43	1908	Nov. 20	12	50·3	...	...	...	Nov. 20	...
						" 23		50·2	...	...	...	" 23	·15165
						" 26		51·0	...	...	...	" 26	...
						" 27	...	...	...	...	...	" 27	·15149
							12	50·5W		...	...		·15157

* Magnetic storm Sept. 11th and 12th. Aurora Sept. 11th.
** Magnetic storm Sept. 29th and 30th. Aurora Sept. 29th.

TABLE II.

This table gives a resume of Table I, together with the values of the horizontal intensity observed with Dover 145.

1977—Tesdorpf Magnetometer.
145—Dover Dip Circle.

Place.	Latitude.		Longitude.		Year.	Month & day.	Declination.		Month & day.	Dip.		Month & day.	Hor. force C.G.S. Units.	Instrument.
	°	'	°	'			°	'						
*Winnipeg, Man., Carnegie Instit't'n Stn	49	52	97	9	1908	July 16–20	13	58·6	July 17-18-20	78	13·0	July 16–18	·13121	1977
									" 17		13·0	" 17	·13060	145
Banff, Alta., Carnegie Institution Stn	51	10	115	37	....	" 22–24	26	5·6	" 23–24	74	58·1	" 22–24	·15955	1977
									" 25		59·3	" 25	·15942	145
Golden, B.C.	51	18	116	57	....	" 27–30	26	3·5	" 27–29	74	42·8	" 27–29	16160	1977
									" 28		40·1	" 28	16142	145
Revelstoke, B.C.	51	0	118	12	....	Aug. 3-4-5	25	48·6	Aug. 1-3-4	74	16·1	Aug. 1-3-4	·16501	1977
									" 5		16·6	" 5	·16458	145
Sicamous, B.C.	50	50	118	59	....	" 6–10	25	52·8	" 6-7-8	73	51·8	" 6–9	·16775	1977
									" 10		55·4	....	·16785	145
Clinton, B.C.	51	6	121	35	....	" 13–16	26	26·4	" 14–15	73	27·6	" 14–15	·17042	1977
									" 13		25·1	" 13	·17223	145
Barkerville, B.C.	53	4	121	30	....	" 22–24	28	7·3	" 22–23	74	58·0	" 22–23	15708	1977
									" 21		57·6	" 21	·15694	145
Quesnel, B.C.	52	59	122	32	....	" 26–28	28	19·0	" 26–27	74	51·1	" 26–27	·15863	1977
									....		49·0	" 28	·15913	145
Alexandria, B.C.	52	35	122	28	....	Aug. 30– ept. 1	28	16·2	" 30–31	74	20·9	" 30–31	·16388	1977
									Sept. 1		18·4	Sept. 1	·16468	145
*Williams Lake, (150 mile post) B.C.	52	6	121	56	....	Sept. 3–5	28	52·8	" 3–5	74	12·3	" 3–5	·16518	1977
									" 5		12·4	" 5	·16507	145
Bridge Creek, (100 mile post) B.C.	51	39	121	27	....	" 8–9	26	47·4	" 8–9	73	35·1	" 8–9	·17172	1977

Ashcroft, B.C., Carnegie Institution Stn	50	44	121	17	. . . .	" 14 15.	27	46 9	" 11-12-14 " 12..	73	26 1 26·8	" 14-15 . " 12.	·17222 ·17208	1977 145
Spence's Bridge, B.C	50	25	121	21	.....	" 17-18..	26	39 4	" 17-18.. " 18	72	58·9 57·6	" 16-17.. " 18 .	·17370 ·17414	1977 145
Nicola, B.C......	50	9	120	40	....	" 19-21..	25	3·0	" 19-20.. " 21 .	72	54·0 53·4	" 19-20.. " 21..	·17546 ·17529	1977 145
North Bend, B.C..........	49	52	121	27	......	" 23-26..	25	48 0	" 23-25 . " 26..	72	32·1 31·2	" 24-25..	·17972 ·17946	1977 145
‡Agassiz, B.C.	49	15	121	45	...	Oct. 1-2..	25	23·6	Sept. 28 Oct. 1, 2 " 28..	71	34 9 36·1	Oct. 1 2.. Sept. 28 .	·18919 ·18902	1977 145
Vancouver, B.C., (Brockton Point). ...	49	18	123	7	... .	" 5-8..	25	23·3	Oct. 6-8.. " 3..	71	42·4 43·7	Oct. 7-8.. " 3.	·18782 ·18669	1977 145
Victoria, B.C., Carnegie Institution Stn.	48	25	123	21	......	" 13-14..	24	34·0	" 12-14 . " 10..	71	19·3 17·0	" 13-14 . " 10..	·18763 ·18779	1977 145
Nanaimo, B.C., (Jesse Island)	49	13	123	52	....	" 17-18..	25	15·3	" 17-18. " 18..	71	20·2 21·5	" 17. " 18	·18827 .18786	1977 145
Ottawa, Ont., Carnegie Institution Stn..	45	24	75	43	....	Nov. 2-5 26	12	48·5W	Nov. 2..	75	41·9	" 2-5..	15156	1977
Ottawa, Ont., (Hut).......	45	24	75	43	. .....	" 20-23-26	12	50·5W	... .	....		Nov. 23-27..	·15157	1977

* Magnetic storm Sept. 4th., p.m.
† " " Sept. 11th and 12th., Aurora, Sept. 11th.
‡ " " " 29th and 30th., " " 29th.
** The "Dip" at Winnipeg was obtained with Dover Dip Circle 145.

In the report of 1898 the Department of the Interior published the magnetic data that had been obtained in connection with the survey and exploration of Dominion lands between the years 1881 and 1890. The declination was generally obtained by means of a long compass needle attached to the lower plate of a transit-theodolite within a narrow box, fitting into a groove, while inclination and total force (intensity) were obtained by a Kew Dip Circle, the constants of which had been determined at the Toronto Magnetic Observatory.

The observations extended in latitude from Port Arthur 48° 26′ to Lake Lindeman 59° 47′ near the head waters of the Yukon, and in longitude from Eastmain, 78° 29′, to Lake Lindeman, 135° 05′. The number of stations distributed over this vast area was 204, but by no means uniformly distributed, the most of them lying along exploratory routes.

In 1883 Sir J. H. Lefroy published his observations in Canada made in 1843-44, covering 314 stations.

These two publications are the only ones up to the present of extended magnetic observations in Canada, except the publications of the United States Coast and Geodetic Survey, which are partly based on the above data and partly on the observations by officers of that survey.

It is thought desirable to bring together the whole of the magnetic data available in our office and publish it.

For the present it is considered more desirable to publish the actual observations than to defer until a reduction has been made to a uniform epoch. The data for most of the stations and many areas, are far too limited to justify such a reduction by themselves. The principal difficulty encountered in reducing to a common epoch, or in reducing from one epoch to another is that of secular variation. Although the existence of secular variation has been known since the days of Gellibrand, 275 years ago, yet its explanation is still unknown. Here is a case where nature absolutely refuses to allow itself to be put in a straight jacket of mathematical formulæ, but instead, pursues its apparently erratic course to the dismay of investigators. As Huxley has well said, that 'our mathematical skill is no guarantee of the quality of the grist,' adding that, 'as the grandest mill will not extract wheat flour from peascods, so pages of formulæ will not get a definite result out of loose data.'

The element, for which for practical purposes, information is from time to time required is the declination, due to the fact that nearly all the older surveys were made with chain and compass, so that in re-tracing or re-establishing an old survey line it is frequently necessary to know the amount of change of the position of the needle, in short, the secular variation for the interval of time. It is impossible to give a general formula from which to deduce the information desired. However, as the original compass survey was at best but an approximation, the secular variation deduced from some empirical formula covering the area under consideration will furnish data for the re-establishment of old survey lines run by compass with a degree of accuracy quite in keeping with the bearing of the original line. The application of secular variation is most applicable in the re-survey of 'timber limits,' where seldom a definite line of reference is available, of which the magnetic bearing at the time of the timber limit survey is given. Such limits generally border a stream or river, the direction of the other sides was mostly made dependent upon the general course or trend of the river. What was accepted at the time by the surveyor as the general course of the river it is impossible subsequently to determine, so that laying off angles with a transit from the river is out of the question, and we fall back on the compass line as corrected for secular variation for re-determining the boundaries of an old timber limit.

For the re-establishment of lot lines in eastern Canada, which was originally almost completely wooded, and where the original surveys were all made by chain and compass, the case is somewhat different. Here 'concessions' and 'side-roads' were the governing factors for the directions of the lot lines, and these former ones were the ones to be opened up first, before the blazes and marks of the original survey were lost and obliterated. Hence in re-running a lot line at present with a compass, one would need only observe the actual magnetic bearing of the governing concession line and apply the difference between it and its original bearing, to the original bearing of the lot line for obtaining its present magnetic direction. Nowadays, however, no surveyor's outfit in Canada is confined to a compass, in fact this instrument on Jacob's staff is obsolete, and the transit-theodolite is used, with which the proper angle would be turned off from the governing line for the lot line irrespective of the magnetic bearing of either.

There are other cases besides those of timber limits and original lot lines. These refer to subdivision lines abutting on original lot lines or other subdivision lines, all run at different periods, the maps thereof showing the magnetic bearing for each line *when* surveyed, which for a closed figure is, on the face of it, a mathematical impossibility. Such cases, personally well known to the writer, tax the ingenuity and skill of the surveyor, armed with theodolite, compass, secular variation, 'deeds' and plans, to do justice to all parties and lines concerned. It may be noted that while the secular variation in general is but a few minutes per year, the daily or diurnal variation is several times that amount. This indicates the importance of noting the time of day when an observation for declination is taken. A disregard of this precaution is equivalent to probably several years displacement theoretically of the year of observation. Conversely, most of our old survey data do not include the time of day when the direction of a line had a certain magnetic bearing, hence with meagre data with reference to different periods or years for a given place, as is the case for many of the stations hereafter given, it is obvious that in the attempt to deduce secular variation therefrom or a general expression for the declination at a given time, we cannot hope to attain more than a rude approximation; much more so when we wish to carry the determination beyond the limits of observation, that is, when we extrapolate instead of interpolate.

The diurnal variation reaches its extreme value eastward at about 8 a.m. and westward at about 1.30 p.m., crossing the average magnetic meridian for the place at about 10.30 a.m. This applies to the southerly part of Canada; in the higher latitudes, the time interval of elongation from the magnetic meridian is increased.

Stations.

In the grouping of our stations, lying between the Atlantic and Pacific oceans and extending to Hudson bay and the Arctic ocean, it was considered more desirable to group them by political divisions as far as possible, *i.e.,* by provinces, than to bound the groups by parallels of latitude and meridians of longitude. In any case we will have contiguous stations falling into different groups. To the general public, to the surveyor, the engineer, the grouping by provinces will be more acceptable than any other scheme.

Canada has hence been divided into the following groups:—

Quebec and Labrador; Nova Scotia, including Cape Breton and Prince Edward Island; Ontario; Hudson bay and surrounding territory; Manitoba; Saskatchewan and Alberta; British Columbia; and Yukon and Northwest Territories, these latter extending from the 60th parallel to the Arctic ocean and west of Hudson bay.

In each of these groups the stations have been arranged in order of longitude, so that, in general, the tabulation will show, considering west declination positive and east declination negative, an algebraic decrease of declination with an increase of longitude.

The agonic line, or line 'without an angle,' *i.e.,* the line joining the points at which the direction of the magnetic meridian is coincident with that of the astronomic meridian, passes at the present time somewhat to the west of Schreiber on the Canadian Pacific Railway, and west of Windsor. Places to the east of it have west declination, and those to the west have east declination.

In the table of compiled magnetic elements,—declination, inclination, horizontal and total intensities,—the column 'Observer' gives the source of the information, indicated by abbreviation, when the observer himself is not given.

The data opposite to the abbreviations C.I., C.S. and L.S., are taken from

TABLE

MAGNETIC

NOVA

C. I.—Carnegie Institution.

Place.	Latitude.		Longitude.		Year.	Month and day.	Hour and minute.	Declination.	
	°	′	°	′				°	′
Louisburg.	45	53·0	60	00·0	1862				
Cape Breton	46	16·0	60	08·0	1862				
Sydney, Cape Breton.	46	09·0	60	11·0	1905·5			24	48 W
" "	46	08·6	60	11·6	1881	Oct. 21, 22		25	11·8 "
" "	46	08·5	60	11·8	1896	July 11, 13		24	53·4
" "	46	06·7	60	12·0	1907	{ Oct. 30, 31 Nov. 1, 2		25	27 9
" "	46	09·0	60	15·0	1905·7			25	09.6 "
Arichat, Isle Madame	45	30·5	61	01·3	1881	Oct. 26		23	25·9 "
Isle Madame, Cape Breton	45	28·0	61	03·0	1862				
Mulgrave	45	35·1	61	22·5	1907	Nov. 5,6		24	13·2
Antigonish	45	35·6	61	59·2	1907	" 8,9		23	25·4
Pictou	45	38·0	62	43·5	1907	Oct. 25,26,28		23	01·9
Truro	45	20·2	63	15·0	1907	" 22,23,24		21	50·7
Point Pleasant	44	37·0	63	34·0	1904·7			21	02·0 "
"		"		"	1905·7			20	47·3 "
Halifax	44	40·0	63	35·0	1834				
"		"		"	1837				
"		"		"	1838·5				
"		"		"	1847·5				
"		"		"	1873				
"		"		"	1879	Sept. 8-10		20	43·3 "
"		"		"	1881				
"	44	39·5	63	35·0	1896	July 6, 7		20	38·6 "
Pugwash	45	50·2	63	40·5	1907	Oct. 19,20,21		22	39·0
Black Point	44	38·0	64	01·0	1905·7			21	01·0 "
Windsor	44	59·6	64	08·4	1847				
"	44	59·6	64	08 4	1881	Nov. 22.		20	42·3 "
Kentville	45	12·0	64	46·0	1847				
Annapolis	44	44·5	65	31·1	1881	Nov. 14,15,16		19	26·8 "
Weymouth	44	24 4	65	59·8	1881	" 11		18	43 4 "
Yarmouth	43	49·9	66	07·2	1881	" 7, 8		17	49·4 "

'United States Magnetic Tables and Magnetic Charts for 1905,' by L. A. Bauer, and published by the United States Coast and Geodetic Survey, 1908.

C.I. refers to observations made by officers of the Carnegie Institution.

C.S. refers to observations made or published by the United States Coast and Geodetic Survey.

L.S. refers to observations by the United States Lake Survey.

III.

RESULTS.

SCOTIA.

Month and day.	Hour and minute.	Dip.		Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature.	Observer.
		°	'						
		76	00·0						Shadwell.
		76	03·0						"
		74	25·0			·1560			French Navy.
Oct. 21, 22		75	10 0	Oct. 21, 22			·5918		S. W. Very.
		74	38·6			·1547	·5842		G. R. Putnam.
		74	16·8			·1563	·5768		White-Fraser.
		74	23·7			·1566			C. I.
Oct. 26		74	43·0	Oct. 26			·6007		S. W. Very.
		75	31·0						Shadwell.
		73	53·6			·1611	·5807		White-Fraser.
		74	17·9			·1596	·5899		"
		74	31·2			·1577	·5910		"
		73	52·5			·1618	·5827		"
		73	58·0			·1624			N. S. Instit. Science
		73	59·6			·1619			C. I.
		75	33·0				·5966		E. Home.
		74	58·0						"
		74	45·0						Estcourt.
		75	37·0				·6026		Keily.
May 13, 15, 16		74	48·2	May 13, 15, 16			·5954		Maclean & Bromley
Sept. 8-10		74	39 2	Sept. 8-10			·6013		J. B. Baylor.
Nov. 2		74	29·0	Nov. 2			·5962		S. W. Very.
		73	54·0			·1632	·5885		G. R. Putnam.
		74	48·8			·1544	·5895		White-Fraser.
		73	59 9			·1617			C. I.
		75	41·0						G. W. Keily.
Nov. 21, 22		74	49·0	Nov. 21, 22			·6026		S. W. Very.
		75	46·0						G. W. Keily.
		74	53·0	Nov. 14, 15			·6059		S. W. Very.
Nov. 10		74	45·0	Nov. 10			·6068		"
" 7		74	35·0	Nov. 8			·6026		"

TABLE

MAGNETIC

QUEBEC—

C. I.—Carnegie Institution.
C. S.—Coast Survey.

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° ′	° ′				° ′
Battle Harbour, Caribou island, Labrador	52 16·3	55 34·5	1881	Sept. 5,6,7,8.		37 12·7W
Grady, Labrador	53 48·2	56 25·3	1881	Aug. 3,4		39 03·8 "
Turnavik, Labrador	55 14·9	59 19·0	1881	July 28,29		40 22·8 "
" "	55 14·6	59 20·3	1896	July 20		38 26·4
Nain, Labrador	56 32·7	61 40·7	1881	Aug. 11 to 18		44 50·2 "
Gaspé Basin	48 50·0	64 30·0	1832			
Rivière du Loup	47 51·0	69 25·0	1876			
"	47 50·0	69 33·0	1906 7			20 38·7W
Brandypot island	47 53·0	69 42·0	1830			
St. Thomas, Montmagny	46 59·0	70 33·0	1876	Aug. 24,25		17 50·1W
Megantic	45 34·4	70 53·2	1907	Sept. 20,21, 23, 24		16 33·2
Alphonse	48 21·0	70 54·0	1906·7			21 54·0 "
Tring Jct	46 15·5	71 00·0	1907	Sept. 26, 27		17 22·2
Chicoutimi	48 25·0	71 03·0	1906·7			20 17·1 "
Quebec	46 48·6	71 13·3	1845			
"	"	"	"			
"	46 48·0	71 14·0	1906·2			17 53·0W
"	46 49·5	71 14·2	1842	Sept. 1		14 12·0 "
"	46 48·4	71 14·5	1859	July 19		16 17·0 "
"	"	"	1879	Sept. 16, 19.		17 13·7 "
Bécancour	46 22·0	71 33·0	1876	Aug. 17,18		15 43 5 "
Sherbrooke	45 23·9	71 56·2	1907	Sept. 14,16, 17, 18		15 59·9
Richmond Jct	45 41·0	72 03·0	1876	Aug. 15		16 59·6 "
Peribonka	48 46·0	72 05·0	1906·7			20 55·7 "
Stanstead	45 02·0	72 07·0	1842			
Kingsey	45 46·0	72 12·0	1842			
Roberval	48 31·0	72 14·0	1906·7			19 44 5W
Mistassini	48 54·0	72 14·0	1906·7			19 20·5 "
Lake Mempbremagog	45 01·0	72 15 0	1845			
Lake Edward	47 40·0	72 15·0	1906·7			19 34 4W
Three Rivers	46 21·0	72 32·0	1842			
"	46 21·0	72 33·0	1906·7			15 26·1W
Farnbam	45 16·1	73 01·5	1907	Sept. 9,10,11		15 12·4 "
Sorel	46 02·0	73 03·0	1842			
"	"	"	"			
St. Johns	45 17·0	73 15·0	1842			
Montreal	45 31·0	73 30·0	1833			
St. Helens island, Montreal	45 31·1	73 31·7	1842	Sept. 19	8 31a	8 57·6W
" " "	"	"	1843			
" " "	"	"	"			
" " "	"	"	"			
Montreal, The Mountain	45 31 0	73 33·3	1845			}
Montreal	45 31·0	73 32·0	1843			
"	45 30·0	73 33·0	1838			
"	45 30·3	73 34·9	1859	July 20		12 21·0W
"	"	"	1879	Sept. 25		13 40·5 "
"	"	73 35·0	1896 8			14 19·0 "
"	"	"	1905·7			14 40·1 "
"	"	"	1906·7			

IV.

RESULTS.

LABRADOR.

Month and day.	Hour and minute.	Dip.	Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature	Observer.
		° ′						
Sept. 6,7,8,9		77 16·0	Sept. 6, 7, 8.			·5794		S. W. Very.
Aug. 3,4,5		77 49·0	Aug. 3, 4			·6060		"
July 28,29		79 56·0	July 28, 29			·5916		"
		79 30·8			·1074	·5901		G. R. Putnam.
Aug. 11, 14, 19		78 22·0	Aug. 11, 15, 19			·5961		S. W. Very.
		78 50·0						Capt. Bayfield.
Aug. 28, 30		77 31 6				·5952		F. E. Hilgard.
		76 34·1			·1408			C. I.
								Capt. Bayfield.
Aug 24, 25		77 11·7				·5952		F. E. Hilgard.
		75 40·6			·1498	·6056		White-Fraser.
		77 56·1			·1279			C. I.
		76 06·7			·1462	·6094		White-Fraser.
		77 36·9			·1334			C. I.
		77 08·8	June 23			·6286		C. Younghusband.
			" 23			·6284		"
		76 01·1			·1477			C. I.
Sept. 1		77 15·3	Sept. 1			·6383		J. H. Lefroy.
July 18.		77 17·5	July 19			·6271		Schott.
Sept. 16, 19.		76 45·1	Sept. 16, 19.			·6243		Baylor.
Aug. 17, 18		76 54·5	Aug. 17, 18			·6005		F. E. Hilgard.
		75 26·7			1512	·6018		White-Fraser.
Aug. 15		75 47·7	Aug. 15			·6009		F. E. Hilgard.
		77 27·4			·1328			C. I.
Sept. 12		77 19·2	Sept. 12			·6282		J. H. Lefroy.
Sept. 10		77 14·0	" 10			·6311		"
		77 33·5			·1329			C. I.
		78 19·4			·1250			"
		76 08·6						A. W. Whipple.
		76 54·2			·1389			C. I.
Sept. 6		77 10·7	Sept. 6			·6383		J. H. Lefroy.
		75 57·1			·1482			C. I.
		75 20·1			·1540	·6095		White-Fraser.
Sept. 8		77 16·4	Sept. 8			·6340		J. H. Lefroy.
" 8.		77 16·5						"
" 14		77 00·1						"
		77 06·0						Back.
Sept. 16		77 13·1				·6326		J. H. Lefroy.
April 25		77 15·7	April 25			·6362		"
" 28		77 02·1	" 28			·6356		"
" 29		77 08·6	" 29			·6317		"
June 20		77 06·7	June 20			·6248		C. Younghusband.
" 20		77 10·3	" 23			·6234		"
			August			·6280		A. D. Bache.
		76 19·0						Estcourt.
July 20.		76 51·4	July 20.			·6308		Schott.
Sept. 25		76 25·7	Sept. 25			·6271		Baylor.
		75 40·2			·1507			C. S.
		75 38·2			·1512			C. I.
		75 38·1						"

TABLE

MAGNETIC

QUEBEC—

C. I.—Carnegie Institution.
C. S.—Coast Survey.

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° ′	° ′				° ′
*Isle Dorval	45 25 0	73 44·0	1843			
"	"	"	"			
"	"	"	" "			
St. Jérôme	45 46·0	73 59·0	1906·7			15 49·2W
Lacombe farm	55 33·0	74 09 0	1843·3			8 26·0 "
Labelle	46 16·0	74 33·0	1906 7			15 24·6 "
*Pointe du Chêne	45 37 0	74 50·0	1843	May 3	6 40p	7 28·0 "
"	"	"	"			
*Mishomis	47 13·0	75 38·0	1906·8			18 15·3W
Baskatong	46 49·0	75 52·0	1906·8			12 16·2 "
Aylmer	45 15·0	75 58 0	1843			
Maniwaki	46 23·0	75 59·0	1906·7			12 20·0W
*Portage des Chats	45 26·0	76 32·0	1843			
"	"	"	"			
Portage du Grand Calumet	45 45·0	76 40·0	1843			
Fort Coulonge	45 54·9	76 45·0	1843			
"	"	"	"			
"	"	"	"			
Pointe Baptême	46 05·0	77 26·0	1843			
Portage des Deux-Joachims	46 12·1	77 40·0	1843			
"	"	"	"			
Trou portage	46 15·0	78 16·0	1843			
"	"	"	"			
Kipawa	46 47·0	78 59·0	1906·8			9 44 9W

* Local disturbance.

IV—*Con.*

RESULTS—*Con.*

LABRADOR—*Con.*

Month and day.	Hour and minute.	Dip.	Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature	Observer.
		° ′						
April 30..	p. m.	77 03·1	April 30....	......	....	·6302	....	J. H. Lefroy.
....	....	....	" 30....	....	....	·6297	....	"
....	....	....	" 30..	....	....	·6261	....	"
....	....	76 08·2	....	....	·1487	....	....	C. I.
....	....	76 50·6	....	....	·1454	....	....	J. H. Lefroy.
....	....	76 29·8	....	....	·1432	....	....	C. I.
May 3......	....	76 55·4	May 3......	....	....	·6273	....	J. H. Lefroy.
....	....	....	" 3......	....	....	·6302	....	"
....	....	77 04·2	....	....	·1392	....	....	C. I.
....	....	76 38·5	....	....	·1417	....	....	"
May 5......	....	76 41·0	May 5......	....	....	·6380	....	J. H. Lefroy.
....	....	76 29·5	....	....	·1441	....	....	C. I.
May 6.. ..	Noon.	75 07·0	May 6......	....	....	·6450	....	J. H. Lefroy.
....	....	....	" 6.. ..	....	....	·6399	....	"
May 7......	p. m.	76 44·4	" 7......	....	....	·6378	....	"
" 8......	p. m.	77 29·7	" 8......	....	....	·6418	....	"
" 8......	....	77 16·7	" 8......	....	....	·6415	....	"
....	....	....	" 8......	....	....	·6433	....	"
May 9......	3 00p	77 19·1	" 9.. ..	....	....	·6351	....	"
" 10.. ...	11 00a	77 03·8	" 10......	....	....	·6374	....	"
....	....	....	" 10......	....	....	·6383	....	"
May 11......	p. m.	77 24·4	" 11 ...	....	....	·6429	....	"
....	....	....	" 11......	....	....	·6403	....	"
....	....	76 41.8	....	....	·1430	....	....	C. I.

TABLE

MAGNETIC

C. I.—Carnegie Institution.
L.S.—Lake Survey.
C.S.—Coast Survey.

ONTA

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° ′	° ′				° ′
Hawkesbury	45 36·0	74 37·0	1906·7			11 51·3 W
Cornwall	45 02·0	74 50·0	1845			
"	"	"	"			
Williamsburg	44 55·0	75 07 0	1843			
"	"	"	"			
Fox Point, Ottawa river	45 32·0	75 22·0	1843			
" "	"	"	"			
Prescott	44 35·0	75 30·0	1843			
Brockville	44 35·9	75 40·7	1907	Sept. 2, 3, 4.		10 34.2
"	44 32·0	75 41·0	1845			
"	"	'	"			
Ottawa.	45 21·0	75 42·0	1856			
"	45 23 6	75 42·9	1907	June 3.		12 36·5
" (C.I.S.)	45 24·0	75 43·0	1908	Nov. 2, 5, 26		12 48·5 W
" (Magnetic hnt).	"	"	"	" 20, 23, 26		12 50 5 "
Kingston Jct	44 15·2	76 28·0	1907	Aug. 27, 28		14 16·9
" (R. M. College*)	44 13·8	76 28·2	"	" 20, 21.		36 46·4
" (Artillery Barracks*).	44 13·0	76 28·6	1842			
"	"	"	"			
"	"	"	1843			
"	"	"	"			
"	"	"	1845			
"	"	"	"			
Kingston (Stewart point)	44 12·0	76 29·0	"			
" "	"	"	"			
Kingston (Barracks)	44 13·0	76 29·2	1907	Aug. 25		*30 07·4
Kingston Junction	44 15·0	76 29·0	1906·7			13 26·0 W
Kingston (The Common)	44 13·0	76 30·0	1845			
" "	"	"	'			
Renfrew	45 29·0	76 40·0	1906·7			11 13·6 W
Sharbot lake	44 46·4	76 41·2	1907			11 28·7
Pembroke	45 49·3	77 07·5	"			10 16·7
Belleville.	44 09·0	77 25·0	1843			
Chalk river	46 00·0	77 26·0	1906·8			10 20·2 W
Barry bay	45 28·8	77 40·3	1907	Aug. 9		08 46·3
Madawaska	45 30·0	77 59·0	1906·7			9 05·2 "
Cobourg	43 56·0	78 10 0	1843			
Peterborough	44 18·0	78 18·0	1906·7			8 16·1 "
Kinmount	44 48·0	78 39 0	1906·7			8 22·7 "
Mattawa	46 19·7	78 41·0	1907	July 23, 24		8 44·3
Little river	46 15 4	78 44·0	1843			
"	"	"	"			
Joe lake	45 35·2	78 46·5	1907	Aug. 6, 7		7 30·6
Niagara village	43 15·0	79 04·0	1843			
Niagara Falls	43 04·0	79 05·0	1841			
"	"	"	1845			
"	"	"	"			
South side of Trout lake	46 18 5	79 13·0	1843			
" "	"	"	"			
Agincourt (Mag. Obsy.)	43 47 0	79 16·0	1905			5 40·3 "
" '	'	"	1906·8			5 47·0 "
"	"	"	1908	July 9, 11.		6 2·2 "
"	"	"	"	" 9, 11.		5 59·0 "
Emsdale	45 32·0	79 18·0	1906·7			7 52.2 "

* Local disturbance.

V.

RESULTS.

RIO.

Month and day.	Hour and minute.	Dip.	Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature	Observer.
		° ′						
		76 03·1			·1500			C. I.
June 16		76 16·5	June 16			·6355		C. Younghusband.
" 16		76 16·3	" 16			6361		"
April 20		76 31·8	April 20			·6425		J. H. Lefroy.
" 20		76 29·8	" 20			·6452		"
May 4		76 35·3	May 4			·6410		"
			" 4			·6370		"
April 19		78 42·5						"
		75 03·6			·1577	·6118		White Fraser.
June 13		76 19·8	June 13			·6320		C. Younghusband.
" 13		76 18·0	" 13			6324		"
August		76 42·9						K. Friesack.
		75 41·2			·1505	6086		White-Fraser.
Nov. 2		75 41·9			1516			C. A. French.
			Nov. 23, 27		1516			"
		74 57·8			·1613	·6219		White-Fraser.
		73 27·3			1708	·5998		"
Nov. 11		77 18·8	Nov. 11			·6816		J. H. Lefroy.
" 11		77 19 1	" 11			·6990		"
April 18		77 18·1	April 18			·6921		"
			" 18			·6967		"
June 10		77 14·2	June 10			·6965		C. Younghusband.
" 10		77 14·7	" 10			.6969		"
			" 11			·6672		"
			" 11			·6652		"
		74 37·3						White-Fraser.
		74 57·3			·1621			C. I.
			June 11			·7137		C. Younghusband.
			" 11			·7125		"
		75 46·7			·1513			C. I.
		74 54·6			·1608	6173		White-Fraser.
		76 11·2			1476	·6182		"
April 17		77 01·0						J. H. Lefroy.
		76 23·5			·1461			C. I.
		75 53·9			·1501	6197		White-Fraser.
		75 54·0			·1503			C. I.
April 16		75 27·2						Corporal Henry.
		74 42·9			·1647			C. I.
		75 18·2			1558			C. I.
		76 41·2			·1429	·6205		White-Fraser.
May 12		77 28 5	May 12			·6448		J. H. Lefroy.
			" 12			·6406		"
		75 56·0			·1525	·6281		White-Fraser.
Mar. 11		74 45·6	Mar. 11			·6387		J. H. Lefroy.
Sept.		74 54·7						J. M. Nicollet.
Oct. 18		74 46·8	Oct. 18			·6342		J. H. Lefroy.
			" 18			·6345		"
May 13		77 21·7	May 13			·6430		"
			" 13			·6437		"
		74 33·8			1643			Observatory.
		74 35 6			·1638			C. I.
July 9		74 32·1	July 10, 11		·1638			C. A. French.
			" 10, 11		·1637			Observatory.
		75 48 7			·1520			C. I.

TABLE

MAGNETIC

ONTA

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° ′	° ′				° ′
Toronto, Magnetic Observatory	43 39·4	79 23·3	1841	12 months..	...	1 14·3W
" "	"	"	1842	" ..	...	1 19·1 "
" "	"	"	1843	...	...	...
" "	"	"	1844	...	...	...
" "	"	"	1845	12 months..	...	1 29·1 "
" "	"	"	1846	" ..	...	1 30·8 "
" "	"	"	1847	" ..	...	1 33·2 "
" "	"	"	1848	" ..	...	1 35·4 "
" "	"	"	1849	" ..	...	1 36·9 "
" "	"	"	1850	" ..	...	1 38·6 "
" "	"	"	1851	" ..	...	1 40·9 "
" "	"	"	1852	" ..	...	...
" "	"	"	1853	July & Aug.	Cor. for year.	1 46·1 "
" "	"	"	1854	Feb. to June		1 48·0 "
" "	"	"	1855	Aug. to Dec.		1 52·3 "
" "	"	"	1856	12 months..	...	1 56 3 "
" "	"	"	1857	" ..	...	2 00·5 "
" "	"	"	1858	" ..	...	2 04·5 "
" "	"	"	1859	" ..	...	2 07·4 "
" "	"	"	1860	" ..	...	2 10·6 "
" "	"	"	1861	" ..	...	2 14·4 "
" "	"	"	1862	" ..	...	2 15·7 "
" "	"	"	1863	" ..	...	2 19·1 "
" "	"	"	1864	" ..	...	2 21·9 "
" "	"	"	1865	" ..	...	2 24·8 "
" "	"	"	1866	" ..	...	2 27·6 "
" "	"	"	1867	" .	...	2 29·8 "
" "	"	"	1868	" ..	...	2 33·2 "
" "	"	"	1869	" ..	...	2 37·1 "
" "	"	"	1870	" ..	...	2 41·9 "
" "	"	"	1871	" ..	...	2 47·9 "
" "	"	"	1872	" ..	...	2 53·3 "
" "	"	"	1873	" ..	...	2 56·9 "
" "	"	"	1874	" ..	...	3 01·5 "
" "	"	"	1875	" ..	...	3 06·4 "
" "	"	"	1876	" ..	...	3 12·5 "
" "	"	"	1877	" .	...	3 22·6 "
" "	"	"	1878	" ..	...	3 31·3 "
" "	"	"	1879	" ..	...	3 36·0 "
" "	"	"	1880	" ..	...	3 40·0 "
" "	"	"	1881	" ..	...	3 46·6 "
" "	"	"	1882	" ..	...	3 50·5 "
" "	"	"	1883	" ..	...	3 54·3 "
" "	"	"	1884	" ..	...	3 57·7 "
" "	"	"	1885	" ..	...	3 59·8 "
" "	"	"	1886	" ..	...	4 02 1 "
" "	"	"	1887	" ..	...	4 04·8 "
" "	"	"	1888	" ..	...	4 08·3 "
" "	"	"	1889	" ..	...	4 12·0 "
" "	"	"	1890	" ..	...	4 18 2 "
" "	"	"	1891	" ..	...	4 23·3 "
" "	"	"	1892	" ..	...	4 29·2 "
" "	"	"	1893	" ..	...	4 36·4 "
" "	"	"	1894	" ..	...	4 42·2 "
" "	"	"	1895	" ..	...	4 44·7 "
" "	"	"	1896	" ..	...	4 48·9 "
" "	"	"	1897	" ..	...	4 52·8 "
" "	"	"	1898	*6 " ..	...	4 55·0 "

* Observatory moved to Agincourt in September 1898. The mean is interpolated from 6 months.
** For January-July, October-December ; 9 months.

V—*Con.*

RESULTS—*Con.*

RIO—*Con.*

Month and day.	Hour and minute.	Dip.	Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature.	Observer.
		° ′						
12 months..		75 16·6						
"		16·4						
"		14·7						
"		14·8						
"		15·5	12 months.			·64284		
"		15·1	"			·64153		
"		15·3	"			·64094		
"		18·3	"			·64234		
"		18·8	"			·64331		
"		20·0	"			·64323		
"		20·4	"			·64311		
		20·5	"			·64054		
10 months		22·2						
12 "		23·0						
"		23·5	Sept. to Dec.			·64276		
"		24 1	12 months..			·64115		
"		24.3	"			·63830		
"		24·4	"			·63871		
"		25·0	"			·63745		
"		24·6	"			·63680		
"		23·8	"			·63709		
"		23·2	"			·63695		
"		21·5	"			·63642		
"		20·9	"			·63680		
"		21·0	"			·63675		
"		19·2	"			·63550		
"		18·8	"			·63610		
"		20·1	"			·63706		
"		16·7	"			·63625		
"		16·3	"			·63451		
"		16·8	"			·63520		
"		15·5						
"		16·2						
"		13·9						
"		14·0						
"		13·3						
"		6·6						
"		2·4						
"		0·5						
"		74 57·3						
"		59·2						
"		55·2						
"		54·1						
"		53·2						
"		51·6						
"		49·0						
"		48·0						
"		46·5						
"		44·7						
"		42·2						
"		37·5						
"		37·0						
"		35·7						
"		34·2						
"		34·2						
"		34·7						
"		36·1						
**9 "		37·0						

observations for the year.

TABLE

MAGNETIC

C. I.—Carnegie Institution.
L. S.—Lake Survey.
C. S.—Coast Survey.

ONTA

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° ′	° ′				° ′
Toronto, Agincourt	43 47	79 16	1899	12 months		5 26·5 W.
" "	"	"	1900	"		5 27·8 "
" "	"	"	1901	"		5 29·4 "
" "	"	"	1902	"		5 31 7 "
" "	"	"	1903	"		5 33·7 "
" "	"	"	1904	10 "		5 36·4 "
" "	"	"	1905	12 "		5 42·2 "
" "	"	"	1906	"		5 45·6 "
" "		"	1907	"		5 50·6 "
North Bay	46 18·3	79 24·7	1907	July, 18,19,20		08 55·6 "
"	46 19·0	79 26·0	1906·8			8 44·2 "
Barrie	44 21·0	79 41·0	1843			
New Liskeard	47 31·0	79 42·0	1906·8			8 50·0 "
Timagami sta	47 04·0	79 47·0	1906·8			11 54·4 "
Lake Nipissing	46 11·0	79 48·0	1843			
Hamilton, in yard of Farmers inn	43 16·0	79 50·0	1842			
" " "	"	"	1845			
Englehart	47 50·0	79 52·0	1906·8			9 05·8 "
Penetanguishene	44 47·0	79 55·0	1906·7			6 58·9 "
"	"	79 58·0	1843			
"	"	"	1825			
"	"	"	1844			
"	"	"	"			
"	"	"	"			
"	"	"	"			
Timagami inn	46 58·0	80 02·0	1906·8			11 26·8 "
Rose point	45 19·1	80 02 3	1907	July 31, Aug. 1,2,3,4		6 49·1
Twin lake	48 16·0	80 17·0	1906·8			7 47·5 "
Simcoe.	42 51·0	80 18·0	1906·8			4 39·7 "
*Ricollet falls	45 57·0	80 30 0	1843			
"	"	"	"			
Berlin	43 27·0	80 31·0	1906·8			5 27·9 "
Owen Sound	44 35·0	80 57·0	1906·7			5 45·8 "
Sudbury	46 30·0	81 00·0	1906·7			6 26·8 "
"	46 29·0	81 00·0	1907	July 15,16,17		6 54·9 "
Small island, Lake Huron	45 55·5	81 02·0	1843			
" "	"	"	"			
" "	"	"	"			
Hyde Park Jc	42 59·0	81 19·0	1906·8			3 26·8 "
Stokes bay	44 59·0	81 22·0	1905·8			6 14·8 "
Southampton	44 30·0	81 23 0	1905·8			6 04·5 "
Kincardine	44 11·0	81 38·0	1905·8			5 12·4 "
Frazer bay, Lake Huron	46 00·0	81 40·0	1843			
" "	"	"	"			
Goderich, in garden foot of hill	43 45·0	81 41·0	1845			
" " "	"	"	"			
" " "	"	"	"			
" " "	"	"	"			
"	43 46·0	81 42·0	1906·7			4 15·5 "
" ¼ mile S. of Town Hall	43 44·0	81 43·0	1860			
Cove island	45 20·0	81 43·0	1860·7			3 58·6 "
"	"	81 44·0	1905·7			7 02·4 "
Goderich	43 44·0	81 44·0	1905·8			4 20·7 "
Cape Ipperwash, Lake Huron	43 13·0	82 00·0	1860			
Kettle point	43 13·0	82 01·0	1905·8			3 43·6 "
Fort La Cloche, Lake Huron	46 07·0	82 03·0	1843	May 18	8 33a	2 10 0 "
" "	"	"	1844			

* Local disturbance.

SESSIONAL PAPER No. 25a

V—*Con.*

RESULTS—*Con.*

RIO—*Con.*

Month and day.	Hour and minute	Dip.	Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature	Observer.
		° ′						
12 months.		74 35·9						
"		32·5						
"		32·1						
"		32·0						
"		32·6						
"		33·2						
"								
"								
"								
		76 35·7			·1433	·6182		White-Fraser.
		76 37·4			·1442			C. I.
Jan. 24		75 49·9						J. H. Lefroy.
		77 34·7			·1348			C. I.
		76 05·9			·1521			C. I.
May 14	p.m.	77 09·5	May 14			·6391		J. H. Lefroy.
Dec. 29		74 56 7	Dec. 29			·6374		"
" 31.		74 54·1						J. H. Lefroy.
		77 49·6			·1320			C. I.
		75 27·9			·1556			C. I.
Jan. 26		76 04·2						J. H. Lefroy.
April 18		76 16 0						Franklin.
Nov. 11		76 19·2	Nov. 11			·6491		J. H. Lefroy.
" 11		76 21·0	" 15			·6483		"
			" 15			·6483		"
			" 15			·6506		"
		76 47·4			·1428			C. I.
		75 36·1			·1525	·6588		White-Fraser.
		77 39·4			·1365			C. I.
		74 04·6			·1701			C. I.
May 15	2 00p	76 45·4	May 15			·6531		J. H. Lefroy.
			" 15			·6406		"
		74 23·3			·1666			C. I.
		75 10·7			·1590			C. I.
		76 22·0			·1477	·6254		C. I.
		76 35·2			·1451			White-Fraser.
May 16		76 31·3	May 16			·6422		J. H. Lefroy.
			" 16			·6394		"
			" 16			·6448		"
		73 56 6			·1704			C. I.
		75 32·0			·1538			L. S.
		75 00·0			·1584			L. S.
		74 36·0			·1641			L. S.
May 17	2 00p	77 05·6	May 17	2 00p		·6412		J. H. Lefroy.
			" 17			·6411		"
Oct. 28		75 04·4	Oct. 28			·6380		"
			" 28			·6374		"
Oct. 28		75 05·3	" 28			·6376		"
			" 28			·6383		"
		74 26·5			·1660			C. I.
July 19		75 02·0				6383		W. P. Smith
		76 32·0			·1506			L. S.
		75 44·0			·1553			L. S.
		74 29·0			·1645			L. S.
May 8		74 46·0	May 28			·6427		W. P. Smith.
		74 03·0			·1680			L. S.
								J. H. Lefroy.
Nov. 8		76 50·2						"

TABLE

MAGNETIC

ONTA

C. I.—Carnegie Institution.
L. S.—Lake Survey.
C. S.—Coast "

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° ′	° ′				° ′
Biscotasing	47 18·0	82 08·0	1906·7			3 07·2 "
Chatham	42 24·0	82 10·0	1906·8			2 13·8 "
Providence bay	45 40·0	82 17·0	1905·7			4 26·4 "
Sarnia, garden near the ferry	45 58·0	82 22·0	1845			
" "	"	"	"			
" "	45 58 0	82 22·0	1845			
" "	"	"	"			
Snake island, Lake Huron	46 10·0	82 40·0	1843			
" "	"	"	"			
Algoma	46 11·0	82 50·0	1906·8			4 35·4 W.
Great Duck island	45 38·0	82 56·0	1905·7			2 22·8
Amherstburg	42 06·0	83 03·0	1845			
"	"	"	"			
Missisagi straits	45 54·0	83 14·0	1905·7			4 06·4 "
*Cockburn island	45 52 0	83 21·0	1905·7			2 11·3 E.
Chapleau	47 50·0	83 27·0	1906·8			4 04·0 W.
"	47 49·6	83 27·0	1907	July 11,12,13		3 47·0
Thessalon point, Lake Huron	46 17·0	83 33 0	1843	May 19	3–26p	0 11·4 "
" "	"	"	"			
Missinaibi	48 20·0	84 07·0	1906·7			5 39·1 "
Sault Ste. Marie	46 30·9	84 21·5	1844	Nov. 4	9–56a	1 14·1 E.
"			"	" 4	10–05a	0 51·1 "
"			"	" 4	11–05a	1 08·2 "
"			1845			
Pointe aux Pins, Lake Superior	46 29·9	84 29·0	1843			
" " "	"	"	"			
" " "	"	"	"			
Sinclair harbour	47 22·0	84 42·0	1906·6			2 41·4 W.
Parisian island	46 39·0	84 42·0	1906·6			2 37·6 "
Gros Cap	46 32·0	84 43·0	1841			
Pointe aux Crêpes, Lake Super'r	46 58·0	84 44·0	1843	May 21	5–08p	3 02·8 E.
Mamainse point	47 02·0	84 47·0	1906·6			0 34·7 "
Michipicoten, Lake Superior	47 56 0	84 50 6	1880	J'ly 21, Sep. 9		1 20·5 W.
" "	47 56·2	84 54·0	1843	May 23	9–55a	0 20·3 E.
" "	"	"	"			
" "	"	"	1844			
" "	"	"	"			
" "	"	"	"			
" "	"	"	1845			
Gargantua I	47 34·0	84 58·0	1906·7			2 26·3 W.
*Cape Gargantua, L. Superior	47 36·9	85 05·0	1843	May 21	2–15p	0 38·0 E.
" " "	"	"	"			
" " "	"	"	"			
White river	48 36·0	85 18·0	1906·7			3 00 6 W.
Michipicoten I	47 42·0	85 46·0	1906·7			1 49·2 E.
Caribou I. No 1	47 20·0	85 50·0	1906·7			1 16·6 W.
Otter island	48 06·0	86 03·0	1906·7			4 07·3 "
*S.E. of Otter I., Lake Superior	48 07·0	86 07·0	1843			
" "	"	"	"			
Tip-Top	48 15·0	86 08·0	1871			
Oiseaux bay	48 22·0	86 10·0	1906·7			1 41·4 "
Rivière Blanche, Lake Superior	48 31·7	86 14·0	1844	Oct. 21	3–51p	2 15·2 E.
" " "	"	"	"			
" " "	"	"	"			
Pic, Lake Superior	48 35·3	86 15·0	1843			
" "	"	"	"			
" "	"	"	1844	Oct. 18	10–38a	5 13·3 E.
" "	"	"	"	" 18	11–06a	5 52·5 "
" "	"	"	"			

* Local disturbance.

V—*Con.*

RESULTS—*Con.*

RIO—*Con.*

Month and day.	Hour and minute.	Dip.	Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature	Observer.
		° ′						
		77 09·4			·1384			C. I.
		73 33·4			·1749			C. I.
		76 00·0			·1513			L. S.
Oct. 25		74 18·6				·6366		J. H. Lefroy.
						·6370		"
Oct. 27		74 12·9				·6370		"
						·6362		"
May 18		77 05·5	May 18			·6383		"
			" 18			·6393		"
		76 24·0			·1467			C. I.
		76 24·0			·1461			L. S.
Oct. 22		73 32·7	Oct. 22			·6347		J. H. Lefroy.
" 22		73 27·2	" 22			·6342		"
		76 40·0			·1421			L. S.
		77 00·0			·1421			L. S.
		77 50·6			·1329			C. I.
		77 54·1			·1321	·6304		White-Fraser.
May 19		76 59·3	May 19			·6484		J. H. Lefroy.
" 19		77 04·8	" 19			·6418		"
		77 51·6			·1330			C. I.
Nov. 4		77 46·2	Nov. 4			·6365		J. H. Lefroy.
" 4		77 45·6	" 4			·6369		"
			" 4			·6386		"
May		77 19·5						Dr. J. Rae.
" 20		77 13·4	May 20			·6510		J. H. Lefroy.
" 20		77 12·1	" 20			6462		"
			" 20			·6481		"
		77 26·0			·1411			L. S.
		76 44·0			·1478			L. S.
Aug		77 05·3						E. Loomis.
May 21		77 11·5	May 21			·6436		J. H. Lefroy.
		77 18·0			·1444			L. S.
								S. W. Very.
May 23		78 06·3	May 23			·6460		J. H. Lefroy.
" 23		78 04·4	" 23			·6496		"
Oct. 30		78 08·1	Oct. 30			·6435		"
" 30		78 08·5	" 30			·6462		"
			" 30			·6417		"
		75 05·2						Dr. J. Rae.
		77 54·0			·1374			L. S.
May 21		77 56·1	May 21			·7019		J. H. Lefroy.
			" 21			·7050		"
			" 21			·7042		"
		78 15·9			·1291			C. I.
		77 36·0			·1379			L. S.
		77 02·0			·1451			L. S.
		78 42·0			·1253			L. S.
May 24	1–30p	79 43·6	May 24			·6226		J. H. Lefroy.
" 24		79 32·8	" 24			·6330		"
Aug. 26		78 56·0	Aug. 26			·6358		C. B. Coomstock.
		78 04·0			·1319			L. S.
Oct. 21	2–00p	78 33·7	Oct. 21			·6509		J. H. Lefroy.
" 21		78 32·5	" 21			·6524		"
			" 21			·6494		"
May 25	a.m.	78 45·8	May 25			·6412		"
" 25	a.m.	78 40·8	" 25			·6460		"
Oct. 17	a.m.	78 32·8	Oct. 17			·6359		"
" 17	a.m.	78 29·9	" 17			·6387		"
			" 17			·6349		"

TABLE

MAGNETIC

C. I.—Carnegie Institution.
L. S.—Lake Survey.
C. S.—Coast "

ONTA

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° ′	° ′				° ′
Pic, Lake Superior	48 35·3	86 15·0	1845			
Peninsula harbor	48 42·0	86 20 0	1906·7			4 53·7W
"	48 44·0	86 28·0	1824			
*Black Rock	48 41·0	86 30·0	1906·7			19 26·4W
Pic island	48 42·0	86 34·C	1906·7			2 45·8 "
Sunday harbor	48 37·0	86 59·0	1906·7			1 21·0 "
Schreiber	48 49·0	87 18·0	1906·7			0 22·4 "
*Battle island, Lake Superior	48 45·0	87 33·0	1843			
" "	48 45·0	87 33·0	1843			
" "	48 45·0	87 33·0	1843			
" "	48 45·0	87 33·0	1906·7			1 57·6W
Simpson island, L. Superior	48 49·0	87 45·0	1843	May 27	6–30a	5 44·8 E
" "	48 49·0	87 45·0	1843			
Isle St. Ignace	48 46·0	87 48·0	1906·7			4 58·1 "
Spar Point island	48 38·0	88 06·0	1906·7			2 00·2 "
Lamb island	48 36·0	88 08·0	1906·7			6 12·0 "
*Porcupine island	48 38·0	88 09·0	1906·7			21 30·1W
Nipigon	49 01·0	88 16·0	1906·7			1 17·5 E
Roche de Bout ids.	48 31·0	88 21·0	1906·7			0 29·4W
Big Edward island	48 22·0	88 38·0	1906·8			3 28·4 E
Porphyry point	48 21·0	88 38·0	1906·8			3 16·2 "
Five miles east of Thunder cape	48 20·0	88 52·0	1843			
" "	48 20·0	88 52 0	1843			
Thunder harbor	48 19·0	88 53·0	1906·8			2 14·0 E
Port Arthur	48 26·0	89 12·6	1884			
Fort William	48 23·5	89 13 5	1843	May 29	5–32p	6 14·3 E
"	48 23·5	89 13 5	1843	" 30	4–12p	6 41·9 "
"	48 23·5	89 13 5	1843	" 30	4-17p	6 56·6 "
"	48 23·5	89 13·5	1843	" 31	9–11a	6 46·1 "
"	48 23·5	89 13·5	1824			9 05·0 "
"	48 23·5	89 13·5	1825	May 12		7 17·5 "
"	48 23·5	89 13·5	1844	Oct. 11		5 01·4 "
"	48 23 5	89 13·5	1844			
"	48 23·5	89 13·5	1844			
"	48 23·5	89 13·5	1845			
Fort William school	48 24·0	89 14 0	1902·8			3 49·9E
Fort William mission	48 24·0	89 14·0	1902·8			3 32·9 "
Fcrt William	48 24·0	89 14·0	1906·7			3 37·2 "
Sturgeon bay	48 11·0	89 18·0	1906·8			2 18·1 "
*Victoria island	48 05·0	89 21·0	1906·8			0 31·3 "
Dog portage	48 39·0	89 30·0	1843			
"	48 39·0	89 30·0	1843			
"	48 39·0	89 30·0	1844			
"	48 39·0	89 30·0	1844			
"	48 39·0	89 30·0	1844			
Pigeon river	48 00·0	89 34·0	1906·8			2 44·8 E
*Portage Ecarté	48 25·0	89 44·0	1843			
"	48 25·0	89 44·0	1843			
Prairie portage	48 57·5	90 01·5	1843			
"	48 57·5	90 01·5	1843			
"	48 57·5	90 01·5	1844			
"	48 57·5	90 01·5	1844			
"	48 57·5	90 01·5	1844			
S. W. of Savanne portage	48 53·0	90 03·3	1825	May 21		9 23·9 E
" "	"	"	1843	June 6	7–52a	8 06·3 "
" "	"	"	1844	Oct. 6	7–12p	7 23·1 "

* Local disturbance.

SESSIONAL PAPER No. 25a

V—*Con.*

RESULTS—*Con.*

RIO—*Con.*

Month and day.	Hour and minute.	Dip.	Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature	Observer.
		° ′						
May..		78 34·0						Dr. J. Rae.
		77 47·0			·1419			L. S.
		78 34·0						Bayfield.
		81 50·0			·1016			L. S.
		78 08·0			·1320			L. S.
		78 18·0			·1298			L. S.
		78 24·8			·1271			C. I.
May 26		76 24·0	May 26			·6294		J. H. Lefroy.
			" 26			·6309		"
			" 26			·6291		"
		79 04·0			·1234			L. S.
May 27	8-00a	78 53·6	May 27			·6468		J. H. Lefroy.
" 27		78 46·2	" 27			·6457		"
		78 10 0			·1298			L. S.
		78 26·0			·1021			L. S.
		79 20·0			·1164			L. S.
		68 48·0			·1983			L. S.
		78 28·6			·1274			C. I.
		78 55·0			·1251			L. S.
		78 21·0			·1294			L. S.
		78 06·0			1315			L. S.
May 28		78 23·2	May 28			·6587		J. H. Lefroy.
" 28		78 30·0	" 28			·6480		"
		78 00·0			·1305			L. S.
July 14	2-40 to 3-20p	78 09·0	July 14	3-45 to 5-30p		·6402		E. Deville.
May 29		78 09·7	May 29			·6528		J. H. Lefroy.
" 29		78 10·2	" 29			·6509		"
			" 29			·6500		"
			" 31			{ 6452 ·6457		"
								Bayfield.
May 11		78 20 0						Franklin.
Oct. 11		78 07·5	Oct. 11			·6428		J. H. Lefroy.
" 11		77 55·5	" 11			·6423		"
" 11		77 55·5	" 11			·6387		"
		78 11·0						Dr. J. Rae.
		77 54·6			·1332			C. S.
		77 54·9			·1331			C. S.
		77 48·0			·1341			C. I.
		77 29·0			·1349			L. S.
		77 51·0			·1348			L. S.
June 3	4-30p	78 26·8	June 3			·6518		J. H. Lefroy.
" 3		78 25·0	" 3			·6480		"
			Oct. 9			·6507		"
			" 9			·6533		"
			" 9			·6547		"
		78 07·0			·1295			L. S.
June 2		77 13·5	June 2			·6463		J. H. Lefroy.
			" 2			6442		"
June 5		78 26·1	" 5			·6486		"
" 5		78 28·2	" 5			·6446		"
			Oct. 7			·6515		"
			" 7			·6560		"
			" 7			·6543		"
May 20		78 39·1						Franklin.
								J. H. Lefroy.
Oct. 6	11-00a	78 21·8	Oct. 6			·6507		"

TABLE

MAGNETIC

C. I.—Carnegie Institution.
L. S.—Lake Survey.
C. S.—Coast Survey.

ONTA

Place.	Latitude.	Longitude.	Year.	Month and Day.	Hour and Minute.	Declination.
	° ′	° ′				° ′
S. W. of Savanne portage....	48 53·0	90 03 3	1844	Oct. 6.....	7-50a	7 25·6 E
" "	"	"	1857			6 53·0 "
Savanne..........	48 58·0	90 14·0	1906·7			4 33·8 "
French portage	48 35·0	91 08·4	1843			
"	"	"	"			
End of the portage of the Two Rivers	48 35·0	91 23·0	1843	June 9....	9-56a	10 57·6 "
" "	"	"	"			
" "	"	"	1844			
" "	"	"	"			
" "	"	"	"			
Ignace..........	49 25·0	91 40·0	1906·7			6 14·6 "
E. end of Lac à la Crosse......	48 24·0	92 04 0	1843	June 10	7-44a	7 52·5 "
" "	"	"	"			
2nd portage, Lac à la Crosse...	48 14·2	92 25·0	"	June 11 ...	7-41a	10 40·3 "
" " ..	"	"	"	"	8 13a	10 01 0 "
Sturgeon lake	48 27·5	92 38·0	"			
"	"	"	"			
Farrington..........	48 46·0	92 48·0	1906·8			7 39·2 "
S. side, Lac à la Pluie.......	48 33·4	92 50·0	1843	June 13	9-30a	10 53·6 "
" "	"	"	"			
Eagle river..........	49 48·0	93 11 0	1906·7			6 39·7 "
Fort Frances..........	48 36·6	93 26·7	1825	May 28......		10 42·6 "
"	"	"	1843	June 14 ...	6-25p	10 33·3 "
"	"	"	"	" ...	6-52p	10 36.7 "
"	"	"	"	" ...	6-00	
"	"	"	"			
"	"	"	"			
"	"	"	1844	Sept. 30....	9-26a	8 36·7 "
"	"	"	"	" ..	3-17p	8 34·1 "
"	"	"	"			
"	"	"	1845			
"	"	"	1857			9 31·0 "
Kenora..........	49 46·0	94 26·0	1906·7			9 54·1 "
Near Rat portage, Winnipeg river..........	49 46·3	94 29·4	1885	June 22 ...	10-30a	11 55·7 "
" "	"	"	"			
" "	"	"	"			
On N. bank of Rainy river....	48 41·0	94 31·0	1843	June 16	7-48a	13 04.5 "
" "	"	"	"			
" "	"	"	"			
*Rainy river..........	48 43·0	94 31·0	1906 8			9 33·8 "
Rat portage	49 45·9	94 33·3	1843	June 20 ...	10-11a	9 38·0 "
"	"	"	"			
"	"	"	"			
"	"	"	1844			
"	"	"	"			
"	"	"	"			
Winnipeg river..........	49 53·1	94 34·2	1885	June 25	10-00a	10 09.1 "
Island in Lake of the Woods..	49 25·0	94 37·0	1843	June 18	3-14p	12 26·0 "
" " ..	"	"	"			
" " ..	49 19·0	94 40 0	"	June 17	7-58a	13 42·6 "
" " ..	"	"	"			
Sand lake, Winnipeg river	50 02 5	94 41·9	1885	June 28	10-45a	10 53·2 "
Settlement, mouth of White Dog river..........	50 08·2	94 54·4	1885	July 1.....	5-45p	9 41·0 "

*Local disturbance.

V—*Con.*

RESULTS—*Con.*

RIO—*Con.*

Month and Day.	Hour and Minute.	Dip.	Month and Day.	Hour and Minute	Hor. Intens.	Total. Intens.	Temperature.	Observer.
		° ′					°	
Oct. 6		78 14·4	Oct. 6			.6499		J. H. Lefroy.
								Palliser.
		78 09·9			.1304			C. I.
June 8		78 20·4	June 8			.6494		J. H. Lefroy.
"		78 05·5	"			6471		"
June 9		77 49·4	June 9			6508		"
"		77 53·2	"			.6473		"
			Oct. 4			6384		"
			"			6422		"
			"			6407		"
		78 27·4			.1279			C. I.
June 10	10-00a	77 51 0	June 10			.6488		J. H. Lefroy.
			"			6474		"
June 11		77 40·1	June 11			.6473		"
			"			.6453		"
June 12	1-00p	77 44·8	June 12			6503		"
			"			.6462		"
		77 42 4			.1349			C. I.
June 13		77 47·9	June 13			.6515		"
"		77 28·7	"			.6461		"
		78 07 8			.1313			"
May 28		77 18·1						Franklin.
June 14		77 28·0	June 14			.6467		J. H. Lefroy.
"		77 22 8	"			.6480		"
			"			.6420		"
			"			.6471		"
			"			.6475		"
			Sept. 29			.6456		"
			"			.6487		"
			"			.6488		"
		77 32·0						Dr. J. Rae.
								Palliser.
		77 58·9			.1318			C. I.
June 22	10-25a to 10-45p	78 31·3	June 22	1-23 to 2-10p		.6444	87	Th. Fawcett.
Oct. 19	8-38 to 9-00a	78 36·1	Oct. 19	9-40 to 10-11a		.6445	34	"
"	9-03 to 9-35a	78 38·5	"	10-11 to 10-50a		.6403	37	"
June 16	9-00a	77 57 4	June 16			.6593		J. H. Lefroy.
"		78 14·9	"			.6633		"
			"			.6575		"
		77 27·2			.1376			C. I.
June 20		78 07·5	June 20			.6480		J. H. Lefroy.
"		78 07·1	"			6463		"
"		78 00·5						"
			Sept. 25			.6417		"
			"			.6452		"
			"			.6446		"
June 25	10-10 to 11-30a	78 28·3	June 25	2-00 to 2-45p		6504	79	Th. Fawcett.
June 18	1-00p	78 16·7	June 18			.6503		J. H. Lefroy.
"		78 15·2	"			.6413		"
June 17	9-20a	78 03·7	June 17			.6516		"
"		78 01·7	"			6482		"
June 28	11-20 to 12-45a	78 31·4	June 28	1-20 to 1-43p		.6538	82	Th. Fawcett.
July 1	6-17 to 7-00p	78 28·2	July 1	7-02 to 8 00p		.6518	72	"

TABLE

MAGNETIC

HUDSON BAY AND

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° ′	° ′				° ′
Eastmain	52 14·7	78 29·3	1890	Sept. 11	5–25 to 5–45p	15 01 6W
"	"	"	"	Oct. 2	4–25 to 4–41p	14 51·5 "
"	"	"	"			
"	"	"	"			
Rupert House	51 29·5	78 43·4	1890	Aug. 13.	5–14 to 5–38p	14 15·1 "
"	"	"	"			
"	"	"	"			
At sea, Hudson bay	63 17·0	78 55·0	1846			58 15·0 "
"	60 10·0	80 10·0	1846			
"	62 10·0	80 10·0	"			
"	52 20·0	80 17·0	"			
"	51 32·0	80 34·0	"			10 41·0 "
"	53 24·0	81 06·0	"			
"	53 42 0	81 09·0	"			12 48·0 "
"	60 20·0	81 12·0	"			
"	62 20·0	81 12·0	"			
"	53 57·0	81 30·0	"			
"	54 43·0	81 32·0	"			13 30·0 "
"	56 24·0	81 50·0	"			
"	56 40·0	81 57·0	"			
"	60 26·0	82 0·80	"			
"	55 25·0	82 14·0	"			11 53·0 "
"	55 29·0	82 24·0	"			
"	57 15·0	82 33·0	"			15 57·0 "
"	57 04·0	82 37·0	"			
"	57 32·0	82 37·0	"			16 15·0 "
"	57 09·0	82 42·0	"			17 16·0 "
"	60 25·0	82 42·0	"			
"	59 11·0	82 45·0	"			
"	60 45·0	82 45·0	"			
"	61 07·0	82 50·0	"			
"	58 53·0	82 52·0	"			20 52·0 "
"	57 15·0	82 53·0	"			15 57·0 "
On shore, Hudson bay	51 08·0	80 44·0	"			10 55·0 "
Moose Factory	51 15·0	80 56·0	"			12 40·0 "
"	51 15 4	80 40·5	1880	Aug. 14, 17, 20		15 27·5 "
"	51 14·5	80 56·0	1890	July 24	4–15 to 4–48p	15 14·7 "
"	"	"	"			
Fort Albany, Hudson bay	51 22·0	82 38·0	1775			
Fort Hope	66 32·0	86 56·0	1846			
"	"	"	"			
"	"	"	1847			
"	"	"	"			

VI.

RESULTS.

SURROUNDING TERRITORY.

Month and day.	Hour and minute.	Dip.	Month and day.	Hour and minute.	Hor. Intens.	Total Intens.	Temperature	Observer.
Sept. 11	3-20 to 3-46p	80 43·4						Wm. Ogilvie.
" 11	4-16 to 4-30p	80 46·7						"
Oct. 2	2-28 to 2-57p	80 47·4						"
" 2	3-35 to 3-56p	80 42·6						"
Aug. 13	10-58 to 11-22a	80 26·6						"
" 13	11-57 to 12-18a	80 34·2						"
Oct. 5	3-47 to 4 09p	80 33·8						"
		86 35·0				·6248		T. E. L. Moore.
		87 01·0				·6160		"
		87 01·0				·6160		"
		81 49·0						"
		80 59·0						"
		82 20·0						"
						·6404		"
		86 07·0						"
		86 07·0						"
		83 02·0				6358		"
		83 47·0				·6381		"
		84 10·0						"
		84 42·0				·6248		"
		85 20·0				·6257		"
		84 00·0				·6266		"
		83 48·0				·6114		"
		84 30·0				·6266		"
		84 31·0						"
		85 15·0				·6123		"
		84 36·0						"
		86 36·0				·6095		"
		86 30·0				·6289		"
		86 41·0				·6261		"
		87 00·0				·6082		"
		85 48·0						"
		84 34·0				·6238		"
		81 02·0				·6487		"
		81 30·0				·6510		"
								S. W. Very.
July 22.	10-20 to 10-48a	80 48·5						Wm. Ogilvie.
" 23	11-30 to 11-57a	80 52·0						"
		79 20·0						Hutchins.
November		88 03·8						Dr. J. Rae.
December		88 14·0						"
January		88 17·5						"
February		88 12·2						"

TABLE

MAGNETIC

Hudson Bay and

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° ′	° ′				° ′
Repulse bay	66 32·0	86 55·0	1846	....	....	....
Near Wager river	65 10·0	87 30·0	"	....	....	....
Three miles N. W. of cape Lady Pelly	64 30·0	88 00·0	"	....	....	....
Knapp bay	64 06·0	88 00·0	"	....	....	....
"	61 09·7	....	"	....	....	....
Mouth of Albany R., Lake St. Joseph	51 12·7	90 09 8	1885	Sept. 10	3–50p	6 09·0 E
" "	"	"	"	" 11	8–30a	5 33·4 "
Lake St. Joseph	51 11 2	90 37·0	1885	Sept. 6	9–30a	5 22·0 "
"	"	"	"	" 6	4–10p	5 18·8 "
" *	50 58·8	91 08·0	"	Aug. 29	5–50p	24 27·2 "
" *	"	"	"	" 30	10–17a	23 43·9 "
On a portage, Root river	50 49·7	91 22·7	1885	Aug. 23	8–00a	7 20·3 E
" "	"	"	"	" 23	4–10p	7 07·5 "
Cat river	51 05·7	91 24 2	"	Sept. 20	10–15a	5 35·3 "
"	"	"	"	" 20	3–33p	5 35·0 "
Root river	50 41·2	91 35·8	"	Aug. 16	10–00a	6 55·7 "
"	"	"	"	" 16	3–15p	6 50·6 "
H. B. Co.'s post, Cat lake	51 44 3	91 46·2	"	Sept. 30	4–00p	4 50·1 "
" "	"	"	"	Oct. 1	6–40a	4 31·1 "
Cat river	51 30·0	91 49·7	"	Sept. 27	9–39a	5 12 3 "
"	"	"	"	" 27	4–13p	4 43·2 "
Cat lake	51 46·3	91 51 1	"	....	....	....
"	"	"	"	....	....	....
Lac Seul	50 23·7	92 04 8	"	Aug. 9	9-20a	8 22·4 E
"	"	"	"	" 9	4-40p	8 09·1 "
H. B. Co.'s post, Lac Seul	50 19·5	92 14·4	"	" 6	4–30p	7 03·9 "
" "	"	"	"	" 7	10–00a	7 09·4 "
At a creek	58 02·0	92 20·0	1846	....	....	....
York Factory	56 59·9	92 26·0	1843	July 24	6–07p	9 37·8 E
"	"	"	"	" 24	6–40p	9 07·8 "
"	"	"	"	" 26	7–21a	8 16·2 "
"	"	"	"	" 26	7–36a	9 00·8 "
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	1845	....	....	....

* Local disturbance.

V I—*Con.*

RESULTS—*Con.*

SURROUNDING TERRITORY—*Con.*

Month and day.	Hour and minute.	Dip.	Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature	Observer.
		° ′					°	
July 27...	....	88 16·7	....	....	....	....	....	Dr. J. Rae.
....	....	87 10·6	....	....	....	....	....	"
Aug. 3....	....	88 27·1	....	....	....	....	....	"
....	....	86 36·5	....	....	....	....	....	"
July 8...	....	86 47·3	....	....	....	....	....	"
Sept. 10....	4-12 to 4-55p	80 18·3	Sept. 10....	5-00 to 5-25p	....	·6481	60	Th. Fawcett.
" 11....	9-00 to 9-30a	80 21·4	" 11....	9-35 to 10-00a	....	·6484	56	"
" 6....	10-00 to 10-30a	80 25·3	" 6....	10-35 to 11-00a	....	·6450	52	"
" 6....	4-35 to 5-00p	80 19·0	" 6....	5-55 to 6-20p	....	·6463	48	"
Aug. 29....	6-10 to 6-38p	81 46·6	Aug. 29....	6-40 to 7-04p	....	·6435	55	"
" 30....	10-20 to 10-40a	81 48·8	" 30....	11-56 to 12-15a	....	·6413	61	"
" 23....	8-27 to 8-55a	79 42·1	Aug. 23....	9-00 to 9-26a	....	·6513	51	"
" 23....	4-26 to 4-54p	79 39·4	" 23....	4-56 to 5-15p	....	·6500	48	"
Sept. 20....	10-15 to 11-08a	80 05·7	Sept. 20....	11-10 to 11-40a	....	·6491	70	"
" 20....	4-03 to 4-30p	80 04·5	" 20....	4-35 to 5-00p	....	·6493	60	"
Aug. 16....	0-08 to 0-33p	79 27·1	Aug. 16....	0-35 to 1 00p	....	·6526	67	"
" 16....	3-28 to 3 52p	79 26·1	" 16....	3-54 to 4-10p	....	6516	70	"
Sept. 30....	4-00 to 4-30p	80 29·0	Sept. 30....	4-32 to 5-00p	....	·6497	46	"
Oct. 1....	7-40 to 8-10a	80 29·0	Oct. 1....	8-18 to 8-42a	....	.6475	47	"
Sept. 27....	10-02 to 10-24a	80 11·6	Sept. 27....	10-26 to 11-00a	....	·6533	67	"
" 27....	4-35 to 5-07p	80 07·0	" 27....	5-09 to 5-25p	....	·6548	61	"
Oct. 1....	3-26 to 4-15p	80 24·6	Oct. 1....	4-20 to 5-07p	....	·6538	55	"
1....	4-17p	80 21·8	" 1....	5-08 to 5-30p	....	·6523	55	"
Aug. 9....	4-40 to 5-35p	79 03·9	Aug. 9....	5-38 to 6-00p	....	.6557	72	"
" 9....	6-07 to 6-30p	79 04·9	" 9....	10-36 to 11-00	....	·6539	70	"
" 6....	4-43 to 5-12p	79 35·3	" 6....	5-18 to 5-40p	....	·6534	70	"
" 7....	10-00 to 10-33a	79 34·4	" 7....	10-35 to 11-00a	....	·6537	69	"
June 20....	....	84 46·4	....	....	....	....	....	Dr. J. Rae.
July 24....	11-00a	83 50·5	July 24....	....	....	·6492	....	J. H. Lefroy.
" 24....	3-00p	83 44·0	" 24....	....	....	·6481	....	"
....	....	....	" 25....	....	....	·6500	....	"
....	....	....	" 25....	....	....	·6433	....	"
....	....	....	" 25....	....	....	·6460	....	"
....	....	....	" 26....	....	....	·6495	....	"
....	....	....	" 26....	....	....	·6494	....	"
Dec. 3....	....	83 54·2	....	....	....	....	....	Dr. J. Rae.

TABLE

MAGNETIC

HUDSON BAY AND

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° '	° '				° '
York Factory......	56 59·9	92 26·0	1846	....	....	....
"	"	"	"	....	....	....
"	"	"	1847	....	....	....
"	"	"	1857	....	....	....
"	"	"	"	....	....	....
"	"	"	1884	Sept. 12....	10-15 to 11-53a	6 45·0E
"	"	"	"	" 13....	9-20 to 9-46a	6 32·0 "
Shanty narrows, Lac Seul.	50 29·3	92 51·57	1885	Aug. 1....	5-33p	6 54·7 "
"	"	"	"	" 2...	7-47a	7 15·7 "
Jct. of the Shamattawa and Hayes rivers..	56 21·0	93 00·0	1843	July 22....	6-15p	10 00·0 "
" "	"	"	"	" 28..	4-03p	12 19·6 "
" "	"	"	"	....	....	....
" "	"	"	"	....	....	....
English river.	50 38·9	93 10 2	1885	July 29...	5-30p	9 21·0E
"	"	"	"	....	....	....
Camping lake, English river...	50 38·1	93 24·1	"	July 26....	9-40a	8 20·0 "
" "	"	"	"	....	....	....
White Mud portage	55 33·0	93 44 6	1843	July 31....	7-19a	10 51·0E
" "	"	"	"	....	....	....
" "	"	"	"	....	....	....
" "	"	"	"	....	....	....
Tide lake, English river.	50 20·6	93 57·0	1885	July 18....	6-15p	9 24·8E
" "	"	"	"	" 19....	5-30a	9 23 8 "
Devils Landing Place	54 24·0	94 00·0	1844	Aug. 1....	8-24a	11 49·4 "
" "	"	"	"	....	....	....
Grassy narrows, English river..	50 10 7	94 02·2	1885	July 15....	5-00p	9 28·0 "
" "	"	"	"	....	....	....
Fort Churchill.....	58 43·8	94 14·0	1846	June 29 ...	a.m.	12 43·0 E.
"	"	"	"	July 1....	p.m.	11 29·0 "
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
Long portage	55 14·0	94 22·0	1819	Sept....	....	11 10·4 E.
"	"	"	1843	July 20.....	5-42a	12 59·4 "
"	"	"	"	Aug. 2....	6-29a	12 13·5 "
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
English river.	50 16·0	94 30 6	1885	July 12...	8-10a	9 44·7 E.
"	"	"	"	....	....	....
"	50 21·8	94 39·3	"	" 9.....	6-00p	10 21·2 E.
"	"	"	"	....	....	....
"	50 14·5	94 59·3	"	July 5....	9-50a	9 07·0 E.

VI—*Con.*

RESULTS—*Con.*

SURROUNDING TERRITORY—*Con.*

Month and day.	Hour and minute.	Dip.	Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature	Observer.
		° ′					°	
Feb. 9		83 42·9						Dr. J. Rae.
April 25		83 35·5						"
Sept. 18		83 47·0						"
Aug. 9		83 53·0				·6466		Blakiston.
						·6463		"
Sept. 11	3-05 to 3-40p	83 47 2	Sept. 11	3-45 to 4-10p		·6419		Otto Klotz.
" 11	4-18 to 4-56p	83 46·7	" 11	3-45 to 4-10p		·6423		"
Aug. 1	5-35 to 6-20p	79 16·3	Aug. 1	6-25 to 6-50p		·6557	59	Th. Fawcett.
" 2	8-00 to 8-55a	79 14·9	" 2	9-00 to 9-32a		·6520	78	"
July 28	4 00p	83 36·2	July 22			.6508		J. H. Lefroy.
" 22		83 41·6	" 28			·6534		"
" 28		83 30·2	" 22			·6504		"
			" 28			·6496		"
July 29	5-50 to 6-30p	79 10·8	" 29	6-40 to 7-06p		·6486	74	Th. Fawcett.
" 29	7-36 to 8-10p	79 13·0	" 29	7-36 to 8-10p		·6474	71	"
" 26	9-40 to 11-00a	79 16·1	" 26	11-05 to 11-48a		·6477	75	"
" 26	4-00 to 4-28p	79 18·2	" 26	4-30 to 5-05p		·6463	67	"
" 21	1-00p	83 02·9	" 21			·6552		J. H. Lefroy.
" 21		83 11·6	" 31			·6511		"
" 31		83 00·0	" 21			·6484		"
			" 31			·6472		"
July 18	6-15 to 7-25p	79 20·0	" 18	7-30 to 8-05p		·6460	60	Th. Fawcett.
" 19	9-30 to 10-35a	79 22·9	" 19	10-40 to 11-25a		·6486	63	"
Aug. 1		82 55·0	Aug. 1			.6576		J. H. Lefroy.
			" 1			·6512		"
July 15	5-00 to 5-50p	79 09·3	July 15	6-00 to 6-30p		·6429	74	Th. Fawcett.
" 15	7-30 to 8-00p	79 02·5	" 15	8-15 to 8-50p		·6471	65	"
June 29		84 57·5						Dr. J. Rae.
" 29		84 44·2						"
July 1		84 33·9						"
" 1		84 53·8						"
" 4		84 44·5						"
								Franklin.
July 19	4-30p	82 13·9	July 20			·6543		J. H. Lefroy.
" 20		82 21·3	Aug. 2			·6566		"
Aug. 2		82 32·2	" 2			·6540		"
			July 20			·6568		"
			Aug. 2			·6534		"
July 12	9-06 to 9-45a	79 19·0	July 12	10 25 to 10-46		·6405	83	Th. Fawcett.
" 12	10-50 to 11-52a	79 13·6	" 12	0-00 to 0-35p		·6414	75	"
" 9	6-00 to 7-00p	79 25 9	" 9	7-30 to 7-55p		·6435	54	"
" 9	8-00 to 8-40p	79 18·7	" 10	7-00 to 7-20a		·6457	64	"
" 5	9-15 to 11-10a	79 08·0	" 5	0-10 to 0-32p		·6464	89	"

TABLE

MAGNETIC

HUDSON BAY AND

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° ′	° ′				° ′
*Oxford House...........	54 56·0	95 30·0	1843	Aug. 3....	5-10p	10 31·5 E.
"	"	"	"	....	....	....
"	"	"	"	....	....	....
Hell Gate, Upper portage.....	54 42·0	96 10·0	"	....	....	....
" " ...	"	"	"	....	....	....
" "	"	"	"	....	....	....
" "	"	"	"	....	....	....
East end Split lake, Nelson river........................	56 13·3	96 18·8	1884	....	....	....
South end of White Fall portage....................	54 23·3	96 31·0	1843	Aug. 5....	3-36p	17 32·0 E.
South end of White Fall portage......................	"	"	"	....	....	....
Nelson river.................	55 20·8	97 06·3	1884	....	....	....
Hairy lake, mouth of R. Echimamish..................	54 20·0	97 28·0	1843	July 15....	4-00p	18 43·7 E.
Hairy lake, mouth of R. Echimamish..................	"	"	"	....	....	....
Nelson river, on an island of granite....................	54 16·8	97 46·4	1884	July 27....	5-40p	16 11·0 E.
Nelson river...................	54 50·1	98 11·8	1884	....	....	....
Duck Nest, Lake Winnipeg...	53 15·5	97 33·5	1886	Aug. 3....	8-45a	16 41·6 E.
" " ...	"	"	"	....	....	....
Old Norway House...........	53 41·6	98 01·4	1819	....	....	....
"	"	"	1843	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
Norway House.............	53 59·6	98 03·9	1843	July 13 ..	6-45p	16 21·9 E.
"	"	"	"	" 13 ...	7-04p	16 00·0 "
"	"	"	"	" 13....	7-10p	15 58·6 "
"	"	"	"	" 13...	7-30p	15 12·1 "
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	1844	Sept. 6.. .	5-22p	14 51·0 E.
"	"	"	"	" 7....	9-12a	15 22·0 "
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	1884	July 22....	4-30p	14 55·0 E.
"	"	"	"	" 24....	4-30p	14 59·0 "
"	"	"	"	Oct. 4....	3-15p	15 00·0 "
"	"	"	"	....	....	....

* Local disturbance.

VI—*Con.*

RESULTS—*Con.*

SURROUNDING TERRITORY—*Con.*

Month and day.	Hour and minute.	Dip.		Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature	Observer.
		°	′						
Aug. 3....	5-30p	82	38·8	Aug. 3 ..	.....	....	·6568	....	J. H. Lefroy.
" 3....	....	82	43·4	" 3....	.....	....	·6542	......	"
....	....	...	......	" 3....	.....	....	·6548	....	"
Aug. 4....	1-30p	81	57·0	" 4....	.....	....	·6557	....	"
" 4	....	81	53·5	" 4....	....	....	·6540	....	"
....	....	...	......	" 4....	....	....	·6544	......	"
....	....	...	......	" 4....	....	....	·6509	....	"
Aug. 17....	4-10 to 4-55p	82	49·9	" 17....	5-05 to 5-39p	...	·6453	61	Otto Klotz.
" 5. ..	1-00p	81	47·9	" 5....	....	....	·6557	....	J. H. Lefroy.
" 5...	....	81	51·6	" 5 ...	....	....	·6524	....	"
" 10....	4-45 to 5-25p	81	58·1	" 10....	5-30 to 5-55p	....	·6593	68	Otto Klotz.
July 15....	4-30p	81	20·9	July 15....	....	....	·6487	....	J. H. Lefroy.
....	....	...	......	" 15..	....	....	·6483	....	"
July 27....	3-45 to 4-35p	81	23·8	" 27 ...	4-45 to 5-15p	....	·6512	69	Otto Klotz.
Aug 3....	5-34 to 6-13p	82	24·3	Aug. 3....	6-17 to 6-44p	......	·6428	67	"
" 3....	9-00 to 10-00a	80	50·8	" 3....	10-30 to 11-30a	....	·5996	....	F. W. Wilkins.
" 3....	1-30 to 2-30p	80	46·8	" 3 ...	2-45 to 3-30p	....	·6026	......	"
Oct. 7....	....	83	40·0	....	....	....	....	....	Franklin.
Aug. 12 ...	....	80	45·4	Aug. 12....	.....	....	·6506	....	J. H. Lefroy.
" 12....	....	80	49·4	" 12 ...	.....	....	·6552	....	"
....	....	...	......	" 12....	....	....	6551	....	"
July 12 ...	....	81	11·0	July 13 ..	....	....	·6536	....	"
" 13.. .	....	81	06 2	Aug. 8....	....	....	·6522	....	"
Aug. 9 ...	......	81	09·4	" 8....	....	......	·6531	......	"
....	....	...	......	" 9 ...	....	....	·6503	....	"
......	....	...	......	July 14....	....	....	·6514	.....	"
....	....	...	......	" 14 ...	....	....	·6513	......	"
Sept. 7 ..	a.m.	81	11·1	Sept. 6 ..	.....	....	·6475	.....	"
" 7....	....	81	11·4	" 6....	....	......	·6515	.....	"
....	....	...	......	" 6....	....	....	·6540	.....	"
....	....	...	......	" 6....	.....	....	·6530	....	"
....	....	...	......	" 6...	....	....	·6560	......	"
July 23....	2-43 to 3-32p	81	05 4	July 23....	3-40 to 4-06p	....	·6525	80	Otto Klotz.
" 23....	4-12 to 4-59p	81	12·0	" 23....	5 02 to 5-19p	......	·6489	70	"
Oct. 4....	9-30 to 10-45a	81	18·0	Oct. 4....	10-50 to 11-15a	....	·6459	52	"
" 4....	0-00 to 0-50p	81	15·8	" 4 ..	1-00 to 1-20p	....	·6463	53	"

TABLE

MAGNETIC

C.I.—Carnegie Institution.

MANI

Place.	Latitude.		Longitude.		Year.	Month and day.	Hour and minute.	Declination.	
	°	'	°	'				°	'
Winnipeg river	50	10·2	95	12·0	1843	June 21	5-12p	12	28·7 E
"		"		"	"				
Slave falls	50	14·7	95	40·0	1843				
"		"		"	"				
Badger	49	12·0	95	56·0	1906·8			11	05·0 "
Fort Alexander	50	36·9	96	22·0	1825	June 5		15	15·7 "
"		"		"	1834				
"		"		"	1843	June 25	6-37p	13	29·0 "
"		"		"	"	" 26	4-49a	14	25·3 "
"		"		"	1844	Sept. 20	7-39a	14	03·4 "
"		"		"	"	" 20	8-26a	14	04·2 "
"		"		"	"				
*Big island, Lake Winnipeg	51	04·0	96	26·0	1844				
" "		"		"	"				
" "		"		"	"				
Bay of Winnipeg river, Lake Winnipeg	50	41·7	96	31·4	1886	June 23	9-00a	12	40·2 "
" " "		"		"	"				
Lake Winnipeg	50	35·0	96	35·6	1843	June 26	6-06p	13	41·0 "
"	50	33·4	96	36·0	1843				
About six miles N. of Loon creek, Lake Winnipeg	51	36·9	96	37·3	1886	July 9	8 45a	14	41·6 "
" " "		"		"	"				
*Lake Winnipeg, on an island	51	34·0	96	43·0	1844	Sept. 17	9-36a	15	06·7 "
" " "		"		"	"				
" " "		"		"	"				
Selkirk	50	09·2	96	51·8	1886				
"		"		"	"				
On Red river	50	18·2	96	52·0	1843				
"		"		"	"				
West Selkirk	50	10·0	96	52·0	1907·8			13	16·8 "
*Opposite Bull's Head, Lake Winnipeg	51	36·7	96	53·0	1843	July 6	7-59a	16	25 1 "
" " "		"		"	"				
On Red river	51	36·0	96	56·0	1843	July 5	6-53p	13	40·9 "
"		"		"	"	" 5	7-05p	13	10·5 "
"		"		"	"	July 5	7-19p	14	04·2 "
Island east of Bear island, Lake Winnipeg	51	46·0	97	00·0	1843				
" " "		"		"	"				
" " "		"		"	"				
*Lake Winnipeg	51	44·5	97	02·0	1844	Sept. 16	9-05a	15	24·2 "
"		"		"	"				
"		"		"	"				
Winnipeg	49	52·0	97	09·0	1906·7			13	56·1 "
Lake Winnipeg	52	20·9	97	10·0	1844	Sept. 14	3-48p	16	54·6 "
"		"		"	"				
"		"		"	"				

* Local disturbance.

VII.

RESULTS.

TOBA.

Month and day.	Hour and minute.	Dip.	Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature	Observer.
							°	
June 21.		79 10·0	June 21.			·6549		J. H. Lefroy.
" 21.		79 11·3						"
June 23.		78 57·1	June 23.			·6498		"
" 23.		78 56·0						"
		77 36·4			·1369			C. I.
June 5.		78 47·1						Franklin.
		78 54·0						Back.
June 25.		78 51·8	June 25.			·6477		J. H. Lefroy.
" 25.		78 55·8						"
Sept. 30.		79 03 4	Sept. 19.			·6561		"
" 30.		79 02 5	" 19.			·6564		"
			" 19.			·6527		"
Sept. 18.	a. m.	79 31·5	Sept. 18.			.6685		"
			" 18.			.6688		"
			" 18.			.6705		"
June 23.	9-30 to 10-30a	78 59·4	June 23.	10-45 to 11-45a		·5999	71	F. W. Wilkins.
" 23.	1-30 to 2-20p	78 58·2	" 23.	2-45 to 3-45p		·5964	70	"
June 26.	7-00p	78 34 4	June 26.			·6514		J. H. Lefroy.
" 27.		79 05·1						"
July 9.	0-15 to 1-30p	78 49·5	July 9.	1-45 to 2-30p		·5981	78	F. W. Wilkins.
" 9.	9-00 to 10-00a	78 48·9	" 9.	10-30 to 11-15a		·6004	72	"
Sept. 17.		79 06·1	Sept. 17.			·6646		J. H. Lefroy.
			" 17.			.6623		"
			" 17.			.6639		"
June 7.	12-00 to 1-15p	78 22·8	June 7.	1-30 to 3-00p		·6008	69	F. W. Wilkins.
" 8.	9-00 to 10-40a	78 20·6	" 8.	11-00 to 12-00a		·6025	70	"
July 4.		78 34·0	July 4.			·6492		J. H. Lefroy.
			" 4.			·6515		"
		78 45·6			·1256			C. I.
July 6.	6-30p	79 38·0	July 6.			·6660		J. H. Lefroy.
			" 6.			·6687		"
July 5.	8-00p	79 11·8	July 5.			·6490		"
" 5.		79 01·2	" 5.			·6514		"
								"
July 7.	1-00p	79 28·3	July 7.			·6638		"
" 7.		79 28·8	" 7.			·6658		"
" 7.		79 32·2	" 7.			·6649		"
Sept. 16.		79 39·0	Sept. 16.			·7074		"
			" 16.			·7091		"
			" 16.			·7112		"
		78 10·3			·1304			C. I.
Sept. 14.		80 24·4	Sept. 14.			·6633		J. H. Lefroy.
			" 14.			·6655		"
			" 14.			·6625		"

TABLE

MAGNETIC

C. I.—Carnegie Institution.

MANI

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° ′	° ′				° ′
Wesleyan Mission, Berens riv..	52 22·6	97 12·0	1843	July 8.....	6–52p	14 13·3 E
" " ..	"	"	"	" 8.....	7–04p	14 20·7 "
Fort Garry..............	49 53·2	97 15·6	1843	June 29.....	5–11p	15 27·6 "
"	"	"	"	" 30.....	7–18p	16 42·1 "
"	"	"	"	......	....	......
"	"	"	"	....	....	....
"	"	"	"	......	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
Winnipeg, C.P.R. station.....	49 53·5	97 08·0	1882	....	.....	....
" " . .	"	"		....	......	....
Winnipeg..............	49 52·0	97 09·0	1908	July 16, 17, 18, 20.. ..	10–30a	13 58.6
Near Leaf river, Lake Winnipeg..........	52 31·6	97 18.0	1843	July 10....	8–03a	19 12·2E
" " "	"	"	"	....	....	....
" " .	"	"	"	....	....	....
" " "	"	"	"	....	....	....
" " "	"	"	"	....	......	....
Four miles south of War Path river, Lake Winnipeg.......	52 18·3	98 14·6	1886	Sept. 22. ..	9–00a	15 48·4 "
" " "	"	"	"	....	....	....
End of Long point, Lake Winnipeg......	53 02 5	98 27·5	1886	Sept. 9. ..	8–45a	15 39·1 "
" " "	"	"	"	....	......	....
North side of Long point, Lake Winnipeg.	53 04·2	98 44·5	1886	Sept. 6. ...	8–45a	17 31·8 "
" " "	"	"	"	....	......	....
North end of Limestone bay, Lake Winnipeg...........	53 53·8	98 48·7	1886	Aug. 19....	8–15a	15 13·8 "
" " "	"	"	"	....	....	....
Lake Winnipeg.	53 31·9	99 12·0	1843	Aug. 14 ..	8–14a	17 07·3 "
"	"	"	"	....	....	....
"	"	"	"	....	....	....
Grand Rapids, east end.... .	53 08·4	99 27·0	1843	Aug. 15....	4–14p	19 12·9 "
" "	"	"	"	....	....	....
" " ..	"	"	1844	Sept. 2. ...	9–43a	17 25·0 "
" " ...	"	"	"	....	....	....
" "	"	"	"	....	....	....
" "	"	"	"	....	....	....
H. B. Co's. post, Grand Rapids	53 13·4	99 29·0	1884	July 17.....	6–15p	15 38·0 "
Cross lake	53 10·1	99 34·0	1843	Aug. 16....	9–34a	18 03·7 "
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
Brandon.	49 50 0	99 57·0	1884	July 18. ..	5–42p	14 46·5 "
"	"	"	"	" 19.....	9–02a	15 06·8 "
" -	"	"	"	" 19. . .	11–32a	14 47·0 "
"	49 52·0	99 58·0	1906-7	....	....	15 00·2 "

SESSIONAL PAPER No. 25a

V I I—*Con.*

RESULTS—*Con.*

TOBA—*Con.*

Month and day.	Hour and minute.	Dip.	Month and day.	Hour and minute.	Hor. Intens.	Total Intens.	Temperature	Observer.
July 8	7-00p	80 39·2	July 8			·6524		J. H. Lefroy.
„ 8		80 28·9						„
July 3		78 19·4	June 29			·6498		„
„ 3		78 16·3	„ 29			·6492		„
June 29		78 17·0	„ 29			·6466		„
„ 29		78 10·0	„ 29			·6465		„
July 3		78 10·7	„ 29			·6462		„
			„ 29			·6486		„
			„ 30			6457		„
			July 1			·6459		„
May		79 50·7						Wm. Ogilvie.
„		79 49·9						„
July 16, 17, 18, 20		78 13·0	July 16, 17, 18, 20		·13121			C. A. French.
July 10		80 03·7	July 10			·6510		J. H. Lefroy.
„ 10	2-03p	80 07·2	„ 10			·6509		„
„ 10		80 08·2	„ 10			·6534		„
			„ 10			·6485		„
			„ 10			·6524		„
Sept. 22	9-10 to 10-00a	79 43·9	Sept. 22	10-15 to 11-00a		·5996	50	F. W. Wilkins.
„ 22	11-15 to 12-15a	79 47·4	„ 22	0-45 to 1-30p		·5953	55	„
Sept. 9	9 00 to 10-00a	80 26·5	Sept. 9	10-15 to 11-00a		·5986	61	„
„ 9	10-15 to 11-15a	80 23·4	„ 9	11-13 to 12-15p		·5992	62	„
Sept. 6	9-00 to 10-00a	81 01·5	Sept. 6	10-30 to 11-15a		·5983	68	„
„ 6	10-30 to 12-15a	80 58·9	„ 6	0-45 to 1-30p		·5988	70	„
Aug, 19	8-30 to 9-30a	81 03·4	Aug. 19	9-45 to 10-30a		·5941	68	„
„ 19	10-45 to 11-30a	80 58·1	„ 19	11-40 to 12-15a		·5984	69	„
Aug. 14	5-00a	80 16·8	Aug. 14			·6533		J. H. Lefroy.
„ 14	5-00a	80 19·7	„ 14			·6483		„
„ 14		80 30·0	„ 14			·6486		„
			„ 14			·6500		„
Aug. 15	6-30p	80 21·5	Aug. 15			·6540		„
			„ 15			6494		„
Sept. 2	6-30a	80 31·6	Sept. 2			6547		„
			„ 2			·6517		„
			„ 2			·6496		„
			„ 2			·6494		„
July 19	4-25 to 5-05p	80 24·9	July 19	5 05 to 5-25p		·6503		O. Klotz.
Aug. 16	p.m.	80 28·2	Aug. 16			6546		J. H. Lefroy.
			„ 16			·6474		„
			„ 16			·6549		„
			„ 16			·6537		„
			„ 16			·6541		„
			„ 16			·6537		„
			„ 16			·6573		„
July 18	3-20 to 4-20p	77 34·9	July 18	4-45 to 5-55p		·6459	72	E. Deville.
„ 19	10-00 to 11-00a	77 37·0	„ 19	11-15 to 12-00a		·6453	82	„
								„
		77 28·7			·1381			C. I.

TABLE

MAGNETIC

C. I.—Carnegie Institution.

MANI

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° ′	° ′				° ′
Hare island, Cedar lake.......	53 12·2	100 00 0	1843	....	....	....
Chemahawin, Saskatchewan river......................	53 20·4	100 32·2	1884	July 5......	8-00p	17 36·0 ″
Devil's Drum island, Saskatchewan R..	53 19 5	100 36·0	1843	Aug. 9	7-30p	17 32·2 ″
" " "	"	"	"	....	....	....
" " "	"	"	"	....	. . ...	... .
Lauder.	49 24·0	100 43·0	1906·7	....	.... .	16 09·5 ″
On bank of Saskatchewan river	53 52·6	101 11·0	1884	. ...	.. ..	....
Kirkella.	50 02·0	101 22·0	1906·7	....	.. . .	16 02·4 ″
Round Turn, Saskatchewan river.	53 48·8	101 23·0	1844	Aug. 31....	10-39a	19 56·8 ″
" " "	"	"	"	....	....	....
" " "	"	"	"	....	....	....
On bank of Saskatchewan river	54 02·2	101 34·9	1844	June 22.....	7-00p	19 22·0 ″
Sturgeon Weir river..........	54 20·9	101 42·9	1888	Oct. 7......	9-50a	18 27·3 ″
At Swan River Barracks.. ...	51 54·4	101 57·3	1880	June 12.....	1-00p	19 37·3 ″
" " "	"	"	"	.. . .	. . ..	....
" " "	"	"	"	....	. ....	....

SESSIONAL PAPER No. 25a

VII—*Con.*

RESULTS—*Con.*

TOBA—*Con.*

Month and day.	Hour and minute.	Dip. °	Dip. ′	Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature °	Observer.
Aug. 18....	....	80	07·1	Aug. 18....	....	....	·6484	....	J. H. Lefroy.
July 7....	1-25 to 2-19p	80	04·4	July 7....	2 25 to 2-48p	....	·6487	... ...	O. Klotz.
Aug. 19....	....	80	00 0	Aug. 19....	....	....	·6393	......	J. H. Lefroy.
....	....	....		" 19....	....	....	·6356	..	"
....	....	....		" 19....	....	....	·6358	.....	"
....	....	76	53·7	....	....	·1433	......	.....	C. I.
June 28 ...	6-08 to 6-50p	80	20·2	June 28 ...	6-54 to 7-20p	....	·6463	56	O. Klotz.
....	....	77	17·0	....	....	·1400	....	......	C. I.
Aug. 31 ...	....	80	24·4	Aug. 31....	....	....	·6600	......	J. H. Lefroy.
....	....	....		" 31....	....	....	·6592	....	"
....	....	....		" 31 ...	....	.....	·6614	..	"
June 22....	5-30 to 6-13p	80	20·3	June 22....	6-20 to 6-50p	....	·6466	81	O. Klotz.
Oct. 7....	10-30 to 10-55a	80	16·3	Oct. 7....	11-27 to 11-45a	....	·6470	60	Th. Fawcett.
June 12....	11-15 to 11-50a	78	33·4	......	....	....	.....	...	W. F. King.
June 7 & 8..	7-30 to 8-15p, 2-00 to 2-30p	78	38·4	....	....	....	....	......	"
" 13....	9-45 to 10-30a	78	36·0	....	....	......	....	....	"

TABLE
MAGNETIC

C. I—Carnegie Institution.

SASKATCHEWAN

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° ′	° ′				° ′
On Ellice and Touchwood trail	50 42·5	102 00·0	1880	May 22....	11-00a	18 51·0 E.
" " ..	"	"	"	" 22....	2-00p	18 56·0 "
" " ..	"	"	"	" 27....	4-00p	18 48·0 "
" " ..	"	"	"	" 31	11-00a	18 48·0 "
On Pelly and Qu'Appelle trail.	51 44·8	102 00·8	"	June 16....	7-00p	20 10·0 "
" " ..	"	"	"	" 17. .	6-00p	20 15·0 "
Limestone point, Beaver lake..	54 26·0	102 10·0	1843	....	....	....
" " ..	"	"	"	....	....	....
" " ..	"	"	"	....	....	....
" " .	"	"	"	....	....	....
" " ..	"	"	"	....	....	....
Cumberland House.	53 56·7	102 19·2	1819	Nov. 19.. .	....	17 17 5 E.
"	"	"	1825	May 22.. .	....	19 14·3 "
"	"	"	1843	Aug. 23....	7-30a	19 52·4 "
"	"	"	"	" 23....	7-58a	19 43·8 "
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	1844	Aug. 29....	5-39p	19 16 7 E.
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	1884	June 17.. .	6-00p	20 09·0 E.
"	"	"	"	....	....	....
" . .	"	"	1888	Oct. 14....	2-30p	19 19·1 E.
"	"	"	"	" 14....	2-40p	19 37·9 "
Broadview..............	50 24·0	102 35·0	1906·7	....	....	17 05·7 "
Carp portage, Great river. ...	54 47·2	102 39·5	1843	Aug. 27....	2-23p	24 08·6 "
Pine portage	55 04·0	102 42·0	1843	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
Estevan..................	49 09·0	102 58·0	1906·7	....	....	17 29 4 E.
Northeast of Beaver hills	51 38·7	103 08·0	1880	June 21....	5-30p	19 30·0 "
" "	"	"	"	" 22....	4-30p	19 30·0 "
" "	"	"	"	" 25....	7-30p	19 41·0 "
Frog portage.	55 24·1	103 15·2	1888	Sept. 21. ..	1-55p	21 10·8 "
"	"	"	"	" 21... .	2-10p	20 30·4 "
On an island, Saskatchewan riv.	53 38 2	103 41·9	1884	June 8. ...	8-00a	20 25·0 "
Northwest of Beaver hills.....	51 32·0	103 42·6	1880	" 27... .	6-30p	19 45 0 "

VIII.

RESULTS.

AND ALBERTA.

Month and day.	Hour and minute.	Dip.	Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature	Observer.
		° ′					°	
May 23	11-00 to 12-00a	78 00·5						W. F. King.
" 24	7-00 to 7-45p	77 51·6						"
" 27	5-00 to 6-00p	77 42·5						"
								"
June 16	7-15 to 7-45p	78 34·8						"
								"
Aug. 26	2-00 to 3-00p	80 34·2	Aug. 26			·6501		J. H. Lefroy.
			" 26			·6421		"
			" 26			·6501		"
			" 26			·6436		"
			" 26			·6408		"
								Franklin.
June 28		80 21·1						"
Aug, 23	7-00a	80 28·2	Aug. 23			·6504		J. H. Lefroy.
" 23		80 31·8	" 23			·6535		"
			" 23			·6460		"
			" 24			·6532		"
			" 24			·6534		"
			" 24			·6522		"
			" 24			·6519		"
			" 24			·6527		"
			" 23			·6552		"
			" 23			·6551		"
			" 23			·6530		"
			" 23			·6528		"
Aug. 29	p.m.	80 20·5	" 29			·6530		"
" 29	p.m.	80 19·5	" 29			·6543		"
			" 29			·6470		"
June 17	9-43 to 10-29a	80 24·3	June 17	10-40 to 11-05a		·6383	84	Otto Klotz.
" 17	4-07 to 4-44p	80 28·4	" 17	4-48 to 5-11p		·6457	80	"
Oct. 14	2-44 to 3-10p	80 26·4	Oct. 14	3-10 to 4-00p		·6476		Th. Fawcett.
" 14	3-12 to 3-33p	80 21·4	" 14	4-00 to 4-15p		·6454		"
		77 37·5			·1359			C. I.
Aug. 27	1-30p	80 39·6						J. H. Lefroy.
" 28	11-00a	80 52·7	Aug. 28			·6532		"
			" 28			·6473		"
			" 28			·6518		"
			" 28			·6501		"
			" 28			·6465		"
		76 18·3			·1490			C. I.
June 23	5-00 to 5-30p	78 21·4						W. F. King.
" 24	8-30 to 9-10p	78 21·1						"
								"
Sept. 21	2-37 to 3-00p	81 00·7	Sept. 21	3-09 to 3-23p		·6451	60	Th. Fawcett.
" 21	3-44 to 4-10p	80 59·1	" 21	3-25 to 3-36p		·6447	60	"
June 8	5-55 to 6-29p	79 49·7	June 8	6-35 to 6-57p		·6474	66	Otto Klotz.
" 26	0-00 to 1-00p	78 18·7						W. F. King.

TABLE

MAGNETIC

C. I.—Carnegie Institution.

SASKATCHEWAN

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° ′	° ′				° ′
Northwest of Beaver hills...	51 32 0	103 42·6	1880	June 28....	7–00a	20 00·0 E.
" " ..	"	"	"			
Fort Qu'Appelle.......	50 46·3	103 48 1	"	July 5......	3–00p	19 30·0 "
"	"	"	"	" 10....	7–30a	19 40·0 "
On Touchwood and Qu'Appelle trail..	51 12 5	103 53 8	"	June 30. ..	7–30p	19 50·0 "
" " ..	"	"	"	July 1......	5–00a	19 50·0 "
Touchwood hills, H. B. Co's post..................	51 21 6	104 00 0	"	June 28	6–00p	18 33·6 "
On bank, Saskatchewan river..	53 18·7	104 04·7	1884			
H. B. Co's post, Stanley......	55 25·4	104 18 9	1888	Sept. 15 ..	8–10a	23 38·2 E.
" "	"	"	"	" 15...	8–30a	22 53·9 "
Mountain portage...........	55 33 4	104 19·2	"	" 13....	3–40p	20 10·7 "
" "	55 33·4	104 19·2	"	" 13 ...	3–50p	21 04·1 "
* Little Rock Portage.........	55 30·0	104 34 0	1843	Aug. 31....	4–18p	16 35·0 "
" "	"	"	"	" 31....	4–51p	15 16·3 "
" "	"	"	"	" 31.. .	5–10p	17 01·4 "
Regina.	50 27 4	104 35·0	1884	July 21....	9–07a	18 44·8 "
"	"	"	"	" 21....	9–07p	18 32·3 "
"	"	"	"	" 21.. .	3–52p	18 40·5 "
"	"	"	"	" 21....	6–30p	18 41 8 "
"	50 26 0	104 36·0	1906 7			19 12·0 "
East end of Great Devil's portage.....	55 40 0	104 47 8	1843	Sept. 1....	9–27a	24 48·5 "
" "	"	"	"			
" "	"	"	"			
" "	"	"	"			
West of Fort à la Corne.. .	53 09·7	104 50·3	1884	May 26....	3–45p	21 50·0 E.
2½ miles below forks of Saskatchewan river....	53 13·0	104 51·6	1844	Aug. 27....	4–44p	24 45·0 "
" "	"	"	"			
" "	"	"	"			
" "	"	"	1859			22 30·0 E.
Trout Falls portage........ ..	55 42·9	104 58·8	1888	Sept. 7....	3–30p	21 48·7 "
" "	"	"	"	" 7....	3–50p	22 52·0 "
Black Bear Island lake........	55 42·5	105 35 5	"	" 2....	9–15a	21 14·0 "
" "	"	"	"	" 2 ..	1–20p	21 32 0 "
Pine portage........	55 43·0	106 00·0	1843			
"	"	"	"			
"	"	"	"			
Carlton House..	52 50·8	106 32·0	1844	Aug. 26. ..	9–00a	22 55·6 E.
"	"	"	"			
"	"	"	"			
Knee lake.....	55 50·8	106 33 4	1888	Aug. 26....	9–30a	27 19·6 E.

* Local disturbance.

VIII—*Con.*

RESULTS—*Con.*

AND ALBERTA—*Con.*

Month and day.	Hour and minute.	Dip.	Month and day.	Hour and minute.	Hor. intens.	Total. intens.	Temperature.	Observer.
		° ′					°	
June 26	3-20 to 4-15p	78 11·4						W. F. King.
" 26	4-45 to 5-25p	78 05·7						"
July 5	6-30 to 7-10p	77 21·0						"
" 5	5-45 to 6-20p	77 25·5						"
June 30	6-15 to 6-30p	77 51·6						"
								"
June 29	11-15 to 12-00a	77 53·2						"
June 2	3-00 to 3-50p	79 09·7	June 2	4-00 to 4-20p		6544	80	Otto Klotz.
Sept. 15	0-10 to 0-40p	80 45·0	Sept. 15	9-50 to 10-10a		·6408	70	Th. Fawcett.
" 15	0-45 to 1-14p	80 45·1	" 15	10-10 to 10-32a		·6408	70	"
" 13	4-25 to 4-37p	80 33·4	" 13	4-40 to 4-58p		·6389	55 to 60	"
" 13	5-15 to 5-30p	80 35·3	" 13	5-00 to 5-13p		·6373	55	"
Aug. 31	3-30p	80 16·4	Aug. 31			·6966		J. H. Lefroy.
			" 31			·6925		"
								"
July 21	9-30 to 10-50a	77 06 2	July 21	11-05 to 12-00a		·6401	76	E. Deville.
" 21	4-15 to 5-05a	77 04.0	" 21	5-15 to 6-15p		·6403		"
								"
								"
		76 57·2			·1427			C. I.
Sept. 1	10-00a	80 30·9	Sept. 1			·6516		J. H. Lefroy.
			" 1			·6514		"
			" 1			·6460		"
			" 1			·6464		"
May 26	4-05 to 5-05p	78 59·3	May 26	5-30 to 6-00p		·6443	64	Otto Klotz.
Aug. 27		79 11·2	Aug. 27			·6422		J. H. Lefroy.
			" 27			·6404		"
			" 27			·6434		"
								H. Y. Hind.
Sept. 7	4-02 to 4-22p	80 37·1	Sept. 7	4-24 to 4-40p		·6422	60	Th. Fawcett.
" 7	5 00 to 5-30p	80 38·1	" 7	4-42 to 4-58p		·6407	60	"
" 2	10-35 to 11-00a	80 43·2	" 2	11-45 to 12-00a		·6512	60	"
" 2	11-00 to 11-30a	80 37·1	" 2	0 02 to 0-18p		·6480	60	"
" 3	4-30p	80 40·3	" 3			·6491		J. H. Lefroy.
			" 3			·6463		"
			" 3			·6450		"
Aug. 26		78 30·2	Aug. 26			·6350		"
" 26		78 31·2	" 26			·6366		"
			" 26			·6339		"
Aug. 26	10-30 to 10-57a	80 48·2	" 26	11-00 to 11-17a		·6505	70	Th. Fawcett.

TABLE

MAGNETIC

SASKATCHEWAN

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° ′	° ′				° ′
Knee lake.	55 50·8	106 33·4	1888	Aug. 26....	2-00p	27 53·7 E.
Snake rapid..	55 44 1	106 35·0	1843	...	...	...
"	"	"	"	...	...	...
"	"	"	"	...	...	...
Near Elbow, South Saskatchewan river	51 04·8	106 37·0	1880	July 17...	8-00p	21 21·0 E.
"	"	"	"	" 18....	6-00p	21 17·0 "
Near the N. W. end of Old Wives lake	50 28·9	106 46·7	"	" 20 ..	7-00p	21 18·7 "
Narrow Rapids lake	55 56·5	107 22·1	1888	Aug. 19....	1-50p	24 03·9 "
"	"	"	"	...	...	...
*Saskatchewan, near Elbow..	52 21·4	107 23·0	1844	Aug. 24. ..	2-30p	25 21 4 E.
Portage Sonnaute	55 54·0	107 36·0	1843	Sept. 7 ..	4-13p	26 43·4 "
"	"	"	"	...	...	...
"	"	"	"	...	...	...
"	"	"	"	...	...	...
Ile à la Crosse.	55 25·6	107 37·0	1888	Aug. 11....	3-00p	25 02·9 E.
"	"	"	"	...	...	...
South Saskatchewan river.....	50 39·6	107 47·9	1884	...	...	...
Fort à la Crosse	55 26·8	107 54·0	1843	Sept. 9 ...	8-26a	24 57·5 E.
"	"	"	"	" 9.. .	8-54a	24 35·0 "
"	"	"	"	" 9....	5-30p	25 11·7 "
"	"	"	"	...	...	...
"	"	"	"	...	...	...
"	"	"	"	...	...	...
"	"	"	"	...	...	...
"	"	"	"	...	...	...
"	"	"	"	...	...	...
"	"	"	"	...	...	...
"	"	"	1819	February...	...	22 15·8 E.
"	"	"	1825	June 27....	...	23 19·3 "
Narrows of Buffalo lake	55 37 9	108 13·5	1888	Aug. 5....	0-50p	25 15·9 "
"	"	"	"	...	...	...
Battleford..	52 42·7	108 18·8	1880	......	...	...
"	"	"	"	...	...	...
"	"	"	1884	July 28 ...	10-00a	22 12·7 E.
"	"	"	"	" 28....	3-00p	21 57·2 "
"	"	"	"	" 28...	6-00p	21 59·9 "
"	"	"	"	" 29....	7-40a	22 15·4 "
"	"	"	"	" 29....	9-10a	22 06·2 "
"	"	"	"	" 29....	0-35p	21 58·2 "
*Willow hills	53 00·1	108 30·0	1844	Aug. 23....	p.m.	28 24·1 "
"	"	"	"	...	...	...
"	"	"	"	...	...	...
Northern end of Buffalo lake..	56 04·0	108 40 0	1843	...	...	...
"	"	"	"	...	...	...
"	"	"	"	...	...	...
"	"	"	"	...	...	...
Sidewood, on Cypress trail	50 02·6	108 51·4	1880	July 24....	7-00p	22 00·0 E.

* Local disturbance.

VIII—*Con.*

RESULTS—*Con*

AND ALBERTA—*Con.*

Month and day.	Hour and minute.	Dip.	Month and day.	Hour and minute.	Hor. intens.	Total intens.	Tem-perature	Observer.
		° ′					°	
Aug. 26..	11-20 to 11-43a	80 45·8	Aug. 26....	11-48 to 12-06a		·6529	65	Th. Fawcett.
Sept. 4....	1-30p	80 38·8	Sept. 4....			·6537		J. H. Lefroy.
			" 4....			·6505		"
			" 4....			·6477		"
July 18....	7-20 to 7-50p	77 05·5						W. F. King.
" 18 ..	6-50 to 7-30p	77 02·3						"
" 20....	5-50 to 6·35p	76 51·3						"
Aug. 19....	2-30 to 3-00p	80 39·8	Aug. 19....	3-00 to 3-30p		·6419	76	Th. Fawcett.
" 19 ...	3-35 to 4-00p	80 34·2	" 19....	5-15 to 5-40p		·6426	73	"
" 24 ...		78 16·6	" 24.			·6495		J. H. Lefroy.
Sept. 7....	p. m.	80 11·2	Sept. 7...			·6481		"
			" 7....			·6482		"
			" 7....			·6438		"
			" 7....			·6499		"
Aug. 11....	to 5-45	79 56·1	Aug. 11....	4-15 to 4-35p		·6371	75	Th. Fawcett.
" 11 ...	6-35	79 58 1	" 11....	6-40 to 7-04p		·6371	66	"
May 8 ...	4-00 to 5-30p	76 32·5	May 8....	5-35 to 6-30p		·6132	58	Otto Klotz.
Sept. 9 ...	6-30	80 09·1	Sept. 9...			·6476		J. H. Lefroy.
" 9....	7-30	80 10·5	" 9....			·6471		"
			" 9....			·6454		"
			" 9....			·6449		"
			" 9...			·6442		"
			" 9. ..			·6442		"
			" 9 ...			·6440		"
			" 9....			·6469		"
			" 9....			·6442		"
			" 9....			·6439		"
								J. Franklin.
July 11. .		79 55·0						"
Aug. 5 ...	1-40 to 2-06p	80 11·9	Aug. 5....	2-13 to 2-36p		·6427	68	Th. Fawcett.
" 5....	2-42 to 3-08p	80 13·3	" 5....	3-10 to 3-35p		·6429	60	"
Nov. 1....	9-45 to 10-10a	77 52·3						W. F. King.
" 2....	11-15 to 11-40a	77 46·4						"
								E. Deville.
								"
								"
								"
								"
Aug. 23 ...	p.m.	78 28·1	Aug. 23....			·6569		J. H. Lefroy.
			" 23....			·6548		"
			" 23....			·6585		"
Sept. 13. ..	7-00a	80 37·0	Sept. 13..			·6472		"
			" 13....			·6470		"
			" 13 ...			·6457		"
			" 13....			·6420		"
July 25....	1-20 to 1-55p	75 50·1						W. F. King.

TABLE

MAGNETIC

SASKATCHEWAN

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° ′	° ′				° ′
River La Loche...	56 11·6	108 57·5	1888	July 29...	2-10p	28 10·0 E.
"	"	"	"			
La Loche lake....	56 26·6	109 12·8	1888	July 22 ..	2-10p	25 49·0 E.
"	"	"	"			
North end of Long portage.....	56 14·7	109 18·0	1843	Sept. 14....	9-35a	28 40·6 E.
"	"	"	"	" 14....	9-43a	28 27·5 "
"	"	"	"			
"	"	"	"			
Portage La Loche......	56 35·2	109 30·2	1888	July 18....	10-00a	26 37·3 E.
"	"	"	"			
Great Methye portage........	56 35·0	109 37·0	1843	Sept. 16....	8-38a	26 15·0 E.
"	"	"	"	" 16....	9-30a	26 59·7 "
"	"	"	"			
"	"	"	"			
Fort Pitt.......	53 34·1	109 47·2	1844	Aug. 22....	6-50a	23 07·3 E.
"	"	"	"	" 22....	7-57a	23 11·2 "
"	"	"	"			
At the gap of Cypress hills....	49 37·7	109 51·4	1880	July 31....	7-00p	21 43 7 E.
Great Methye p'tge, N.W. end	56 43·7	109 52·3	1820	"		25 02·5 "
"	"	"	1843	Sept. 17....	7-09a	28 30·3 "
"	"	"	"	" 17....	7-22a	28 25·0 "
"	"	"	"	" 17....	7-30a	28 30·6 "
Clear Water river...	56 42·7	110 03·9	1888	July 8 ..	10-00a	26 53·5 "
"	"	"	"			
Land survey station..	51 05·0	110 15·0	1882			
Clear Water river............	56 39·4	110 46·6	1888	July 1....	10-40a	28 54·3 E.
"	"	"	"	" 1....	2-00p	28 56·9 "
Two miles below mouth of Pembina river.............	59 39 0	110 55·0	1843			
" "	"	"	"			
" "	"	"	"			
" "	"	"	"			
Saskatchewan river near Moose Hill creek...........	53 50·0	110 59·0	1844	Aug. 21....	8-08a	24 26·6 E.
" "	"	"	"			
" "	"	"	"			
Fort McMurray.............	56 43·9	111 13·6	1888	June 23..	9-00a	29 02·4 E.
" "	"	"	"			
Fort Chipewyan, L. Athabaska	58 43·0	111 18·7	1843	Sept. 23 ...	3-50p	28 09·1 E.
" "	"	"	"	" 23....	3-59p	27 08·4 "
" "	"	"	"	Oct. 16 ..		28 30·8 "
" "	"	"	"			
" "	"	"	"			
" "	"	"	"			
" "	"	"	1820	March		22 49·6 E.
" "	"	"	1825	July 11.....		25 29·0 "
" "	"	"	1843			

VIII—*Con.*

RESULTS—*Con.*

AND ALBERTA—*Con.*

Month and day.	Hour and minute.	Dip.	Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature	Observer.
		° ′					°	
July 29	3-00 to 3-22p	80 34 0	July 29	3-24 to 3-43p		·6456	61	Th. Fawcett.
" 29	3-45 to 4-20p	80 33·1	" 29	4-25 to 4-45p		·6435	59	"
" 22	2-45 to 3-20p	80 31·9	" 22	4-32 to 5-02p		·6409	76	"
" 22	3-47 to 4-25p	80 35·5	" 22	3-22 to 3-45p		·6352	86	"
Sept. 14	10-15a	80 19·7	Sept. 14			·6380		J. H. Lefroy.
			" 14			·6425		"
			" 14			·6401		"
			" 14			·6432		"
July 18	10-40 to 11-10a	80 29·3	July 18	11-14 to 11-35a		·6397	88	Th. Fawcett.
" 18	11-45a to 0-13p	80 28·3	" 18	0-15 to 0-40p		·6417	81	"
Sept. 16	9·00a	80 36·4	Sept. 16			·6444		J. H. Lefroy.
			" 16			·6457		"
			" 16			·6426		"
			" 16			·6467		"
Aug. 22	a. m.	78 43·0	Aug. 22			·6533		"
" 22	"	78 39·1	" 22			·6520		"
			" 22			·6526		"
July 28	0-15 to 0-45p	75 20·4						W. F. King.
								Franklin.
Sept. 17	6-00a	80 38·3						J. H. Lefroy.
								"
								"
July 8	11-15 to 11-45a	80 27·4	July 8	11-50a to 0-15p		·6377	76	Th. Fawcett.
" 8	0·20 to 0·50p	80 25·5	" 8	0-55 to 1-20p		·6425	65	"
" 15		76 14·1						Wm. Ogilvie.
" 1	11·10 to 11-40a	80 09·1	July 1	11-40 to 12-00a		·6419	66	Th. Fawcett.
" 1	3-40 to 4-00p	80 12·1	" 1	4-04 to 4-50p		·6460	68	"
Sept. 19	8-30a	80 36·2	Sept. 19			·6456		J. H. Lefroy.
			" 19			·6414		"
			" 19			·6364		"
			" 19			·6419		"
Aug. 21		78 33·5	Aug. 21			·6410		"
			" 21			·6350		"
			" 21			·6391		"
June 23	9-30 to 10-00a	80 07·8	June 23	10-04 to 10-35a		·6334	57·	Th. Fawcett.
" 23	10-40 to 11-04a	80 09·8	" 23	11-04 to 11-30a		·6371	59·	"
Sept. 30	9-00a	81 37·7	Sept. 25			·6374		J. H. Lefroy.
" 30	11-00a	81 37·5	" 25			·6413		"
			Oct. 9			·6383		"
			Sept. 30			·6449		"
			Oct. 6			·6446		"
			" 10			·6456		"
								J. Franklin.
July 24		81 26·1						"
			Oct. 13			·6419		J. H. Lefroy.

TABLE

MAGNETIC

SASKATCHEWAN

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° ′	° ′				° ′
Fort Chipewyan, L Athabaska	58 43·0	111 18·7	1843	....	....	....
" " ..	"	"	"	....	....	....
" " ..	"	"	"	....	....	....
" " ..	"	"	"	....	....	....
" " ..	"	"	"	....	....	....
" " ..	"	"	"	....	....	....
" " ..	"	"	"	....	....	....
" " ..	"	"	1844	....	....	....
" " ..	"	"	"	....	....	....
" " ..	"	"	"	....	....	....
" " ..	"	"	"	....	....	....
" " ..	"	"	"	July 2.....	9-34a	29 52·0 E.
" " ..	"	"	"	....	....	....
" " ..	"	"	"	....	....	....
" " ..	"	"	1884	....	....	....
" " ..	"	"	1888	Nov. 22....	3-20p	27 15·3 E.
" " ..	"	"	"	" 23....	3-30p	27 09·5 "
" " ..	"	"	"	" 24....	10-15a	27 17·9 "
" " ..	"	"	"	....	....	....
In the valley of Vermilion river..	53 35·9	111 24·0	1880	Oct. 17...	10-30a	25 46·4 E.
Point Brulé, Athabaska river..	58 07·0	111 25·0	1843	....	....	....
" " ..	"	"	"	....	....	....
" " ..	"	"	"	....	....	....
" " ..	"	"	"	....	....	....
*Pierre au Calumet...........	57 24·0	111 35·0	"	Sept. 20 ..	5-03p	26 35·1 E.
" " .	"	"	"	" 20....	5-15p	25 24·9 "
" " ..	"	"	"	....	....	....
" " ..	"	"	"	....	....	....
Land survey station	51 00·5	111 40·5	1882	....	....	....
" "	"	"	"	....	....	....
Pelican portage	59 58·0	111 51·0	1844	June 27.....	6-24p	36 15·0 E.
Point Providence........ ...	58 58·0	112 10·0	"	July 5.. .	3-11p	30 35·0 "
On Saskatchewan river.... .	54 04·5	112 19·5	"	Aug. 20 ..	9 20a	23 55·0 "
" "	"	"	"	" 20 ...	9-33a	24 56·0 "
" "	"	"	"	....	....	....
On Peace river	58 58·0	112 56·1	"	July 7 ..	7-19a	32 24·0 E.
Willow creek	49 45·3	113 24·0	1880	Aug. 17....	6-00p	22 32·0 "
"	"	"	"	" 18...	9-00a	22 43·0 "
"	"	"	"	" 18....	9-10a	22 39·0 "
Athabaska river........	54 51·0	113 25·0	1888	May 27. ..	4-00p	24 33·3 E
"	"	"	"	" 28.....	6-50a	24 16·4 "
Fort Edmonton....	53 32·0	113 30·1	1844	Aug. 16. ...	7-31a	23 47·0 "
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	1880	Oct. 6 . ..	2-00p	26 43·2 "
"	"	"	"	....	....	....

*Local disturbance.

SESSIONAL PAPER No. 25a

VIII—*Con.*

RESULTS—*Con.*

AND ALBERTA—*Con.*

Month and day.	Hour and minute.	Dip.	Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature	Observer.
							"	
			Oct. 13			·6399		J. H. Lefroy.
			" 13			·6428		"
			" 13			·6418		"
			" 13			·6411		"
			" 14			·6386		"
			" 14			·6453		"
			" 14			·6425		"
			Mar. 1			·6384		"
			" 1			·6363		"
			" 1			·6331		"
			" 1			·6368		"
Feb. 27	1-04p	81 35·4	July 2			·6431		"
			" 2			·6433		"
			" 2			·6426		"
Sept. 17		81 26·6						H. P. Dawson.
Nov. 22	1-50 to 2-21p	81 22·2	Nov. 22	2-25 to 2-45p		·6335	17·5	Wm. Ogilvie.
" 22	3-06 to 3-24p	81 21·4	" 22	2-48 to 3-04p		·6306	17·5	"
" 23	1-45 to 2-07p	81 23·3	" 23	2 05 to 2 20p		·6348	18·	"
" 23	3-05 to 3-25p	81 21·7	" 23	2 40 to 3-01p		·6355	16·	"
Oct. 17	2-45 to 3-05p	77 56·8						W. F. King.
Sept. 21	4-00p	81 30·6	Sept. 21			·6402		J. H. Lefroy.
			" 21			·6475		"
			" 21			·6438		"
			" 21			·6493		"
Sept. 20	2-30p	81 16·8	Sept. 20			·6739		"
			" 20			·6615		"
			" 20			·6597		"
			" 20			·6631		"
Aug. 6		76 16·5						Wm. Ogilvie.
" 6		76 09·7						"
June 27		82 26·8						J. H. Lefroy.
July 5		81 46·1						"
Aug. 20		78 05·2	Aug. 20			·6330		"
			" 20			·6311		"
			" 20			·6316		"
July 7		81 36·9						"
Aug. 17	3-50 to 4-20p	74 44 8						W. F. King.
" 17	5-25 to 5-40p	74 47·9						"
								"
May 27	4-26 to 5-05p	78 08·3	May 27	5-07 to 5-40p		·6351	70	Th. Fawcett.
" 28	7-35 to 8-28a	78 07·2	" 28	7-40 to 8-28a		·6415	51	"
Aug. 17		77 53·4	Aug. 17			6476		J. H. Lefroy.
" 17		77 55·1	" 17			·6418		"
			" 17			·6474		"
			" 17			·6499		"
			" 17			·6468		"
Oct. 6	4-40 to 5-00p	77 31·6						W. F. King.
" 7	10-20 to 10-40a	77 29·4						"

TABLE

MAGNETIC

C. I.—Carnegie Institution.

SASKATCHEWAN

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° ′	° ′				° ′
Fort Edmonton	53 32·0	113 30·1	1888	May 17	1-30p	25 28·7 E
"	"	"	"			
At north branch, Pipestone creek	53 04·3	113 35 5	1880	Sept. 25	6-00p	25 14·4 "
Mosquito creek	50 22·4	113 48·8	"	Aug. 20	7-00p	22 03·0 "
"	"	"	"			
Forks of the Athabaska	55 13·0	113 53·2	1844	Aug 7	4-44p	26 28·0 "
Fourth base on 5th meridian	50 02·9	114 00·0	1887	July 19	1-50p	23 53·7 "
Land survey station	54 21·3	114 00·0	1883			
Athabaska river	54 43·0	114 00·2	1844	Aug. 9	9-10a	26 29·1 "
Crossing of Pembina river	54 03·2	114 00·2	"	" 14	9-42a	22 23·0 "
Mouth of Lesser Slave lake	55 29·0	114 03·5	1888	June 4	noon.	27 22·5 "
" "	"	"	"	" 4	3-15p	27 25·3 "
Land survey station	55 10·0	114 03·5	1883	May 9		27 45·4 "
"	"	"	"			
"	"	"	"			
Near Fort Calgary	51 03·0	114 04·0	1880			
Poplar island	58 39·0	114 10·7	1844	July 9	9-30a	26 29·8 "
Morleyville, Rocky Mt	51 10·5	114 18·5	1880			
" "	"	"	"			
Fort Assiniboine	54 21·7	114 28·4	1844	Aug. 11	7-02a	24 39·0 "
"	"	"	"			
Falls of the Peace river	58 24·2	114 51·1	"	July 10	10-38a	30 22·0 "
Swan point, Lesser Slave lake	55 26·0	115 03·1	"	Aug. 6	10-00a	26 19·0 "
Sulphur mountain	51 09·0	115 34·0	1907·5			25 53·5 "
Banff	"	"	"			25 59·3 "
Tunnel mountain	51 11·0	"	"			25 57·4 "
Banff (C.I.S.)	51 10·0	115 37·0	1908	July 22-24		26 5·6 "
Fort Vermilion	58 24·5	115 58·6	1844	July 11	6-31p	32 40·0 "
"	"	"	"			
"	"	"	"			
"	"	"	"			
"	"	"	"			
Fort of Lesser Slave lake	58 32·6	116 00·0	"	Aug. 3	5-37p	26 52·5 "
" "	"	"	"			
" "	"	"	"			
Land survey station	55 32·5	116 08·6	1883			
On Peace river	57 19·0	117 01·7	1844	July 17	8-39a	28 53·0 "
Opposite River Cadotte	56 47·0	117 01·7	"	" 19	9-17a	27 03·0 "
Island opposite Baril river	57 57·0	117 04·7	"	" 15	8-22a	29 56·0 "
Land survey station	56 08·0	117 50·6	1883			
"	"	"	"			
Fort Dunvegan	55 55·6	118 28·5	1844	July 23	10-05a	27 09·0 "
"	"	"	"	" 25	5-49p	27 24·0 "
"	"	"	"			
"	"	"	"			
"	"	"	"			

VIII—*Con.*

RESULTS—*Con.*

AND ALBERTA—*Con.*

Month and day.	Hour and minute.	Dip.	Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature	Observer.
							°	
May 17	1-50 to 3-05p	77 30·4	May 17	4-11 to 5-00p		6391		Th. Fawcett.
" 17	3-21 to 3-53p	77 30·9						"
Sept. 26	6-30 to 6-50a	77 03·2						W. F. King.
Aug. 20	5-45 to 6-10p	74 40·1						"
" 21	6-15 to 6-30a	74 48·2						"
Aug. 7		78 55·2						J. H. Lefroy.
July 19		74 37·5						J. S. Dennis.
Jan. 1		77 58·1						Wm. Ogilvie.
Aug. 9		78 34 1						J. H. Lefroy.
" 14		77 54·0						"
June 4	1-00 to 1-30p	78 31·7	June 4	1-38 to 2-05p		·6308		Th. Fawcett.
" 4	1-38 to 2-40p	78 33·3	" 4	2-07 to 2-40p		·6323		"
May 10		78 24·1						Wm. Ogilvie.
" 11		78 28·2						"
" 11		78 29·9						"
Sept. 11	1-00 to 1-20p	75 23·4						W. F. King.
July 9		81 04·8						J. H. Lefroy.
Sept. 16	0-25 to 0-45p	75 14·3						W. F. King.
" 16	3-00 to 3-15p	75 19·7						"
Aug. 11		78 16·9						J. H. Lefroy.
" 11		78 13 5						"
July 10		80 50·8						"
Aug. 6		78 29·9						"
		74 54·0			·1590			C.I.
		74 56 3			·1593			C.I.
		74 57·6			·1593			C.I.
July 23, 24		74 58·1	July 22-24		·15955			C. A. French.
July 11		80 48·4	July 11			·6505		J. H. Lefroy.
" 11		80 47·6	" 11			·6409		"
			" 11			·6472		"
			" 11			·6515		"
			" 11			·6463		"
Aug. 3		78 36·2	Aug. 5			·6422		"
" 3		78 41·8	" 5			.6397		"
			" 5			·6369		"
Oct. 3		{78 18·1 / 78 12·4}						Wm. Ogilvie.
July 17		79 27·0						J. H. Lefroy.
" 19		79 20·7						"
" 15		80 00·7						"
Sept. 22		78 14·3						Wm. Ogilvie.
" 22		78 20·2						"
July 22		78 45·7	July 23			·6477		J. H. Lefroy.
" 22		78 46·8	" 23			·6439		"
			" 23			·6445		"
			" 23			·6452		"
			" 23			·6452		"

TABLE

MAGNETIC

C.I. —Carnegie Institution. BRITISH

Place.	Latitude.		Longitude.		Year.	Month and day.	Hour and minute.	Declination.	
	°	'	°	'				°	'
Akamina station	49	01·0	114	04·0	1861	Aug. 2		23	12·0 E
*Wigwam river section	49	00·0	114	45·0	"	July15, Aug. 14		23	52·0 "
Camp No. 11	49	07·0	115	16·0	"				
Joseph's prairie, Camp No. 14	49	31·0	115	35·0	"				
Stephen, Rocky mountains	51	27·0	116	17·7	1886	May 14	4-00p	23	55·0 "
Near Leanchoil, along C.P.R.	51	13·8	116	37·9	"	" 28	4-45p	23	33·0 "
Between Palliser and Golden, C.P.R.	51	17·9	116	51·7	"	June 4	11-00a	25	40·0 "
Golden	51	18·0	116	57·0	1908	July 27-30		26	03·5
"	"		"		"				
One mile north of Golden	51	18·8	116	58·5	1886	June 9	5-54p	25	37·0 E
Keefe and Clarke siding	51	30·9	117	20·4	"	" 18	9-21a	26	34·0 "
Glacier	51	16·0	117	28·0	1907·8			25	57·1 "
Near Rogers pass, along C.P.R.	51	17·6	117	31·0	1886	June 30	2-45p	25	27·5 "
Near Revelstoke, along C.P.R.	51	00·1	118	11·9	"	Aug. 15	4-23p	27	17·5 "
Revelstoke	51	00·0	118	12·0	1908	Aug. 3, 4, 5.		25	48·6
"	"		"		"				
Inchwointum station	49	00·0	118	28·0	1860	Nov. 13		20	17·0
Sicamous	50	50·0	118	59·0	1908	Aug. 6-10		25	52·8
Sicamous narrows	50	49·7	118	59·6	1885	Oct. 21	11-20a	24	46·2 "
"	"		"		"				
120 yds. west of station 1569 of traverse	50	44·7	119	14·5	"	" 4	4-50p	24	37·5 "
"	"		"		"				
Lake Shuswap, Blind bay	50	51·0	119	19·5	"				
" "	"		"		"				
Southwest end of Salmon Arm, Lake Shuswap	50	45·9	119	19·9	"	Sept. 25	5-10p	24	55·9 E
" "	"		"		"	" 27	5-15p	24	46·9 "
"	"		"		"				
" "	"		"		"				
Little Shuswap	50	48·6	119	41·2	"	Sept. 13	4-45p	25	07·5 E
"	"		"		"				
Ashtnolaon station	49	00·0	120	00·0	1860	Aug. 17, 18		22	44·0 "
On Ashtnolaon river	49	10·0	120	00·0	"	July		22	10·0 "
350 yds. south of station 1289 traverse	50	38·9	120	06·9	1885	Sept. 6	4-00p	24	59·4 "
" "	"		"		"				

* Local disturbance.

IX.

RESULTS.

COLUMBIA.

Month and day.	Hour and minute.	Dip.	Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature	Observer.
		° ′					°	
Aug. 2 ...	... ...	73 42·7	Aug. 2....	... ...	....	·6265	....	R. W. Haig.
July 15, Aug. 14..	....	73 30·8	July 15, Aug. 14........	....	... ...	6223	....	do
... .	....	73 37·8	....	....	....	....	.. ....	J. L. Harris.
. .. ..	....	73 50·4	....	....	....	·6226	.. .. ..	do
May 14....	4 45 to 5-25p	75 04·6	May 14...	5-30 to 5-55p	....	·6177	47	O. Klotz.
" 28 ...	5-00 to 5-35	74 49 5	" 28....	5-43 to 6-10p	....	·6174	59	do
June 4....	11-30 to 0-05p	74 54·2	June 4....	0-07 to 0-50p	.. ....	·6168	85	do
July 27-29..	. . ...	74 42·8	July 27-29..	....	·16160	... ..	....	C. A. French.
" 28		74 40 1			·16142			do
June 9 ...	4-11 to 4-36p	74 50·4	June 9....	4-40 to 5-14p	....	·6171	72	O. Klotz.
June 18. ..	9-40 to 10-03a	74 52·5	June 18....	....	....	·6166	59	do
....	....	74 29·9	....	....	·1625	.. . ..	....	C. I.
June 30....	3-01 to 3-22p	74 41·6	June 30....	3-25 to 3-44p	....	·6167	61	O. Klotz.
Aug. 15 ...	4-52 to 5-36p	74 26·4	Aug. 15...	5-50 to 6-44p	....	·6144	70	do
Aug. 1, 3, 4.	....	74 16·1	Aug. 1, 3, 4.	....	·16501	....	....	C. A. French.
" 5....	....	74 16·6	" 5...	....	·16458			do
Nov. 13 . .	... .	72 48·8	Nov. 13....	....	....	·6119	....	R. W. Haig.
Aug. 6, 7, 8.	... .. .	73 51·8	Aug. 6, 9...	....	·16775	....	.. ....	C. A. French.
Oct. 21....	9-45 to 10-02a	74 06·1	Oct. 21....	10-08 to 10-27a	....	·6141	44	W. Ogilvie.
" 21....	10-51 to 11-10a	74 07·8	" 21 ...	10-33 to 10-46a	. ...	·6123	45	do
" 4.. .	3-08 to 3-27p	73 58·9	" 4...	3-32 to 3-48p	....	·6139	65	do
" 4...	4-18 to 4-40p	73 58·2	" 4....	3-54 to 4-11p	.. ..	·6146	62	do
Sept. 20....	2-55 to 3-20p	73 58·0	Sept. 20....	3-25 to 3-45p	....	·6169	66	do
" 20 ...	4-20 to 4-45p	73 59·0	" 20...	3-50 to 4-13p	....	·6164	65	do
" 25....	3-25 to 3-41p	73 59 0	" 25....	3-45 to 4-06p	....	·6164	62	do
" 25....	4-33 to 4-59p	73 57·1	" 25....	4-10 to 4-27p	... ...	·6143	62	do
" 27....	2-48 to 3-11p	73 58·8	" 27....	3-18 to 3-34p	.. ...	·6139	59	do
" 27 ..	4-10 to 4-30p	74 00·4	" 27....	3-45 to 4-04p	....	·6144	59	do
Sept. 13....	2-30 to 2-50p	73 55·2	" 13 ...	2-55 to 3-20p	.... ..	·6143	64	do
" 13 .	4-05 to 4-25	73 48·0	" 13...	3-30 to 3-56p	.. ..	·6170	63	do
Aug. 17, 18.	....	72 27·0	Aug. 17, 18.	... .	....	·6142	....	R. W. Haig.
July.	....	72 37·0	July.	... .	......	·6098	... .	do
Sept. 6....	2-15 to 2-35p	73 41·4	Sept. 6 ...	2-40 to 3-03p	....	·6098	84	W. Ogilvie.
" 6....	3-30 to 3-32p	73 41 0	" 6....	3-08 to 3-23p	....	·6096	84	do

TABLE

MAGNETIC

C. I.—Carnegie Institution.

BRITISH

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° ′	° ′				° ′
Thompson river	50 41·0	120 11·0	1833	...	...	...
Kamloops	50 39·9	120 20·2	1885	Sept. 2	3–50p	24 20·5 E
"	"	"	"	" 3	5–30p	23 35·5 "
"	"	"	"	...	...	...
"	"	"	"	...	...	...
Nicola	50 09·0	120 40·0	1908	Sept. 19–21	...	25 03·0
"	"	"	"	...	...	...
Van Horne	50 44·4	120 50·3	1885	...	...	...
St. Cloud	50 45·9	121 07·8	"	Aug. 16	4–55p	23 51·5 E
"	"	"	"	...	...	...
Ashcroft (C. I. S.)	50 44·0	121 17·0	1908	Sept. 14, 15	...	27 46·9 E
"	"	"	"	...	...	...
"	"	"	1907·7	...	...	27 36·1 E
Near Black canyon	50 39 6	121 17 9	1885	Aug. 9	4-55p	27 22·5 "
"	"	"	"	...	...	...
Spence's bridge	50 24·3	121 20·7	"	" 2	Noon	23 43·8 E
"	"	"	"	...	...	...
"	50 25·0	121 21·0	1908	Sept. 17, 18	...	26 39·4
"	"	"	"	...	...	...
Chilukweyuk	49 02·0	121 23·0	1859	...	...	...
Chilukweyuk camp	49 06·0	121 23·0	"	...	...	...
Bridge creek (100-mile)	51 39·0	121 27·0	1908	Sept. 8, 9	...	26 47·4
North Bend	49 52 0	121 27·0	"	" 23-26	...	25 48·0
"	"	"	"	...	...	...
Barkerville	53 04·0	121 30 0	1908	Aug. 22-24	...	28 07·3 E.
"	"	"	"	...	...	...
Salmon river	49 58·3	121 30·6	1885	July 12	5–00p	24 59·0 "
"	"	"	"	...	...	...
Cisco station	50 07·4	121 34·4	"	...	...	...
"	"	"	"	...	...	...
Clinton	51 06·0	121 35·0	1908	Aug. 13-16	...	26 26·4
"	"	"	"	...	...	...
Agassiz	49 15·0	121 45·0	"	Oct. 1, 2	...	25 23·6
"	"	"	"	...	...	...
Williams lake (150 mile)	52 06·0	121 56·0	"	Sept. 3-5	...	28 52·8 E.
"	"	"	"	...	...	...
Harrison river	49 13·4	121 56·0	1885	June 14	6–20p	22 21 3 "
"	"	"	"	" 14	6–25p	22 25·4 "
Schweltza lake station	49 02·0	122 00·0	1859	July 4, 5	...	21 37·0 "
Sumas prairie	49 01·0	122 12·0	1858	Oct. 4, 5; Nov. 10	...	21 30·0 "

SESSIONAL PAPER No. 25a

IX—*Con.*

RESULTS—*Con.*

COLUMBIA—*Con.*

Month and day.	Hour and minute.	Dip.	Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature	Observer.
		° ′					°	
April		73 43·0				·5939		D. Douglas.
Sept. 2	2-00 to 2-23p	73 35·8	Sept. 2	2-27 to 2-42p		6071	75	Wm. Ogilvie
" 2	3-25 to 3-48p	73 34·2	" 2	2-53 to 3-18p		·6065	75	do
" 3	3-48 to 4-10p	73 37·5	" 3	4-15 to 4-30p		6054	79	do
" 3	5-00 to 5-20p	73 39·0	" 3	4-35 to 4-54p		·6085	79	do
Sept. 19, 20		72 54·0	Sept. 19, 20		·1755			C. A. French.
" 21		72 53·4	" 21		·1753			do
Aug. 23	2-50 to 3-15p	73 28·0	Aug. 23	3-20 to 3-43p		6037	71	Wm. Ogilvie.
Aug. 16	2-45 to 3-10p	74 00·8	Aug. 16	3-18 to 3-40p		·6166	94	do
" 16	4-22 to 4-47p	74 02·6	" 16	3-50 to 4-10p		·6157	96	do
Sept. 11, 12, 14		73 26·1	Sept. 14. 15.		·1722			C. A. French.
" 12		73 26·8	" 12		·1721			do
		73 22·2			·1725			C. I.
Aug. 9	2-48 to 3-06p	73 37·5	Aug. 9	3-10 to 3-32p		·6123	88	Wm. Ogilvie.
" 9	4-08 to 4-38	73 40·3	" 9	3-42 to 4-02p		·6111	88	do
" 2	9-45 to 10-20a	73 26·8	" 2	10-25 to 10 55a		·6048	85	do
" 2	11-47 to 12-17a	73 27·2	" 2	11-05 to 11-35a		·6072	85	do
Sept. 17		72 58·9	Sept. 16, 17.		·1737			C. A. French.
" 18		72 57·6	" 18		·1741			do
" 7		72 31·0	Sept. 7			·6077		R. W. Haig.
		72 22·2				·6125		J. S. Harris.
Sept. 8, 9		73 35·1	Sept. 8, 9		·1717			C. A. French.
" 23-25		72 32·1	Sept. 24-25.		·1797			do
" 26		72 31·2	"		·1795			do
Aug. 22, 23		74 58·0	Aug. 22, 23.		·1571			do
" 21		74 57·6	" 21		·1569			do
July 12	3-20 to 3-48p	72 39·4	July 12	3-50 to 4-15p		6063	85	W. Ogilvie.
" 12	5-18 to 5-38p	72 40·7	" 12	4-22 to 4-41p		6052	82	do
" 19	1-50 to 2-16p	72 44·7	" 19	2-20 to 2-44p		6066	84	do
" 19	3-16 to 3-40p	72 41·1	" 19	2-50 to 3-10p		·6067	80	do
Aug. 14, 15		73 27·6	Aug. 14, 15.		·1704			C. A. French.
" 13		73 25·1	" 13		1722			do
{ Sept. 28 / Oct. 1, 2 }		71 34·9	Oct. 1, 2		·1892			do
Sept. 28		71 36·1	Sept. 28		·1890			do
Sept. 3, 5		74 12·3	" 3, 5		·1652			do
" 5		74 12·4	" 5		·1651			do
June 14	4-00 to 4-30p	72 28·3	June 14	4-35 to 5-00p		·5994	75	W. Ogilvie.
" 14	5-33 to 5-54p	72 28·0	" 14	5-05 to 5-25p		·6011	73	do
July 4, 5		72 04·0	July 4, 5			·6125		R. W. Haig.
{ Oct. 4, 5 / Nov. 10 }		72 22·0	{ Oct. 4, 5 / Nov. 10 }			6163		do

TABLE

MAGNETIC

C. I.—Carnegie Institution.
C. S.—Coast Survey.

BRITISH

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° '	° '				° '
Alexandria	52 35 0	122 28·0	1908	Aug. 30 – Sept. 1		28 16·2
"	"	"	"			
Fort Alexandria	52 33·0	122 29·0	1833			
Quesnel	52 59·0	122 32·0	1908	Aug. 26-28		28 19·0
"	"	"	"			
Port Hammond	49 12 1	122 38·9	1885	May 26	6-38p	22 46·2 E.
"	"	"	"			
Camp Semiamu	49 01·0	122 46·0	1857			
Station Semiamu	49 00·7	122 46·2	1857			
Port Moody	49 17·0	122 52·6	1885	June 3	4-45p	22 45·8 E.
"	"	"	"	" 3	4-55p	22 46·3 "
New Westminster	49 13·0	122 53·0	1862			
Vancouver	49 18·0	123 07·0	1898·4			24 30·0 E.
Vancouver (Brockton Pt.)	49 18 0	123 07·0	1908	Oct. 5-8		25 23·3
"	"	"	"			
Burrard inlet	49 16·0	123 10 0	1859			
Victoria (C. I. station)	48 25·0	123 21·0	1908	Oct. 13, 14		24 34·0
" "	"	"	"			
"	48 25·0	123 21·0	1907·7			24 15·2 E.
"	48 26·0	123 25·0	1858			
"	48 25·8	123 22·2	1880			
Victoria, Laurel point	48 25·4	123 22·5	1862			
Esquimalt	48 25·0	123 26·0	1881·8			22 55·6 "
"	48 26·0	123 27·0	1859			
"	"	"	1862			
"	"	"	1892·7			
"	"	123 28·0	1898·3			23 42·9 E.
Nanaimo (Jesse island)	49 13·0	123 52·0	1908	Oct. 17, 18		25 15·3
"	"	"	"			
Departure bay, Vancouver I.	49 12·6	123 57·0	1881	Oct. 7		23 55·6 E.
" "	49 12·6	123 58·5	1880			
Nanaimo	49 10·0	124 00·0	1862			
Stuart lake	54 27·0	124 20·0	1833			
Fraser lake	54 03·0	124 40·0	1833			
Bayne sound (Maple spit)	49 28·0	124 45·0	1898·4			24 25·7 E.
" (Beak point)	49 36·0	124 51·0	1898·6			24 14·1 "
Union	49 36·0	124 54·0	1900·8			25 55·6 "
"	"	"	1904·3			26 05·6 "
Union (1)	49 36·0	124 54·0	1906·5			26 00·9 E.
Union (2)	"	"	"			26 17·4 "
Waddington harbour	50 54·0	124 49·5	1881	July 30		25 22·0 "
Henry bay, Vancouver island	49 36·0	124 51·0	1860			
Hecate bay, "	49 15·0	125 56·0	1861			
Port Neville	50 31 0	126 04·0	1860			
Anchorage cove, Kingcome inlet	50 52·8	126 11·7	1881	Aug. 3		25 42·7 "
Nootka sound, Vanc'ver island	49 36·0	126 37·0	1778			
" "	"	"	1791			
" "	"	"	1792			
Friendly cove, "	49 35·5	126 37·5	1881	Sept. 27		23 36·2 "
Beaver harbour	50 43·0	127 25·0	1860			
North harbour, Quatsino sound	50 29·4	128 03·6	1881	Sept. 24, 25		24 53·7 "
Port McLoughlin	52 08 4	128 10·3	"	Aug. 7		26 42·9 "

IX—*Con.*

RESULTS—*Con.*

COLUMBIA—*Con.*

Month and day.	Hour and minute.	Dip. °	Dip. '	Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature.	Observer.
Aug. 30, 31		74	20·9	Aug. 30, 31		·1639			C. A. French.
Sept. 1		74	18·4	Sept. 1		·1647			"
May		74	50·0				·5985		D. Douglas.
Aug. 26, 27		74	51·1	Aug. 26, 27		·1586			C. A. French.
		74	49·0	" 28		1591			"
May 26	3-10 to 3-43p	71	58·6	May 26	3-48 to 4-15p		6030	68	W. Ogilvie.
" 26	5-00 to 5-38p	71	59·0	" 26	4 20 to 4-48p		6064	66	"
Sept.		72	02·0	Sept.			6114		J. S. Harris.
Sept. 8, 9 / Oct. 18		71	57·0	Sept. 8, 9 / Oct. 18			6106		J. S. Harris.
June 3	2-15 to 2·52p	72	13·0	June 3	2-55 to 3-30p		·6118	70	W. Ogilvie.
" 3	4-12 to 4-35p	72	10·5	" 3	3-36 to 3-50p		·6102	70	"
		72	15·0						Richards.
		71	51·5			·1870			British Navy.
Oct. 6-8		71	42·4	Oct. 7, 8		1878			C. A. French.
" 3		71	43·7	" 3		·1867			"
		72	14·0						Richards.
Oct. 12-14		71	19·3	Oct. 13, 14		·1876			C. A. French.
" 10		71	17·0	" 10		·1878			"
		71	18·1			·1881			C. I.
		71	39·0						K. Friesach.
May 4		71	22·1	May 4			·5925		W. H. Dall & Baker
		71	39·0						Richards.
		71	30·3			·1881			C. S.
		71	34·1	Jan. 24 / Mar. 22			·6042		R. W. Haig.
		71	52·0						Richards
		71	27·4			·1905			French Navy.
		71	32·4			1868			British Navy.
Oct. 17, 18		71	20·2	Oct 17		1883			C. A. French.
" 18		71	21·5	" 18		·1879			"
" 6		71	42·2	Oct. 7			5973		H. E. Nichols.
May 6		71	29·2						W. H. Dall & Baker
		71	54·0						Richards.
June		76	09·0	June			6090		D. Douglas.
"		75	48·0	June			·6059		"
		71	53·6			1844			British Navy.
		71	56·5			1854			"
		71	30·2						C S.
		71	26·4			1898			C S.
		71	24·2			·1901			C. S.
		71	25·3			·1910			"
July 30		71	58·6	July 30			·5969		H. E. Nichols.
		72	25·0						Richards.
		72	37·0						"
		72	19·0						"
Aug. 3		72	46·1	Aug. 3			·5928		H. E. Nichols.
April		72	29·0						J. Cook.
Aug. 16, 17		70	20·7						Don. A. Malespina.
Oct.		73	56·0						G. Vancouver.
Sept. 26		71	33·0	Sept. 27			·5950		H. E. Nichols.
		72	37·0						Richards.
Sept. 22		71	41·3	Sept. 24, 25			·5942		H. E. Nichols.
Aug. 5, 6		73	12·1	Aug. 7			6038		"

TABLE

MAGNETIC

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Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
						° ′
Salmon cove, Observatory inlet	55 15·6	129 52·0	1793	Between July 27 and August 12	......	25 18·0 "
Port Simpson..........	54 33·6	130 22·8	1881	Aug. 10, 12..	...	27 54 1 "
"	54 33·5	130 23·8	1862	....	.....	....
Rose harbour, Queen Charlotte island..........	52 09·1	131 15·0	1881	Sept. 20....	......	26 00·6 "
Lake Lindeman..	59 47·2	135 04·8	1887	June 25...	1-00p	32 16·8 "
"	"	"	"	...	......	....

I X.—*Con.*

RESULTS.—*Con.*

COLUMBIA—*Con.*

Month and day.	Hour and minute.	Dip	Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature.	Observer.
		° ′						
Between July 27 and August 12.	....	75 54·5	....	.. ..	....	....	... .	Vancouver.
Aug. 9....	....	74 21·0	Aug. 10, 12..	....	....	·5987	....	H. E. Nichols.
... .	....	74 53·0	....	....	....	....	....	Richards.
Sept. 19....	.. ....	72 30·2	Sept. 20....	.. ..	....	·5957	....	H. E. Nichols.
June 25....	10-55 to 11-19a	77 03·9	June 25 ...	11-23 to 11-50a	....	·5987	56	Wm. Ogilvie.
" 25....	0-19 to 0-47p	77 06·5	" 25....	11-52a to 0-13p	....	·5973	56	"

TABLE

MAGNETIC

YUKON AND

(North of

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° ′	° ′				° ′
Portage du Grand Détour..	60 22·0	113 00·0	1844	June 25....	5-58p	35 15·0 E.
Fort Resolution	60 10·7	113 46·0	1825	....	....	29 15·6 "
"	"	"	1844	June 22....	10-20a	37 12·5 "
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	1888	Sept. 20....	4-45p	38 20·2 E.
"	"	"	"	....	....	....
Fishing station, Little lake....	61 11·7	116 38·0	1844	June 20....	6-02a	35 28·0 E.
" "	"	"	"	....	....	....
Fort Confidence............	66 54·0	118 49·0	1839	....	....	....
"	"	"	1849	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	1850	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
Fort Simpson	61 51·7	121 25·3	1825	....	....	....
"	"	"	1844	Mar. 30..	7-58a	37 52·0 E.
"	"	"	"	" 30....	9-13a	38 43·0 "
"	"	"	"	" 30....	3-46p	37 28 0 "
"	"	"	"	" 30....	4-56p	38 02·0 "
"	"	"	"	May 8....	9-00a	37 57·0 "
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	1888	Aug. 27....	8-20a	37 42·4 E.
"	"	"	"	....	....	....
"	"	"	"	....	....	....
Fort Norman..........	64 40 6	124 44·8	1844	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	64 54·3	125 43·1	1888	July 29....	8-15p	33 39·0 E.
"	"	"	"	....	....	....
Mackenzie river..........	64 26·7	125 03·8	"	Aug. 5....	7-17p	41 34·6 "
"	"	"	"	....	....	....
Fort Good Hope..........	66 16 0	128 31·0	1844	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....

X.

RESULTS.

NORTHWEST TERRITORIES.

Latitude 60°).

Month and day.	Hour and minute.	Dip.	Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature	Observer.
		° ′					°	
June 25		82 33·6						J. H. Lefroy.
								J. Franklin.
June 22	a.m.	82 43·5	June 22			·6428		J. H. Lefroy.
″ 22	a.m.	82 45·4	″ 22			·6439		″
			″ 22			·6437		″
Sept. 19	4-00 to 4-23p	82 10·1	Sept. 19	4-34 to 4-49p		·6308	60	Wm. Ogilvie.
″ 19	5-15 to 5-32p	82 08·0	″ 19	4-51 to 5-08p		·6307	60	″
Mar. 18		82 08·7	June 20			·6390		J. H. Lefroy.
			″ 20			6369		″
June		84 48·0						T. Simpson.
October		84 49·4	October			·6289		J. Rae & J. Richardson.
November		84 51·1	″			·6179		″
December		84 50·0	November			·6101		″
						·6454		″
			December			·5994		″
			″			·6567		″
January		84 48·8	January			·6467		″
February		84 53·9	February			·6162		″
March		84 50·4	″			·6406		″
			March			·6101		″
			″			·6363		″
Aug. 5		81 53·1						J. Franklin.
Mar. 28	4-05p	81 53·8	May 2			·6314		J. H. Lefroy.
May 12	12-00a	81 50·7	″ 2			·6394		″
			″ 2			·6344		″
			″ 2			·6411		″
			″ 2			·6388		″
			June 12			·6373		″
			″ 12			·6334		″
			″ 12			·6373		″
			″ 12			·6427		″
			″ 12			·6350		″
Aug. 25	6-00 to 6-20p	81 17·2	Aug. 25	6-23 to 6-44p		·6249	66	Wm. Ogilvie.
″ 27	5-41 to 6-03a	81 20·9	″ 27	6-06 to 6-26a		·6230	46	″
″ 27	6-56 to 7-16a	81 17·4	″ 27	6-30 to 6-47a		·6225	46	″
May 28		82 34·3	May 28			·6250		J. H. Lefroy
			June 2			·6235		″
			″ 2			·6304		″
			″ 2			·6385		″
July 29	5-15 to 5-35p	81 59·1	July 29	5-40 to 6-00p		·6154	76	Wm. Ogilvie.
″ 29	7-38 to 8-00p	82 01·9	″ 29	6-03 to 6-40p		·6156	74	″
Aug. 5	4-48 to 5-06p	81 58·2	Aug. 5	5-12 to 5-30p		·6142	68	″
″ 5	6-35 to 6-55p	81 54·0	″ 5	5-35 to 6-00p		·6176	66	,
May 29	10-40p	82 55·8	May 29			·6268		J. H. Lefroy.
″ 29	10-40p	82 56·1	″ 29			·6277		″
			″ 29			·6297		″
			″ 29			·6297		″
			″ 29			·6409		″

TABLE

MAGNETIC

YUKON AND

(North of

Place.	Latitude.	Longitude.	Year.	Month and day.	Hour and minute.	Declination.
	° ′	° ′				° ′
Fort Good Hope..	66 16·0	128 50·0	1888	July 13...	6-10p	41 30·9 E.
"	"	"	"	....	....	....
Marsh lake, Yukon river......	60 21·1	134 17·2	1887	July 17....	6-15p	32 46·1 E.
" "	"	"	"	....	....	....
Fort McPherson.. ..	67 26·0	134 57·0	1888	June 22....	4-25p	46 00·8 E.
"	"	"	"	....	....	....
Lewes river	60 42·3	135 04 1	1887	June 24	6-40p	30 55·7 E.
"	"	"	"	....	....	....
"	62 04·4	136 04 0	"	Aug. 7....	7-20p	33 54·8 E.
"	"	"	"	....	....	....
Fort Selkirk ...	62 47·6	137 24·9	"	Aug. 18....	6-00p	34 18·0 E.
"	"	"	"	....	....	....
Richardsons Chain....	69 01·0	137 25·0	1826	....	....	....
La Pierre's House..	67 23·0	136 54.0	1888	....	....	....
"	"	"	"	....	....	....
Yukon river...	63 20·3	139 28 5	1887	Aug. 27 ...	5-40p	33 52·8 E.
"	"	"	"	....	....	....
Mouth of White river.....	63 11·9	139 37·8	"	Aug. 26 ...	9-45a	34 27 0 E.
"	"	"	"	....	....	....
Porcupine river	65 43·0	139 40·0	1888	May 16....	11-45a	37 44 3 E.
"	"	"	"	" 20....	7-02p	37 24·2 "
"	"	"	"	....	....	....
"	"	"	"	....	....	....
Yukon river	64 25·5	140 31·7	1887	Sept. 12. .	10-15a	35 01·1 E.
"	"	"	"	....	....	....
Clarence bay, Arctic ocean...	69 38·0	140 51·0	1826	....	....	....
Boundary, Observatory.	64 41·0	140 54·0	1888	Feb. 27....	4-15p	35 45·3 E.
"	"	"	"	" 28....	11-45a	35 47·5 "
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....
"	"	"	"	....	....	....

SESSIONAL PAPER No. 25a

X—*Con.*

RESULTS—*Con.*

Northwest T[illegible]ries—*Con.*

Latitude 60°).

Month and day.	Hour and minute.	Dip.	Month and day.	Hour and minute.	Hor. intens.	Total intens.	Temperature	Observer.
		° ′					°	
July 13. ..	4-05 to 4-26p	82 17·9	July 13..	4-33 to 4-54p	.. ..	·6123	72	Wm. Ogilvie.
〃 13.....	5-20 to 5-44p	82 18·9	〃 13 .	4-58 to 5-17p	..	·6117	72	〃
July 17. ...	4-39 to 5-05p	77 31·1	〃 17....	5-41 to 6-01p	....	·6035	....	〃
〃 17.....	6-08 to 6-31p	77 33·7	〃 17....	5-08 to 5-35p	. ....	·6009	....	〃
June 22.....	2-15 to 2-35p	81 51·8	June 22....	2-38 to 2-55p	.....	·6089	72	〃
〃 22.....	3-44 to 4-06p	81 45·9	〃 22....	2-58 to 3-18p	......	·6085	73	〃
July 24....	4-22 to 4-50p	77 42·8	July 24....	4-55 to 5-14p	. ...	·5948	76	Wm. Ogilvie.
〃 24....	6-05 to 6-35p	77 45·2	〃 24 ...	5-18 to 5-36p	....	·5935	76	〃
Aug. 7....	5-02 to 5-24p	78 16·4	Aug. 7 ...	5-30 to 5-52p	.. ....	·6026	72	〃
〃 7 ...	6-40 to 7-00p	78 16·4	〃 7....	5-55 to 6-13p	.. ..	·6023	70	〃
〃 18....	4-00 to 4-22p	79 08·2	〃 18....	4-28 to 4-50p	....	·6019	81	〃
〃 18 ..	5-14 to 5-40p	79 08·4	〃 18. ..	4-53 to 5-09p	....	·6012	78	〃
....	... .	82 22·0	....	... .	....	....	....	J. Franklin.
June 7....	8-12 to 8-32p	81 23·7	June 7..	8-36 to 8-55p	....	·5989	48	Wm. Ogilvie.
〃 7....	9-22 to 9-40p	81 25·7	〃 7....	9-00 to 9-18p	....	·5995	48	〃
Aug. 27....	3-25 to 3-45p	78 35·2	Aug. 27....	3-50 to 4-10p	. . . .	5960	67	〃
〃 27....	4-48 to 5-12p	78 38·3	〃 27....	4-22 to 4-44p	....	·5965	64	〃
〃 26...	8-00 to 8-25a	78 20·3	〃 26....	8-28 to 8-50a	..... .	·5966	54	〃
〃 26 .	9-15 to 9-40a	78 18·6	〃 26 ...	8-55 to 9-12a	. . . . .	·5971	55	〃
May 16....	9-45 to 10-07a	79 57·6	May 16....	10-15 to 10-33a	....	·6023	44	〃
〃 16 . .	11-00 to 11-18a	79 57·1	〃 16....	10-39 to 10-45a	.. ...	·6012	44	〃
〃 20....	4-24 to 4-45p	79 51·5	〃 20....	4-50 to 5-06p	..... .	·5949	41	〃
〃 20....	5-30 to 5-55p	79 53·2	〃 20....	5-08 to 5-26p	..... .	6004	41	〃
Sept. 12. ..	7-12 to 8-20a	78 45·5	Sept. 12....	8-25 to 8-40a	....	5942	46	〃
〃 12....	9-15 to 9-35a	78 46·9	〃 12....	8-47 to 9-10a	....	·5930	48	〃
....	....	83 27·0	....	.... . .	....	.. ..	.. ..	J. Franklin.
Jan. 3....	0-40 to 1-22p	78 49·7	Jan. 3....	1-40 to 1-50p	....	·5994	10	Wm. Ogilvie.
〃 3....	2-25 to 2-50p	78 50·1	〃 3....	1-55 to 2-20p	....	·5995	9·5	〃
Feb. 27....	1-40 to 2-01p	78 50·0	Feb. 27....	2-12 to 2-30p	....	·6004	12	〃
〃 27....	3-10 to 3-29p	78 48·9	〃 27. ..	2-45 to 3-00p	....	·5993	12	〃
〃 28....	9-25 to 9-43p	78 48·6	〃 28 ..	9-55 to 10-09a	....	6005	7	〃
〃 28....	10-53 to 11-10a	78 50·1	〃 28....	10-20 to 10-34a	......	·6004	9	

Comparison at Agincourt.

On July 9, 1908, a series of readings were taken with magnet 10, Tesdorpf magnetometer 1977, magnet erect, and maguet inverted.

The resulting declination July 9, at 14^h 33^m was. . .	6° 01′·4 W
Observatory standard magnetometer.	5° 57′·6
Similarly on July 11 at 14^h 05^m, Tesdorpf.	6° 03′·1
Observatory.	6° 00′·4
Mean difference O – T.	— 3′·2

Heuce west declinations as observed with the Tesdorpf instrument must be numerically decreased by 3′·2, and east declinations increased numerically by the same amount.

For horizontal intensity the following comparisons were obtained:—

July 10 at	14^h 05^m, Tesdorpf.	·16400	in C.G.S. units.
"	14^h 05^m, Observatory.	·16387	"
"	16^h 33^m, Tesdorpf.	·16391	"
"	16^h 33^m, Observatory.	·16379	"
July 11 at	10^h 23^m, Tesdorpf.	·16356	"
"	10^h 23^m, Observatory.	·16349	"
"	11^h 44^m, Tesdorpf.	·16365	"
"	11^h 44^m, Observatory.	·16357	"
Mean difference, O – T.		·00010	

This is equivalent to ·00061 H, which is the quantity to be deducted from observed values of H. In figures 2, 3, 4, are shown the observations made for ascertaining the effect, if any, of the electric car service already referred to. The smooth curves drawn exhibit the diurnal variation clearly, showing the hours of the day when it changes most rapidly.

It will be seen that for April 24, 1909, the range was nearly 17 minutes of arc.

In figure 5, is shown a curve based upon the one of the preceding date. This curve represents the actual liue that would be run by a surveyor with a compass in trying to lay down a true N.-S. liue, starting at 7 a.m, of that day, getting half-mile sights, theu resetting at hour intervals, always with the same magnetic reading of the compass without getting back-sights on the preceding station. The scale of offsets is much exaggerated in the figure.

The result would be that after running six miles by evening, he would be 104 links or about 69 feet west of the line on which he started in the morning.

This shows the theoretical inaccuracy of a compass line due to diurnal variation aloue. Of course with the ordinary surveyor's compass it is not possible to read to single minutes, far less to fractions thereof such as enter into the above curve. But the point is, one cannot get away from the important effect of diurnal variation, though it be masked by larger errors of reading. When compass lines are, or were, run in the open a fairly straight line could be run by using back-sights or simply 'picketing' the line, but this condition was rarely the case; the most of the compass lines were run through the woods, the trees being 'blazed' along the line, those on the line were 'notched' and left standing, and the compass simply put on the other side of the obstruction and the line continued on the same bearing as uear as it was possible to read the needle.

The actual magnetic bearings of the astronomic north and south line at Ottawa on that day were:

Hour.	Bearing.	Offset at end of each course from true N.-S. line of first course.
7^h (a.m.)	12° 52′·4 W	0·0 links.
8	51 ·2	1·4 "
9	51 ·0	3·0 "
10	54 ·8	0·2 "
11	59 ·0	7·7 "
12	13° 03′·0	19·8 "
13	6 ·0	35·5 "
14	7 ·4	52·8 "
15	6 ·4	69·5 "
16	4 ·4	83·2 "
17	2 ·4	95·0 "
18	0 ·5	104·4 "

For the coming season it is intended to send the observer along the northern shore of the St. Lawrence from Quebec eastward to Blanc Sablon, near the western entrance of the strait of Belle Isle. The data from this territory are very meagre. so that the magnetic elements to be derived on this stretch of about 750 miles will be of particular value.

The accompanying map shows the position of the various stations given in the table, and the direction of the magnetic meridians at the respective stations or places.

GRAVITY.

During the past season no member of the staff was available for making gravity observations.

I have the honour to be, sir,

Your obedient servant

OTTO KLOTZ.

Fig. 1—Magnetic Hut, Ottawa.

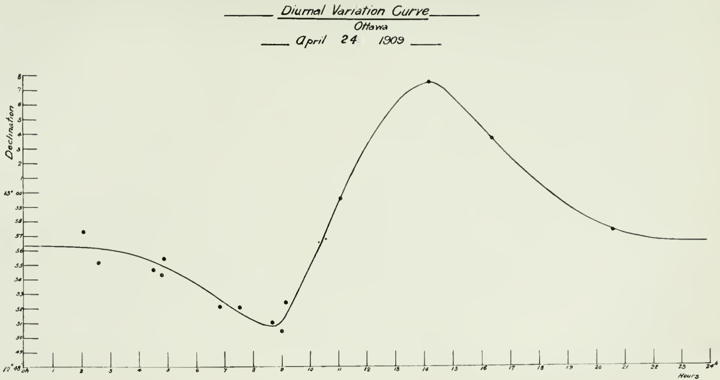
Diurnal Variation Curve
Ottawa
April 24 1909
Declination
13° 00
12° 48
Hours

FIG. 2.

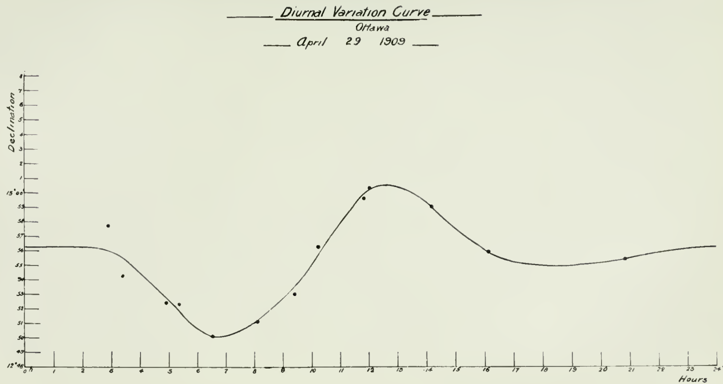
Diurnal Variation Curve
Ottawa
April 29 1909
Declination
Hours

Fig. 3.

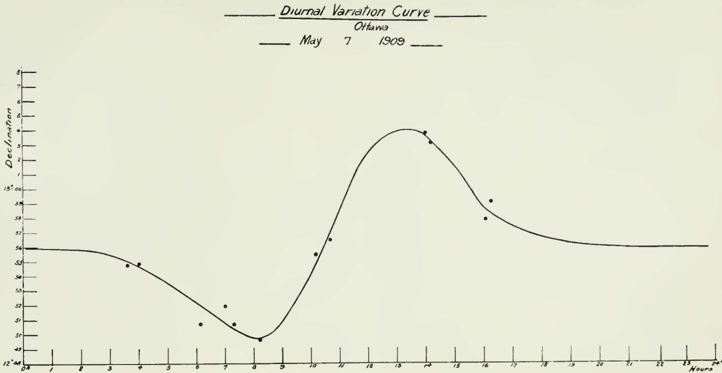
Diurnal Variation Curve
Ottawa
May 7 1909
Declination
13°·00
12°·48
0h
Hours

FIG. 4.

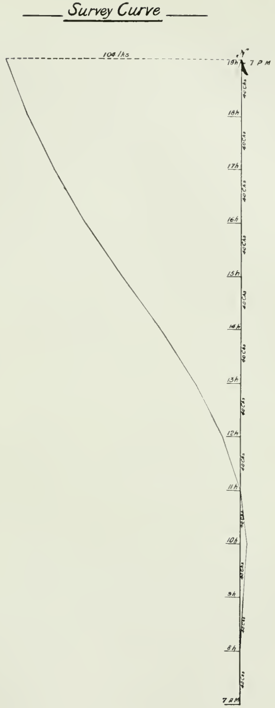
Survey Curve
104 lks
N
19h
7 P M
18h
17h
16h
15h
14h
13h
12h
11h
10h
9h
8h
7 A M

FIG. 5.

APPENDIX 2.

REPORT OF THE CHIEF ASTRONOMER, 1909.

ASTROPHYSICAL WORK

BY

J. S. PLASKETT, B.A.

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APPENDIX 2.

ASTROPHYSICAL WORK BY J. S. PLASKETT, B.A.

OTTAWA, March 31, 1909.

W. F. KING, C.M.G., LL.D.,
Chief Astronomer,
Department of the Interior,
Ottawa.

SIR,—I have the honour to submit the following report upon the work carried on in the Astrophysical Department and in the other departments of the work of the Observatory under my direction during the past year.

It gives me pleasure to report satisfactory progress in all lines and to state that the work accomplished both in quality and quantity shows gratifying improvement over the records of previous years. As in previous years also it has been found necessary to spend considerable time in preparatory work, in testing, adjusting, and perfecting the instruments and appliances used, and in experimenting to determine the best methods of procedure. Although the time spent on such work necessarily diminishes the quantity of routine work accomplished, it is in my opinion time well spent, if through such investigations and experiments we are in a position to do a larger quantity of more accurate work. Consequently, much of my time during the past year has been devoted to investigations bearing on improvements in instruments and methods, of which full details will be given later.

It gives me much pleasure to be able to speak in the highest terms of the very satisfactory work done by my assistants, Messrs. Harper, Motherwell, DeLury, Cannon and Parker.

As heretofore, the principal work has been the determination of the radial velocities of stars by means of the spectroscope, and in this work observations have been chiefly confined to known spectroscopic binaries for the determination of the elements of their orbits. However, observations on some stars with early type spectra have also been secured during times when sufficient binaries have not been available, and in measuring up the plates we have found the velocities of four of these stars to be variable; δ Herculis, γ Aquarii, ι Andromedæ, ξ Persei. The two latter, it has since been learned, had been previousy found variable at the Yerkes Observatory, but not published, so that our discovery was independent.

The elements of the orbits of five spectroscopic binaries have been obtained, least squares corrections being applied in every case. The stars are θ Aquilæ, α Coronæ Borealis, η Boötis, ϵ Herculis, β Orionis. These stars will be discussed in detail below, but it may be of interest to mention that only in one case, η Boötis, have the observations been entirely satisfied by velocity curves due to simple elliptic orbits. In θ Aquilæ and ϵ Herculis a secondary disturbance due possibly to a third body, has been present. In α Coronæ Borealis the elements deduced from the hydrogen lines and the calcium, K, line differ from those obtained from the magnesium λ4481·4, while in β Orionis the amplitude of the velocity seems to be variable. This latter is of especial interest on account of the measures made at Yerkes and Lick Observatories showing its velocity to be constant within the apparent errors of observation.

Besides the binaries above, whose orbits have been determined, there are twelve others under observation, on three or four of which the work is well advanced. On the remainder, however, a considerable number of observations are still required. About 90 per cent of the binaries observed here are stars of early type, in the majority of which the lines in the spectra are broad and diffuse, in some cases unsymmetrically so, and consequently difficult of measurement. In such cases the agreement among the lines in a plate is poor and the error of measurement is high, the probable errors of single plates being as great as 7km. per second in some cases. It is evident that, unless there is a large range of velocity, the elements of the orbits of such stars are subject to considerable uncertainty, and indeed in several cases the star has had to be abandoned on this account after considerable work had been done on it.

The instrumental equipment for this work has been increased since my last report by the addition of a new single-prism spectrograph designed by myself, and constructed, except the optical parts, entirely in our own workshop. Owing to press of repair and other work it was not completed and put into commission until about the first of March, but it has fulfilled all expectations both as regards shortening of exposure time and in respect to its stability and freedom from flexure. The displacement of the spectrum lines produced by a revolution of 180°, this producing the maximum amount of flexure, is quite unmeasurable and is not even certainly visible under high power magnification; there is no question but that it is the most stable single-prism spectograph ever constructed. The difference between it and the previous instrument, which was for its type a rigid example, is very marked, the displacement in the early instrument being equivalent to a velocity of over 100km. per second.

My investigation on the fields given by different types of camera objectives for spectrographs was completed, and a concise account of the performance of all the objectives tested will be given below and will also appear in the Astrophysical Journal in May. Since my previous report a new single material Brashear objective for the new single prism spectrograph has been received and tested. Its angular aperture is about 50 per cent greater than the original one and when received, owing to the greater difficulty in correction, it had a small amount of positive aberration. By the kindness and through the skill of Mr. McDowell this aberration was finally removed and the objective is now practically perfect for its purpose. A special short focus objective by Ross has also been received and tested, giving beautiful definition and a fairly flat field. Thus, the requirements for all types of camera objectives have been successfully met, and there are now available suitable objectives for all classes of radial velocity and other spectroscopic work.

The investigation on the effect of increasing the slit width on the errors of measurement in radial velocity work has been continued with the two different dispersions now available. The new single-prism spectrograph and a short focus objective with the three prism instrument have been tested, giving results that bear out and extend those previously obtained. It is shown that, so far as early type spectra are concerned, both accidental and systematic errors approach a minimum value for a slit 0·051mm. wide and that the use of a narrower slit, instead of increasing the accuracy as has generally been supposed, has to a certain degree the opposite effect, to say nothing of the proportional increase of exposure required. A detailed report of this work will be postponed to allow it to be finally completed.

In presenting the work on radial velocities and allied investigations in detail, I have adopted the same plan as last year, of having each observer give the details and results of the work he has been engaged on. Consequently, below will be found, besides my own remarks on radial velocities in general, my description of the new spectrograph, the investigations on camera objectives and on the effect of slit width, and the orbit of β Orionis, the orbits of θ Aquilæ, η Boötis and ϵ Herculis by Mr. Harper, and the orbit of α Coronæ Borealis by Mr. Cannon. Mr. Parker, the third observer in radial velocity work, besides measuring many miscellaneous plates, spent a great deal of time on the binary τ Tauri, but owing to difficulties due to causes outlined above was unable to obtain a satisfactory orbit and further observations next season will probably be necessary.

Work with the coelostat telescope in spectroscopic investigations of the sun has made satisfactory progress, although not as much has been accomplished as we had hoped. This has been due to various unavoidable constructional delays in having the 23-foot spectrograph and its attachments completed, to a long delay while the solar research laboratory was torn up for the installation of underground pipes and an electric pump for draining the transit house piers, and to a very thorough investigation of some peculiar properties in the plane grating used as the dispersion piece in the spectrograph. This investigation, which is fully described by Dr. DeLury below, showed that only by masking part of the grating could even fair definition be secured, while the best definition is necessary for accurate results in the determination of the solar rotation. A number of plates for this purpose have been secured and some preliminary measures by Dr. DeLury will be given. An illustrated description of the coelostat telescope and mechanism will be given by myself, and a description of the spectrograph and attachments by Dr. DeLury.

Mr. Motherwell has used the equatorial on three half nights per week in micrometric measures of double stars and has obtained a number of good measures, although his, as well as all other work with the telescope, has been much handicapped by the exceptionally poor observing weather of last fall and early winter. For nearly four months, smoke and cloud prevented almost all observations. This was especially unfortunate on account of the presence of Morehouse's comet, an especially interesting object, photographically, which this bad weather prevented from being photographed here more than half a dozen times. However, Mr. Motherwell will give an account in Appendix D of the double star measures obtained, of the occultations of stars by the moon observed, and of the photographs of the comet secured.

A full account of an interesting and useful investigation by Mr. Motherwell on the aberration of the 8″ Brashear Photographic Doublet, used in making the comet pictures, will be given. When this instrument was first tested by me, soon after the Observatory was completed, it was found to give halos around the stars of medium intensity, while in the brighter stars this halo had become so fully exposed as to make images of uniform intensity and of large diameter. This difficulty I ascribed to spherical aberration, but this diagnosis was opposed by the makers of the lens.

I suggested to Mr. Motherwell as a suitable and useful subject for investigation to determine by Hartmann's method of extra-focal exposures the amount of spherical aberration present. His thorough tests showed the lens to have negative aberration to the extent of about 3·5mm., which in our opinion was quite sufficient to account for the halo observed. A suggestion of Mr. McDowell that it was due to chromatic aberration was found by Mr. Motherwell not to be the case. The matter remained in abeyance for some time, when on a further suggestion from Prof. Hastings the separation of the elements of the front component was changed to remove the halo, supposedly a 'ghost' due to internal reflections. However, a test showed no improvement on the original positions in the slight change proposed. Further correspondence with Mr. McDowell resulted in a suggestion from him to increase the separation by about 2mm., which would practically remove the aberration. On this being done and the distance adjusted so that the aberration was removed, the halo disappeared which was a striking confirmation of our contention that it was caused by aberration. A recent letter from Mr. McDowell admits that we were right as he had proved by refiguring a lens giving a similar halo.

In consequence, the objective will be sent to Alleghney to have this aberration removed and with its already very flat field we should have an unequalled star camera. In this regard, I would urge upon you the desirability of supplying the camera with a separate mounting. Its attachment to the equatorial telescope results in seriously limiting its usefulness; for when star photographs are being made, no work, other than the guiding, can be done with the equatorial. A separate mounting, however, would enable the two to be used independently and much more use could be made of the camera than is possible at present.

The quantity of repair and other work has increased so greatly, that the two mechanicians, Mr. Mackey and Mr. Lucas, the latter having been appointed since my last report, have not been able to keep up with all the work required. Repairs and minor alterations in the field instruments used in the Geodetic and Boundary Surveys, occupy about one-half their time, leaving the remainder for new work. The new single-prism spectrograph, the mechanical parts of the solar 23-foot focus spectrograph, and new hardened steel pivots on the meridian circle are the principal pieces of work accomplished. Besides these are numerous smaller pieces of work. Scarcely a day passes that some work does not come in.

The equipment of the machine shop has been increased by a 14 inch by 7 foot Hendry Norton lathe, which is installed and in use. With two lathes there is now no possibility of delaying work for lack of tools. The lathe is the tool most used in machine work and frequently cases occurred where both men required the lathe at the same time; in consequence the work could not be done to the best advantage. The workshop is too small for the tools and the amount of work done, and moreover the light in it is not of the best. It is desirable that, as soon as possible, provision be made for a suitable workshop above ground with ample room and light. The necessity and economy of a suitably equipped workshop for the Observatory are so evident, and the probability of an increase in its capacity being required is so great, as to justify the question of a more suitable location than the present one being carefully considered.

The field instruments and others of a portable nature have been most carefully looked after by Mr. Motherwell, who has kept a careful record of their movements. This work has become, with the increase in the staff and in the number of instruments, one of considerable labour and trouble and takes much of his time in the spring and fall.

The Saturday open nights of the telescope for the public continue to be well patronized, the average attendance on fine nights being upwards of fifty, and much intelligent interest is manifested by many of the visitors in astronomy. This interest is further fostered by the papers presented at the evening meetings of the Royal Astronomical Society of Canada, of which the majority are given by officers of the Observatory. It may not be amiss here to refer also to the value of the work done by the members of the Observatory staff in the afternoon or technical lectures given alternately with the evening ones. These lectures and papers presenting in most cases original work in different lines of astronomy have been of great value, not only in keeping us acquainted with each other's work but also in encouraging researches along original lines which have been frequently of distinct value to science.

The following papers by members of the staff of the Astrophysical Division have been published since the date of the last report:—

1. The spectroscopic Binary ι Orionis, by J. S. Plaskett and W. E. Harper, Astrophysical Journal XXVII., p. 272, May, 1908.

2. Effect of increasing the slit-width upon the accuracy of Radial Velocity Determinations, by J. S. Plaskett, Astrophysical Journal XXVIII., p. 259, Nov., 1908.

3. The spectroscopic Binary ψ Orionis, by J. S. Plaskett, Astrophysical Journal XXVIII., p. 266, November, 1908.

4. The Orbit of ι Orionis, by J. S. Plaskett, Astrophysical Journal XXVIII., p. 274, November, 1908.

5. The Astronomical and Astrophysical Society of America, by J. S. Plaskett, Journal of the Royal Astronomical Society of Canada II., p. 255, September-October, 1908.

6. The Reduction of Cadmium by Mercury and the Electro-Motive Force of Cadmium Amalgam, by R. E. DeLury and G. A. Hulett, Journal of the American Chemical Society, volume 30, No. 12, p. 1805, December, 1908.

7. Comet 1908 (Morehouse), by R. M. Motherwell, Journal of the Royal Astronomical Society of Canada III., p. 28, January-February, 1909.

8. The Orbit of θ Aquilæ, by W. E. Harper, Journal of the Royal Astronomical Society of Canada VII., p. 87, March-April, 1909.

Besides the above the following papers are to appear shortly, the work on them having been completed and sent to the publishers:—

9. Camera Objectives for Spectrographs, by J. S. Plaskett, Astrophysical Journal, May, 1909.

10. The Spectroscopic Binary β Orionis, by J. S. Plaskett, Astrophysical Journal, July, 1909.

11. The design of Spectrographs, by J. S. Plaskett, Journal of the Astronomical Society of Canada, May-June, 1909.

In addition to the above the Astrophysical Division have sent in the titles of the following seven papers to be read before the Royal Society of Canada at their meeting, May 25, 1909:—

12. A new Single Prism Spectrograph, by J. S. Plaskett.

13. Slit width and Errors of Measurement in Radial Velocity Determinations, by J. S. Plaskett.

14. The spectroscopic Binary β Orionis, by J. S. Plaskett.

15. The System of ϵ Herculis, by W. E. Harper.

16. Aberration of a Stellar Camera Objective, by R. M. Motherwell.

17. Convection and Stellar Variation, R. E. DeLury.

18. The Orbit of α Coronæ Borealis, by J. B. Cannon.

In general the work represented by these papers will appear in detail below, arranged sometimes in a little different form, and including as a rule the whole of the original measurements and data which were abbreviated or left out in the published papers.

THE SPECTROGRAPHS.

During the year just passed the Ottawa spectrograph, illustrated and described in the 1907 report, has been used almost entirely, the new single-prism spectrograph not having been ready for service until about March 1, 1909. The former instrument has been used mostly in the single-prism form, the three prisms having been used only for some plates of β Orionis and a few others. The spectrograph has not been changed in any way since the last report, and its performance has continued satisfactory. Nothing further need be added about this instrument, except that towards the close of the year the Zeiss Tessar objective of 300mm. focus, referred to in the last report, was temporarily mounted for the purpose of continuing the tests on the effect of slit-width on errors of setting so far as applies to a dispersion of three prisms with a short focus camera. This mount will be placed in a permanent form as soon as time can be found in the workshop, and used on solar type binaries too faint to be obtained with the long focus camera.

Before proceeding to describe the new single-prism spectrograph, which was briefly referred to in my last report, it has seemed desirable to enter more fully than was there done into the principles on which its design was based, and for this purpose I can not do better than give here a paper on 'The Design of Spectrographs,' which I read at an afternoon technical meeting on May 25, 1908, and which will appear in the May-June number of the Journal of the Royal Astronomical Society of Canada.

THE DESIGN OF SPECTROGRAPHS FOR RADIAL VELOCITY DETERMINATIONS.

Read before R.A.S.C., May 28, 1908.

The subject of spectroscopy is so broad that one can not hope in a single paper to do more than touch upon a single aspect of it, and, even then, one must further limit his treatment to a particular application of this phase. Consequently, I propose to present some considerations bearing upon the design of spectrographs suitable for the accurate determination of stellar radial velocities. This branch of spectroscopy is comparatively new and is still probably only in the experimental and tentative stage. The present practice in this line has, however, reached a certain uniformity and the general theoretical principles governing the design of spectroscopes may be applied to the case under consideration, modified, of course, in many ways by the experience of the various observers. The question is one of a judicious combination of theory and experience, and I propose to present my own views, founded, of course, on theoretical considerations, but modified partly by the practice of other spectroscopists, partly by my own experience in the work and by the results of special investigations bearing on the most suitable form and dimensions of the instrument.

'The determination of the radial velocities of stars by means of the spectroscope is one of the most exacting of astronomical investigations, and requires the closest attention to all details to ensure accurate values. This will be more readily recognized when the smallness of the displacement of the spectral lines on which the velocity depends is known. Thus, in the Ottawa Spectrograph a velocity of 20km. per second, which is greater than the average velocity of the stars, causes a displacement at $H\gamma$, the centre of the measurable range, of about 1/2700 inch for the single-prism, and about 1/600 inch for the three-prism form of the instrument. The accidental errors arising in the measurement of this displacement, in spectra with good lines, are, however, not so much to be feared as systematic displacements of the lines as a whole, of which no evidence is given in the measurements, caused by flexure of the parts of the spectrograph, by temperature changes in the prisms and lenses and also in the metal frame, by faulty adjustment of the focal positions of camera and collimator, as well as by numerous other causes. Some idea of the magnitudes of these displacements may be gained from the following figures. An hour's exposure in one of the modern spectrographs introduces flexure displacement equivalent, in some positions of the telescope, to a velocity of 10km. per second. A change of temperature of 1°C. in the prism displaces the lines by about 20km., which may be increased further by the expansion of the metal parts. An inaccuracy in the focal setting of the camera of only 0·1 mm. 1/250 inch, may, when combined with poor guiding, cause a displacement of about 5km. It does not follow that such displacements necessarily cause a corresponding error in the velocity as they may be compensated for, partially at any rate, by a similar displacement of the comparison lines. But the possibility remains, and inaccurate results can only be prevented by constant and careful attention to all details. It becomes, therefore, a question of equally great importance with proportioning the optical parts to give accurately measurable spectra in the shortest possible exposure time, to so design the whole instrument that systematic errors due to the above or other causes may be provided for and eliminated as far as possible.

The design of a spectrograph may be most conveniently attacked under two separate headings:

1. The character and proportions of the optical parts.

2. The mechanical connection of these parts into a symmetrical and stable whole, with suitable auxiliary devices for controlling the temperature, applying comparison, &c.

The Optical Parts.

'Up to the present, prisms of dense flint glass have been the sole dispersing medium used for radial velocity work. Gratings, so useful in other branches of spectroscopy, have not yet been applied in this work, chiefly on account of the division of the incident pencil into a number of spectra with the consequent loss of light, and also on account of the difficulty of maintaining their position invariable without distorting the surface. Prisms have very decided advantages over gratings in this respect as, when set at minimum deviation, a small angular rotation of the prism will scarcely displace the spectrum lines, while with a grating the angular displacement of the lines is double that of the prism. The optical parts of a spectrograph are then:—1. The slit, whose width is usually between 0·025 and 0·051mm., one and two thousandths of an inch, on which the star image is condensed by the telescope. 2. The collimating lens placed at its focal distance from the slit and consequently rendering the incident pencil parallel. 3. The prism or prisms placed at minimum deviation for some particular wave-length usually near $H\gamma$. 4. The camera lens which forms an image of the spectrum on the photographic plate.

'As the terms dispersion, resolving power, purity, &c., will be frequently used and as the prism angle, thickness of base, &c., require computing, it seems preferable to give here a short synopsis of the theory involved and the formulæ used, particularly as these are not readily available in a suitable form or collected together in one place.

'When a pencil of parallel white light is incident upon a prism, the direction is changed, the light is deviated, and it is also decomposed into its constituent colours forming a spectrum, the wave-lengths of the light giving rise to these colour-sensations, diminishing as you go from red to violet. The fundamental formula determining the direction after refraction is, i being the angle of incidence, r of refraction,

$$\sin i = \mu \sin r.$$

μ is the index of refraction which varies for different materials and for different wave lengths in the same material, increasing as the wave length diminishes. In all spectroscopes the prisms are used at the position of minimum deviation, which, it may be easily shown, requires the angles of incidence and emergence to be equal. The discussion will therefore be confined to this particular case, resulting in a considerable simplification.

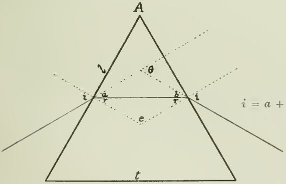


Fig. 1.

$$A + e = 180°$$
$$e + 2r = 180°$$
$$\therefore r = \frac{A}{2};$$
$$\theta = a + b; \quad a = b,$$
$$\therefore a = \frac{\theta}{2}.$$

$$i = a + r = \frac{A + \theta}{2}, \text{ and as } \sin i = \mu \sin r,$$

$$\mu = \frac{\sin \frac{A + \theta}{2}}{\sin \frac{A}{2}}.$$

If a is aperture of incident pencil just filling prism,

$$l = a \sec i.$$

$$t = 2\, l \sin \frac{A}{2} = 2\, a \sec i \sin \frac{A}{2}.$$

'If θ the deviation and μ the index are given to find A or the angle of the prism,

$$\sin\frac{A+\theta}{2} = \mu \sin\frac{A}{2} \text{ and reducing and simplifying}$$

$$A = 2\sin^{-1}\frac{\sin\frac{\theta}{2}}{\sqrt{\sin^2\frac{\theta}{2} + \left(\mu - \cos\frac{\theta}{2}\right)^2}}.$$

'The dispersion of a prism is usually defined as the ratio of the change in deviation to the change in wave length or $\frac{d\theta}{d\lambda}$. As the deviation varies with the index of refraction and as the latter varies with the wave length we may put

$$\frac{d\theta}{d\lambda} = \frac{d\theta}{d\mu}\cdot\frac{d\mu}{d\lambda}, \text{ but}$$

$$\mu = \frac{\sin\frac{A+\theta}{2}}{\sin\frac{A}{2}}$$

$$\therefore \frac{d\theta}{d\mu} = \frac{2\sin\frac{A}{2}}{\cos\frac{A+\theta}{2}} = \frac{2\sin\frac{A}{2}}{\cos i}$$

$$= \frac{2\sin\frac{A}{2}}{\sqrt{1-\sin^2 i}} = \frac{2\sin\frac{A}{2}}{\sqrt{1-\mu^2\sin^2\frac{A}{2}}},$$

$$\text{also } \frac{d\theta}{d\mu} = \frac{2\sin i}{\frac{\mu}{\cos i}} = \frac{2}{\mu}\tan i.$$

'To obtain $\frac{d\mu}{d\lambda}$ we require a relation between λ and μ. The simplest is obtained from Hartmann's interpolation formula.

$$\mu = \mu_0 + \frac{c}{\lambda - \lambda_0}$$

$$\therefore \frac{d\mu}{d\lambda} = -\frac{c}{(\lambda-\lambda_0)^2} \text{ and consequently}$$

$$\frac{d\theta}{d\lambda} = \frac{d\theta}{d\mu}\cdot\frac{d\mu}{d\lambda} = -\frac{c}{(\lambda-\lambda_0)^2}\cdot\frac{2\sin\frac{A}{2}}{\sqrt{1-\mu^2\sin^2\frac{A}{2}}}.$$

'Let us now consider resolving power or the ability of the prism to separate lines close together in the spectrum. Lord Rayleigh has shown, in the case of the image of an infinitely narrow slit produced at the focus of a telescope lens, that the linear distance ξ of the first diffraction minimum from the principal maximum is given by the equation.

$$\frac{a\,\xi}{m\,\lambda\,f} = 1,$$

where a is the aperture and f the focus of the lens and m is a constant, 1·0 for rectangular and 1·2 for circular apertures.

$$\frac{\xi}{f} = \frac{m\,\lambda}{a}$$

$\frac{\xi}{f}$ is then the least angular distance at which two rays can be seen separated. Calling the angle $d\theta$ we have

$$d\,\theta = \frac{m\,\lambda}{a}.$$

For the case of a prism we have

$$a = l \cos i,\; t = 2\,l \sin\frac{A}{2}$$

$$\therefore \frac{t}{a} = \frac{2\sin\frac{A}{2}}{\cos i} = \frac{d\,\theta}{d\,\mu}$$

Combining we get the minimum condition of resolution

$$t = \frac{m\,\lambda}{d\,\mu}.$$

Again, omitting the constant m, we have

$$d\,\theta = \frac{t\,d\,\mu}{a} = \frac{\lambda}{a},$$

and multiplying by $\frac{a}{d\,\lambda}$ we get

$$a\frac{d\,\theta}{d\,\lambda} = t\frac{d\,\mu}{d\,\lambda} = \frac{\lambda}{d\,\lambda}$$

where $\frac{\lambda}{d\lambda}$ is the minimum value which permits resolution of close lines. $\frac{\lambda}{d\lambda}$ or the ratio between the mean wave length of a pair of lines which can just be resolved in a spectroscope and the difference in wave length between the two components is called the resolving power of the spectroscope and is usually designated by the letter R.

'The linear dispersion $\frac{d\,s}{d\lambda}$ where f = focal length of camera is

$$\frac{d\,s}{d\,\lambda} = f \cdot \frac{d\,\theta}{d\,\lambda} = f \cdot \frac{R}{a}.$$

'The resolving power R refers to infinitely narrow lines through an infinitely narrow slit. When, as necessarily occurs in practice, neither of these two conditions holds, we speak of the purity of the spectrum or the practical resolving power for wide slits. Schuster has given a simple expression for the purity which is always a fraction of the theoretical resolving power R. This expression has been elaborated by Wadsworth and later still Schuster has given tables for determining the purity. But as no appreciable error will be introduced in the relative values used in this work, it has seemed preferable to adhere to the simple form. If d = slit width and ψ = angular aperture of the collimator $= \frac{a}{f}$, the Purity $P = \frac{\lambda}{d\,\psi + \lambda} \cdot R$.

'We have now obtained all the formulæ necessary to compute the data for any optical system and to compare the efficiency of different forms of spectroscopes. To take a concrete case, which is more applicable for our purpose than a general discussion, I propose to consider the question of the most suitable aperture to be given a single-prism spectrograph which is being constructed for the Dominion Observatory. The present spectrograph, which is arranged to be used with either one or three prisms, has a collimator of 35mm. aperture, 525mm. focus and two cameras, one for each form of 525mm. focus. It performs excellently for both purposes, but when, as often happens, both single and three prisms are required on the same night, the change from one form to the other is somewhat tedious, requiring 15 or 20 minutes, and moreover, what is far more important, such change involves uncertainties as to the temperature conditions of the optical parts and therefore corresponding uncertainties as to the accuracy of the velocities obtained.

'In order to fill the collimator lens completely with star light its aperture ratio $\frac{a}{f}$ must be the same as that of the equatorial. The aperture ratio of the Ottawa telescope is 1 to 15, consequently the focal length of the collimator must be 15 times the aperture. This aperture is limited on the lower side by the condition that sufficient purity must be obtained, purity being proportional to the aperture at a practicable width of slit, to so separate lines and blends of lines that sufficiently accurate identifications of lines and the true wave lengths of blends may be obtained. It is limited on the upper side by the difficulty of obtaining homogeneous prisms of large size, by the increased absorption of such prisms, and by the increased size and weight of the instrument. In all the spectrographs used in radial velocity work the apertures lie between 30 and 51mm., and these seem to be about the practical limits. It remains to determine the most suitable.

'The basis of the discussion* rests upon the results obtained for the effective diameter of the star image given in my paper on 'The Star Image in Spectroscopic Work,' No. II, which was read here last fall and published in the Astrophysical Journal, March, 1908. The results of a number of experiments, photographs of star images, spectra and trails, went to show that only very rarely is the effective diameter of the image less than 2 secs. of arc (about 0·055mm.) at the focus of the refractor. Generally the diameters of images and the widths of spectra and trails are considerably greater, increasing to over 0·1mm. with longer exposures. As the theoretical diameter of the central disc is only 0·57″ (about 0·015mm.) and, as the condensing system of visual objective and photographic correcting lens is practically perfect, the enlargement in diameter is undoubtedly due to atmospheric disturbances. These consist probably partly of a blurring or spreading out of the central disc and partly of small displacements in all directions from its mean position. In consequence there results considerable loss of light at the slit jaws with the widths usually employed, and further experiments showed that the proportion transmitted varied almost directly with the width until this reached 3 or 4 secs. I reproduce below part of the table for slit transmission given in the paper referred to:—

* An able discussion of this subject on somewhat similar lines, to which I am much indebted, has been given by Newall (M. N. 65, p. 608).

SLIT TRANSMISSION.

Slit Width.		Comparative exposure for equal intensity of spectrum.	
Linear mm.	Angular secs.	Observed.	Corrected for loss by diffraction.
0·025	0·91	100	100
0·051	1·82	40	50
0·076	2·73	27	35
0·102	3·64	25	32

'This table shows that if the slit width can be increased the exposure is proportionally diminished, double the slit width halve the exposure, which means, of course, an increase in the output and in the practical range of the equipment. But on the other hand, a widening of the slit, other conditions remaining unchanged, decreases the accuracy of measurement of the resulting spectra. This loss of accuracy is due to two causes: first, diminished purity rendering uncertain identifications and wave lengths of blends; second, increased diffuseness of the spectral lines rendering measurements more difficult. We will take up these two considerations separately and find under what conditions the slit may be widened without loss of accuracy.

'The equation for purity of spectrum, $P = \frac{\lambda}{d\psi + \lambda} \cdot R$, shows that the purity is almost proportionally diminished as the slit width is increased as $d\psi$ is, even for slit 0·025mm., nearly ten times λ. To increase the purity of a spectrum only two courses are open—to diminish the slit width or increase the resolving power. As we wish to widen the slit the resolving power of the spectroscope must be increased, which may be done in three ways.

1. By increasing the aperture of the prism or prisms $R = \frac{\lambda}{d\lambda} = a\frac{d\theta}{d\lambda}$ or R varies directly with the aperture.

2. By increasing the number of prisms.

3. By shifting the region of spectrum under observation towards the violet. The resolving power varies inversely as the cube or slightly higher power of the wave length. This will be seen directly when we compute resolving powers, but it follows at once by differentiating Cauchy's form of dispersion formula.

$$\mu = A + \frac{B}{\lambda^2} + \frac{C}{\lambda^4} + \ldots \text{ or simply}$$

$$\mu = A + \frac{B}{\lambda^2}$$

$$\frac{d\mu}{d\lambda} = -\frac{2B}{\lambda^3}.$$

'The use of the second method increases the dispersion which is usually not allowable on account of the proportional increase of exposure time entailed. The third method can not be used with a refractor and glass prisms on account of the strong absorption of ultra violet light by the glass of the lenses and prisms. With a reflector and a quartz or ultra-violet glass spectrograph it might be applicable. We are therefore practically limited to the use of a larger prism and consequently larger collimator and camera lenses.

'The size of prisms in use in radial velocity work, as previously stated, lies between about 30 and 51mm. Prisms of 51mm. aperture are successfully used in the Yerkes Spectrograph, but Frost's experience as also that of Hale in large spectro-heliograph prisms shows that the limit is nearly reached.

'In discussing the necessary conditions for using a wider slit, let us take as an example a comparison between the efficiencies of single-prism spectrographs of 35mm., the aperture of the present instrument, and 51mm. aperture, the latter having been decided upon, after careful consideration, as the aperture of the new instrument. A spectrograph of such aperture, outside of considerations of the homogeneity of larger prisms, is the practical limit as regards size and weight that can be attached to a 15-inch equatorial.

'The glass generally used for the prisms is Jena glass 0·102, Dense Silicate Flint, and this was chosen for the spectrographs here. It is very colourless considering its density and dispersion. The indices of refraction of the particular melting from which the present prisms were made, as furnished by the makers, are as follows:—

Wave Length.	Index of Refraction.
·00006563 cm	1·6413
.00005893 cm	1·6467
.00004862 cm	1·6603

'From these values substituted in the Hartmann formula $\mu = \mu_0 + \frac{c}{\lambda - \lambda_0}$ we obtain the values of the three constants μ_0, c and λ_0.

$\lambda_0 = \cdot 00002190.$

$\mu_0 = 1 \cdot 61146.$

$\log c = \bar{6} \cdot 115595.$

'From these constants were calculated for a number of wave lengths μ and $\frac{d\mu}{d\lambda}$. From $\frac{d\mu}{d\lambda}$, R was obtained for prisms of 35 and 51mm. aperture, and of refracting angle 63° 50′, this being the angle required to deviate the ray at minimum, λ 4415, 60°. The formulæ used were previously derived and are:

$$\frac{d\mu}{d\lambda} = -\frac{c}{(\lambda - \lambda_0)^2}.$$

$$R = t\frac{d\mu}{d\lambda} \text{ where } t = 2a \sec\frac{A+\theta}{2}\sin\frac{A}{2}.$$

Wave Length.	μ	$\frac{d\mu}{d\lambda}$	R Prism 35 mm.	R Prism 51 mm.
4862	1·6603	1829	14420	21010
4550	1·6667	2343	18470	26910
4415	1·6701	2636	20780	30280
4341	1·6721	2822	22250	32420
4102	1·6796	3490	27520	40100
4000	1·6833	3983	31400	45750
3970	1·6848	4119	32380	47180

'The resolving power for the two apertures obtained, the purity of spectrum for different slit widths is readily calculated from $P = \frac{\lambda}{d\ \psi + \lambda} \cdot R$, ψ in this case, being $\frac{1}{15}$ or ·0667. The results are given in the following table for the wave length 4341 or $H\gamma$, this being the usual central ray.

PURITY OF SPECTRUM.

Slit Width.	Prism 35 mm.	Prism 51 mm.
0·025	4596	6697
·040	3114	4537
·051	2518	3670
·063	2084	3036
·076	1755	2558

'These figures show that with the larger prism the slit may be made 50 per cent wider and still have practically the same purity of spectrum, and consequently the same accuracy of velocity determinations.

'The slit transmission table previously given showed that an increase in slit width of 50 per cent when below 0·076mm. increased the quantity of star light transmitted by nearly 50 per cent; consequently, other conditions being equal, half as many more spectra could be made in a given time. But an increase in the size of the prism means also an increase in the quantity of light absorbed by the glass of the prism, although the amount reflected will be the same. We can obtain an accurate knowledge of the quantity of light absorbed in the two prisms of O. 102 glass from Vogel's experiments (Astrophysical Journal, V., p. 75), who showed that $H\gamma$ light transmitted through 100mm. of O. 102 glass suffered absorption of about 47 per cent. The absorption for prisms of 35 and 51mm. aperture, average length of path 39 and 57mm. respectively, may be readily calculated by the formula $I_1 = I_0 K^{\frac{x}{a}}$, where x is thickness of glass for which absorption is required, a is thickness for which percentage transmitted is K, I_0 intensity of incident, I_1 of transmitted beam. We obtain for prism of 35mm. aperture 78 per cent, of 51mm. aperture 71 per cent transmission. If 100 be intensity of incident pencil for small prism, then 150 will be intensity of pencil giving equal purity with large prism. After transmission intensities will be 78 and 150 × ·71 or 106·5, respectively, and the required exposures will be inversely proportional or as 3 to 4, a very considerable gain. Even when the slight additional absorption in the thicker camera and collimator lenses is considered a substantial saving of time will result by the use of the larger prism.

'We have tacitly assumed in the foregoing discussion that a decrease of purity entails loss of accuracy in the velocity values. This is undoubtedly true for complex spectra such as those given by solar or allied type stars, spectra in which are hundreds of lines and in which every decrease in purity means increased uncertainty in the wave lengths of the more complex blends of lines thereby produced. In the case of early-type stars, however, such as those of the hydrogen or helium groups, where there are only few lines, and these single, there can be no trouble with blends, and the question of the purity of the spectrum has not so much weight. On such grounds there would be no material advantage in using the larger aperture. However, a consideration of the second effect produced by widening the slit—the increased diffuseness of the spectral lines—will show a similar advantage for the larger aperture even where purity does not come into question.

'This may be best shown, as before, by considering a special case and we may take the same example with advantage. The present single-prism spectrograph has a collimator objective of 35mm. aperture and 35 x 15 or 525mm. focus. The camera has a focus of 525mm., and therefore the image of the slit on the plate will be of the same size, and the minimum width of line will be the width of the slit. The new spectrograph will have a collimator of 51mm. aperture and 51 x 15 or 765mm. focus. The camera will be of about 455mm. focus. Hence the image of the slit on the plate will be diminished in the proportion of 455 to 765 or about ⅗. If the camera were of the same focus as the one now in use, 525mm., the image of the slit would be diminished to about 7/10. Hence the slit can be made in the one case 5/3, in the other 10/7, the width with the present spectrograph, and have the lines of the same width, and consequently equally accurately measurable. The gain in efficiency is thus about equal under the latter consideration and that of the maintenance of equal purity, and we may therefore consider that a decided advantage may be obtained in stars of all types by increasing the aperture of the prism. Such conclusions are, of course, subject always to the test of actual use under similar external conditions before they can be accepted as final.

'However, some experiments that I made here last winter on the effect of widening the slit upon the accuracy of velocity determinations* substantiate the above conclusion, and I will therefore give a short summary of some of the results reached. As previously stated, when the slit is widened, the purity is diminished and the lines become broader and more diffuse. To simplify the investigation, the question of the effect of purity was eliminated by choosing a star, β Orionis, for the test whose lines are single and moderately sharp. There remains, then, only the question of the effect of the increasing breadth and diffuseness of the lines on the accuracy of the measures. Evidently such a question can only be settled by making and measuring a number of spectra at each slit width. Six plates were made for each slit width 0·025, 0·038, 0·051, 0·076mm. for two dispersions, (*a*) single-prism 525mm. camera, (*b*) three-prism 525mm. camera and six each at slit widths 0·025, 0·051 and 0·076mm. for a dispersion of three prisms and camera of 275mm. focus. In all 66 plates were made, of which I have to thank Mr. Harper for measuring 18 and thus lightening the considerable labour involved. Owing to the different dispersions, different lines were measured in the three sets, but as the main dependence can be placed on the three lines *Mg* λ4481·400, *He* λ4471·676, H_γ 4340·634, the results from these three lines only are given. Computations using all the star lines measured were also performed without, however, changing the conclusions reached.

'There are evidently two kinds of error to be considered, accidental and systematic. Under the first will be considered the accidental errors of the setting of the microscope wire on the individual lines in a plate, resulting in a mean velocity for that plate differing from the true velocity in a greater or less degree depending upon the quality of the lines. The systematic error of a plate is the displacement of the star lines as a whole with respect to the comparison lines. This may be due, as previously stated, to one or more of several causes—change of temperature, flexure, faulty adjustment or aberrations in the optical train, &c. As the lines are in general equally affected, such displacement will not be apparent in the measure of a single plate. It is only by comparing the velocities of a number of plates of a star of constant velocity that such an error can be detected.

'To compare the accidental errors for the different slit widths it will be necessary, to prevent systematic displacements from affecting the result, to treat the measures for each of the six plates for one slit width separately, to obtain the residuals from the mean velocity of each plate and finally the probable error of measurement of an average star line from these residuals. Some idea of the relative magnitude of the sys-

* Since published in the Astrophysical Journal, Vol. XXVIII, p. 259.

tematic errors may be obtained by treating the velocities from each of the six plates. However, this result will not be that due to systematic error only, as the velocity from each plate will also be affected by accidental errors. The results of the measures and computations are given below:—

PROBABLE ERRORS.

Dispersion.	Slit Width.	Accidental Prob. Error, Average Line.	Systematic Prob. Error, Single Plate.
Single Prism ...	0·025	±4·5 km.	±1·7 km.
	·038	2·4	2·7
525 mm. Camera ...	·051	2·3	3·0
	·076	4·3	7·7
Three Prisms ...	0·025	±2·3	±1·5
	·038	2·1	1·3
525 mm. Camera ...	·051	2·5	0·7
	·076	2·1	0·9
Three Prisms ...	0·025	±2·9	±2·1
	·051	2·9	3·0
275 mm. Camera ...	·076	3·8	2·9

'These results were to a considerable extent unexpected. The great difference in the apparent quality for measurement of the spectra made with slit 0·025 and 0·076mm., especially with the single-prism, would lead one to expect a marked increase in the errors of setting, but this is not very distinctly shown, not at all in the higher dispersion. The systematic errors, however, are very markedly increased in single-prism plates, so much so as to prohibit the use of slits wider than 0·051mm. In a higher dispersion spectroscope this increase has disappeared, and, so far as the rather small number of plates shows, it is slightly more accurate in the case of dispersion (*b*) to use slits 0·051 and 0·076mm. than slits 0·025 and 0·038mm. It is evident that these results corroborate the conclusions previously reached, by showing that increase in resolving power removes or diminishes the loss of accuracy when the slit is widened. Consequently, with the 50 per cent greater resolving power and the 60 per cent greater ratio of collimator to camera focus, it is probable that the slit-width may be increased 50 per cent without affecting the accuracy of the results and with a corresponding increase in the output.

Mechanical Design.

'The question of the most favourable dimensions of the optical parts having been discussed, there remains the mechanical structure connecting these parts into one stable whole. Owing to the attachment of the instrument to a moving telescope and the consequent varying direction of gravity on the parts, the prevention of flexure is one of the most difficult of the problems to be overcome, and this is especially the case where the instrument is to be attached to a telescope of moderate size, where its weight can not exceed a certain small limit. The weight of our spectrograph complete with temperature case, attaching truss, &c., can not much exceed 100 lbs., and the problem is consequently a much more difficult one than in the case of the Yerkes equipment, for example, where the spectrograph weighs about 500 lbs. Most of the early and some of the recent spectrographs have lacked sufficient stiffness and stability to prevent line displacements due to flexure of the parts. A displacement of the camera and plate of only one one-thousandth of an inch is equivalent in a single-prism spectrograph to a velocity of about 50km. per second. It is evidently a difficult matter in the extended form of a single-prism instrument to reduce this flexure to an inappreciable amount. No material is perfectly rigid and when we consider that even its own weight deforms the strongest material available, the difficulty of the problem will be realized.

'Until very recently all spectrographs were attached to and overhung the end plate of the telescope and thus, like a beam fixed at one end, were subjected to the maximum amount of flexure. An improvement in the principle of attachment was applied at the Lick Observatory recently, in which the spectrograph proper is made self-contained and is held in an independent cradle at two points of support. It is thus like a beam supported at both ends and the flexure is thereby much reduced.

'The original spectroscope belonging to the Observatory was by Brashear of an adjustable universal type and was not, for this very reason, suitable for radial velocity determinations. Braces were added to stiffen the frame as much as possible, but it could not be freed from flexure. Many of the results obtained were uncertain and its use was discontinued as soon as a new combined one and three-prism spectrograph, designed by myself and very satisfactorily constructed by Mr. Mackey in the Observatory workshop, was completed.

'This instrument, whose general form is readily obtained from the figures, page 78 in my report to the Chief Astronomer for 1906-7, has many original features, has given excellent satisfaction and produced reliable results. It is, as will be noticed, a form of the first class mentioned attached only to the end plate of the telescope. It was designed and partly constructed before anything was learned of the new type. Moreover it was desired for the sake of economy of time and money to combine single and three-prism instruments in one (since found by experience to be a mistake), and this could not be advantageously effected in the new form.

'The form of truss designed has some advantages over previous instruments, and has probably less flexure than any other of the same type and weight. The main difference lies in the close grouping of the triangular truss at the lower end and the addition of the substantial diagonal brace, which serves the two purposes of stiffening the outer end of the prism box and lower end of the camera when used in three-prism work, and of tying the outer end of the camera when used with a single prism. The maximum flexure of the three-prism instrument is equivalent to 1·8km. only, while the maximum flexure of the modern Bonn three-prism instrument, the only one for which data have been published, is about 70km. For an hour's exposure with the Bonn instrument there is a flexure of 7km., while a similar exposure with both single and three-prism forms here shows no appreciable flexure. The maximum flexure with our single prism is much greater, about 100km., equivalent to a linear displacement of about 1/400 inch. This great difference in the two forms is due to two causes. First, to the threefold greater kilometre value for the same linear displacement. Second, to the much more extended form of the single-prism instrument. Calculations have shown that the amount of flexure is nearly that caused by the actual extension and compression of the truss members due to their own weight, and consequently it can not be avoided or much reduced in this form of instrument. However, the flexure occurring during a two hour's exposure is only slight except at such great hour angles as are rarely used.

'Both forms of instrument are frequently required on the same night, for stars of varying brightness and type. The time lost in making the change from single to three prism or vice versa, and the uncertainty in the temperature conditions prevailing after the change, close temperature regulation being equally as important, perhaps more important than avoidance of moderate flexure, were considerations leading to the decision, which had the approval of Dr. King, to design and construct a separate single-prism spectrograph, with separate temperature control and attaching stand, so that the change could be made in a minute or two, and without disturbance of temperature.

'Besides using a larger prism for the reasons fully entered into above, the opportunity was taken of changing the mode of attachment to the telescope. Curtiss, of Ann Arbor, designed a form of single-prism instrument modelled after the Lick pattern, which has two points of support, one near the slit and the other near the base of the prism. The spectrograph proper consists of a triangular brass box with angles of about 120°, 30°, 30°. The prism is at the obtuse and the slit and camera at the acute angles of the triangle. The camera end hangs out unsupported and flexure will still occur though in a much diminished degree.

'The form I have designed and am now having constructed in the workshop follows that of Curtiss in that it is of the box form, but the design and construction of the box and the method of attachment to the telescope are different. The box is made of hard cast-steel plates (saw steel) much stiffer than brass, is rigidly braced and cross braced, and is provided with three points of support in a cradle of T iron attached to the end plate of the telescope. Two of the points are similarly situated to those of Curtiss, while the third acts near the camera end. The two first are attached by a kind of universal joint, so that no strain can be induced in the box by any bending of the cradle. The third support, near the camera, consists of a pair of counterbalancing levers, one on each side of the box, arranged to equalize the pressure on the three supports in any position of the telescope without it being possible to ever induce any strain in the box itself. By this means it is believed that no measurable or even noticeable flexure will occur.

'A simple triangular box of this form without projections of any kind is much more readily adapted for temperature regulation than the complicated shape of the regular truss form. Moreover, any stratification in the temperature case is much less likely to occur, and if it does, can not do nearly so much harm as if it were acting on only one member of the truss. A further improvement will be the introduction of a non-conducting material, such as vulcanized fibre in the supporting arms between the cradle and the box, so that heat will not be conducted away at these points and unequal temperature and possible distortions take place.

'In the present spectrograph, conduction through the arms of the truss is so great as to cause a gradual drop of the temperature in the prism box, as the outside temperature falls, of about 0·1°C. every one or two hours. The distance between the spectrograph box, which will be entirely covered with thick felt, and the inside of the felt-lined outer case will be uniform, the heating wires will be uniformly distributed, and consequently little difficulty with inequalities of temperature should result.

'Although until the instrument is completed and tested, no definite statement can be made, I have little doubt that the new spectrograph will be a considerable improvement over the present or any existing single-prism instrument.'

THE NEW SINGLE-PRISM SPECTROGRAPH.

The Optical Parts.—After the dimensions of the optical parts of the new instrument had been determined as above they were ordered from the J. A. Brashear Co., in the early part of 1908.

Some correspondence was carried on in regard to the 'Isokumatic' Collimator objective in reference to the yellowish colour of the middle component. It was, however, decided to use it in preference to the less absorbing ordinary objective, on account of the flatter colour curve given by the former. Consequently an 'Isokumatic' of 51mm. (2 inches) free aperture and 765mm. focus was ordered and received at the same time as the other optical parts, about the end of last March. Although no direct tests have as yet been made, there is no question of its being a first class objective, as otherwise the good definition now obtained would not be possible. The prism of Jena glass O. 102 had its angle 63° 30′ computed, so that the central ray for this instrument $\lambda 4325$ had a deviation of 60°. The length of the side of the prism was made 110mm., so as to transmit the full pencil from the collimator, and the height 57mm. in order that any effect produced by pressure or unequal temperature of the supports might be minimized. The prism is a beautiful piece of glass and the tests have shown it to be of first rate optical quality, and fears as to its possible lack of homogeneity groundless.

The camera objective, owing to the excellent performance of the Brashear Single Material in the previous instrument, was chosen of the same type and is of 57mm. aperture, a sufficient margin above 51mm. to transmit the full usable pencil, and 455mm. focus. It was tested soon after being received and, although it gave a flat field, the definition was not as good as that given by the original objective, and a preliminary test showed this to be due to spherical aberration. The objective consists of two widely separated converging elements of very light crown glass, and consequently the resulting positive aberration can only be removed by departure from spherical surfaces. The amount to be removed in the case of the original objective of 45mm. aperture and 525mm. focus was quite within the possibilities of ordinary figuring, but when the aperture ratio is increased to so large an extent as from $f12$ to $f8$, it becomes a much more difficult problem to deal with. In this case it was only after the introduction of a special method and with the great personal skill of Mr. McDowell in figuring, that the aberration was finally removed, and the objective gave practically perfect definition and a widely extended flat field. A full description of the tests, with the plotted fields resulting from different objectives, is given in full in another place.

The Guiding Telescope.—Instead of reflecting the light used for guiding down a tube parallel with the collimator and there further reflecting it to the guiding telescope so placed as to also receive light reflected from the front surface of the prism, the guiding telescope has in this case been placed about 15cm. above the slit, where star light coming from the inclined speculum-metal jaws is reflected by a right-angled prism to a small objective placed at its focal distance along the optical path from the slit. The resultant parallel pencil is then received by the bent guiding telescope shown, Fig. 2, which can be rotated to any convenient direction. Two reflections are hereby avoided, resulting in some saving of light and probably better definition. It had been found in the previous instrument that the method of guiding by light reflected from the front prism surface was never used, and consequently in the new spectrograph this needless complication was omitted. It may be said, however, that the position of the guiding telescope is in some positions of the equatorial, not quite so convenient as if it were lower down.

The Comparison Apparatus.—Experience has shown that in actual work more than one metal is never used as electrode, and consequently the rotating wheel with four sets of electrodes used previously has been omitted here, and one pair of adjustable electrodes of the alloy of iron and vanadium, whose spectrum is exclusively used for comparison, has been substituted. These terminals are mounted on a brass plate which swivels on two points attached to the top of the guiding telescope, and when not in use is simply turned back upon the latter, thus leaving the star light unobstructed. Directly below the terminals in the optical axis is screwed the short tube shown, in the upper end of which is a piece of ground glass and in the lower a small condensing lens with an angular aperture twice that of the collimator. Both of these are adjustable and ensure in every case a uniform pencil of spark light incident upon the collimator objective and prism.

Slit and Slit Diaphragms.—The slit is of the Huggins type of reflecting slit, with polished speculum metal jaws inclined at an angle of $3\frac{1}{2}°$, so that the reflected pencil of star light and consequently the prism which intercepts it is entirely out of the way of the direct pencil. One jaw is fixed and the other movable micrometrically, a single division representing ·001 inch (·025mm.). The slit has a tangent screw slow motion to enable it to be placed exactly parallel to the refracting edge of the prism, and is very

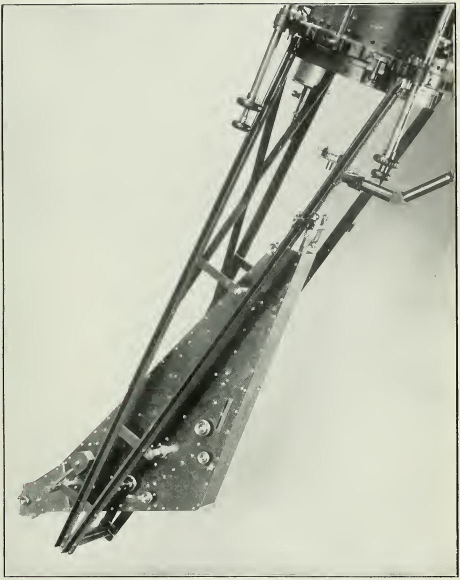


Fig. 2—New Single-Prism Spectrograph.

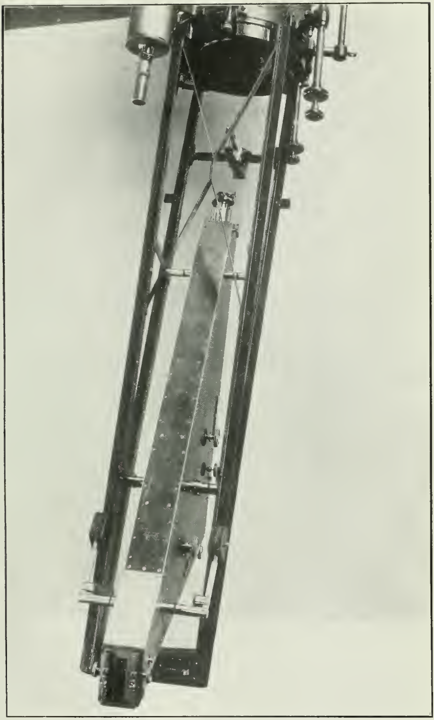


Fig. 3—New Single-Prism Spectrograph.

rigidly attached to the end of the heavy collimator tube. To the end of this tube is also screwed the attachment holding the sliding diaphragms, which serve to limit the star and comparison spectra. Rectangular openings of the proper width, in this case a single opening 0·4mm. for star spectrum and two openings 1·5mm. separated by a tongue 0·45mm. for comparison spectrum, are placed directly opposite one another on a plate which is moved by means of a knurled wheel transversely between stops across the slit. To expose the spark spectrum all that is necessary is to turn down the spark apparatus, turn the knurled wheel above mentioned about a quarter turn, and close the switch which controls the current through the step-up transformer used for producing the spark, this switch being on the telescope tube about a foot above the spark apparatus. To change back to star spectrum the operations are reversed, the whole cycle occupying only about ten seconds.

The Mechanical parts.—As outlined above the instrument consists essentially of two parts—1. A rigid, hollow, triangular shaped, steel box containing at the obtuse angle the prism, and at the two acute angles the slit and plate and comprising the spectrograph proper; 2. The T iron frame or cradle attached to the end plate of the telescope, in which the spectrograph proper is flexibly supported, and which serves to keep it collimated without flexure of this support producing any stresses in the box itself.

The Spectrograph Box.—The box consists of two triangular shaped plates made of hard saw steel about 1·7mm. thick forming the sides, while the edges consist of plates of the same material and thickness, 79·4mm. (3⅛ inches) wide. In addition to the edges there are a number of internal braces and supports of the same material, well shown in Fig. 4, which gives a good idea of the construction of the box. These braces as well as the edges of the box have pieces of small angle iron securely riveted along both edges, to which the side plates are firmly screwed. These angle irons are not shown in the figure, as the frame was first put together, the angles then riveted on and finally the plates screwed to these angles and to the internal castings, the heads of the screws being shown on the side of the box in Fig. 2. It was constructed in this manner to prevent as far as possible any internal stresses in the frame of the box. In addition there are iron castings *A, B, C, D, E, F,* Fig. 4, planed to exactly the same width as the edges and braces. *A,* may be called the main casting, having a hole bored through the centre through which the principal supporting shaft passes. The two legs projecting from the triangular part are bored out to fit the collimator and camera tubes. The casting, *D,* is also bored out for the collimator tube and forms the end plate of the box, while the casting, *F,* is bored out to carry the upper end of the camera tube. *C,* and, *E,* have clearance around them and do not touch the collimator tube, the upper support being attached to the centre of *C.* The part, *B,* has the third supporting shaft screwed into the centre of each side, and also forms the connection between the box proper and the camera end. The latter is made separate, so that camera objectives of different focal lengths may be used if desired.

The prism is mounted in a separate cast-iron cell, but is prevented from touching the metal at any point by facings of hard rubber about 3mm. thick, and is kept in its adjusted position by hard rubber stops. It is held firmly in this position in the cell by the gentle pressure produced by three small clamp screws passing through the top of the cell and bearing upon one of the facings of hard rubber 3mm. thick, above mentioned, resting on top of the prism. The base of the cell is surfaced flat, and rests in its compartment on one of the side plates, to which it is rigidly attached by five screws passing through slotted holes to permit of adjustment for minimum deviation.

Collimator and camera tubes are provided with racks and pinions for adjustment, their position being read on millimetre scales, the one attached to the camera being provided with a vernier, reading to tenths of a millimetre. The collimator tube is provided with two clamp screws, one at the top and one at the bottom bearing, while the camera tube has a single clamp screw at the front end. The pinion and clamp wheels and the scales are well shown in Figs. 2 and 3. The camera attachment, whose form and construction can be fairly well obtained from Figs. 2 and 3, is built in box form of the same material, and is firmly screwed to the casting, *B*, Fig. 4, it and the spectrograph box thus forming what is to all intents and purposes one continuous piece. Between the sides of the camera box, swivels the plate holder attachment which is quite similar in form to the one used with the other spectrograph. It consists essentially of a semi-cylinder 79·4mm. long, 101·6mm. diameter, pivoted along its axis between the sides of the box to permit a wide range in plate inclination. This cylinder is constructed from a section cut from a piece of 4-inch brass tubing, on the ends of which pieces of heavy brass plate are screwed and soldered, and on the plane of section is fastened the brass camera back provided with screws for clamping the holders firmly in place. The plate holder carrier has solidly constructed ways permitting lateral movement of about 15mm., enabling a number of narrow spectra to be made side by side on the same plate if desired. The axis on which the camera back rotates is provided with knurled clamping wheels, while other screws moving in concentric slots enable adjustment and firm clamping to be effected in any desired position, read off on graduations on the cylinder.

As will readily be seen from its design and construction and from the character of the material from which it is made, this spectrograph is exceedingly rigid and the flexure produced by changes of position, however supported, would be very small. This flexure, however, is reduced to a vanishingly small quantity by the new supporting system used in this instrument. The self-contained spectrograph box is, as has been indicated above, supported flexibly on three points in the carrying cradle.

The Supporting Cradle.—This truss made of $1\frac{3}{8}''$ T steel is attached at the upper end to a heavy ring casting, which is fastened by the same three swivel bolts used for the other spectrograph to the end plate of the telescope, the mode of attachment being shown in Fig. 3, which with Fig. 4, well shows the form of the truss. It is evident that the only flexure of this truss in a direction parallel to the sides of the spectrograph will be that due to the extension of one arm and compression of the other in each pair, and this will hence be very slight. Owing to the fact that these two pairs of trusses had to be separated about 20cm. at the lower end, to admit the spectrograph with outside temperature case between them, it is evident that flexure in a direction at right angles, parallel to the movement in right ascension, will be greater. This is minimized as much as possible by joining the two ends by a solid webbed casting and by introducing cross braces at the upper end of the truss as shown. At small hour angles, however, which it is desirable for many reasons to use as far as possible, the component of the weight in this direction will be very small and the flexure negligible. Even at large hour angles which are sometimes required, the flexure cannot be great. In any case from the method of attaching cradle and box, to be presently described, no flexure of the cradle can induce any stresses in the box and the only effect of such flexure will be to slightly alter the axis of collimation of the spectrograph. This can not, however, induce any displacement of the spectral lines, not only on account of its relatively small magnitude but also because it can occur practically only parallel to the spectrum lines and to the refracting edge of the prism, which will have no effect on the position of the line.

The principal and central support and connection between cradle and box consists of a shaft 1 inch (25·4mm.) diameter passing through the hole in the main casting. This shaft is left the full size of the hole only for about 2mm. at the centre, so that the box is free to swivel in every direction around the centre to the extent of 2 or 3 degrees. This swivelling motion is, however, limited, by projecting points on the shaft at the ends of the hole, to one parallel to the motion in right ascension and to the slit, rotation around the axis of collimation being prevented. Consequently any flexure of the cradle can not induce any distorting stress in the box.

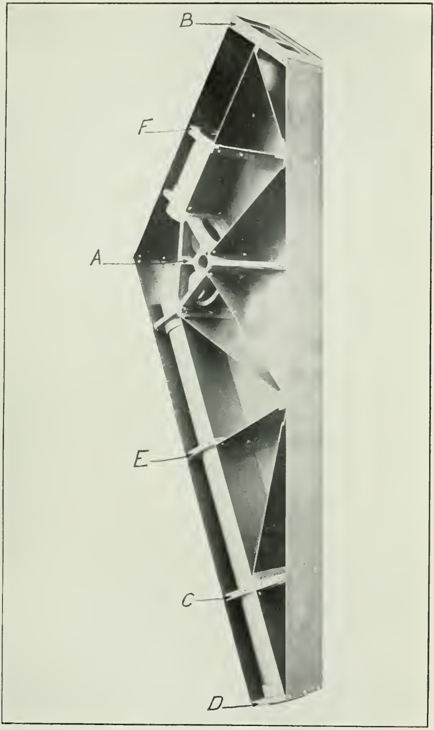


FIG. 4—Spectrograph Box.

The upper supporting shaft has a transverse hole in the centre through which a pin screwed into casting *C* passes, thus allowing longitudinal motion parallel to the axis of collimation as well as swivelling motion in every direction.

The third point of support consists of shafts rigidly screwed into the centre of each side of casting, *B*. A second short shaft at each side carried by plates screwed to the cradle, as shown (Figs. 2 and 3), is placed about 2·5cm. from the first in a direction which, if produced would nearly pass through the centre of mass of the box. A lever attached to these two shafts at each side in such a way as to allow more than sufficient motion without binding, carries a counterbalancing weight, the combined resultant upward thrust of the two on the box being computed to equal the proportional part of the weight that should be carried by this support.

The box is hence carried equally on the three supports without any possibility of distortional stresses occurring in it due to flexure of the cradle, the only effect of such flexure being to slightly change the axis of collimation, which at the utmost can only induce displacements of the second order in the position of the spectral lines.

Temperature Control.—Every precaution having been taken, successfully as will be seen later on, against flexure, there remains, as the other main cause of systematic displacements possibly more dangerous than flexure, displacement due to changes of temperature in the optical and mechanical parts of the instrument. The changes in temperature between day and night or even between evening and morning at Ottawa are considerable, averaging about 8°C. for the former and 6° for the latter. In many cases the temperature in the dome becomes 10°C. lower than that in the temperature case, rendering satisfactory maintenance of constant temperature in the case a difficult matter.

As mentioned in the two previous reports, such difficulty was experienced and the temperature in the prism box dropped gradually about 0·1°C. per hour as the temperature in the dome became lower. When practically the whole of the inside of the case was covered with the heating coils this drop was not so great, but was not entirely overcome. It was believed to be due to the conduction of the heat through the metal parts of the attaching truss, the collimator tube, &c., exposed to the outside air and that, although the temperature inside the case undoubtedly remained nearly constant, the temperature inside the prism box would diminish with the lowering of the outside temperature owing to the greater loss of heat through the exposed supports.

To overcome this as far as possible in the new instrument all of the shafts attaching the box to the cradle were cut at points about 3cm. from the box, just inside the outer case, were bored out and threaded, and a piece of vulcanized fibre separating the ends about 7mm. screwed in. This fibre, seen dark on the shafts in Fig. 3, is a poor conductor of heat, prevents direct metallic conduction from the box inside the temperature case to the cradle outside, and the only part of the spectrograph exposed is the slit head. The temperature inside the outer case is automatically controlled by a pair of electric contact thermometers placed not, as in the previous instrument, one on each side of the prism box, but one in the front near the upper end and one at the back near the camera.

Each of these thermometers controls the heating coils in the corresponding half of the outer case. It was hoped by thus arranging the thermometers and coils to keep the temperature over the whole interior of the case more nearly uniform than previously. These thermometers act in exactly the same way as in the former instrument described in the 1907 report. When the temperature in the case rises the mercury in the open capillary makes contact with an adjustable platinum wire and the resulting battery current attracts the armature of a relay, thus breaking the heating circuit; similarly when the temperature falls the mercury recedes from the platinum terminal, the relay armature is released and current is turned on the heating coils. In practice the regulation is very good, current in the coils as indicated by pilot lamps being turned on and off every few seconds. To smooth down any remaining irregularities the whole exterior of the spectrograph box is covered with a layer of half-inch thick felt, small hinged doors being made over the indexes and scales of collimator and camera.

The temperature case is in this instrument constructed of wood chiefly on account of its greater ease of construction, of its greater heat insulating power, and of the smaller danger of short circuits in the heating coils over one made of aluminum. Moreover, owing to the simple form of the spectrograph, a wooden case can easily be made amply strong. This case is made of ½-inch thick pine, lined inside with felt about ⅜-inch thick and is divided into three sections, the line of junction of the body of the case necessarily following the supporting shafts. The third section, which was necessary for constructional reasons, is a small box-shaped piece at the camera end. All joints between the sections and the joints around the doors in the case, necessary for the adjustment and clamping of collimator and camera and of the contact wires in the thermometers, are carefully padded with felt to be air-tight. This case, which is shown in Fig. 5, is attached securely to the supporting cradle and does not touch the spectrograph proper, the openings around the end of the collimator tube and the supporting shafts being made large enough for free clearance and at the same time heat-tight by washers of felt.

On the felt lining on the inside of this case is stretched about 1,200 feet No. 28 single silk covered German silver wire, arranged in four circuits of 300 feet each, two of these circuits in multiple are controlled by each of the electrical contact thermometers, each governing the coils in its own section of the case. This wire is distributed as uniformly as possible over the inside of the case, the space between the felt coverings of the case and spectrograph being about 2·5cm. and uniform throughout. By the division of the heating coils into two sections, their uniform distribution, and the uniform space between spectrograph and case, the temperature throughout the case should be maintained nearly uniform and not much trouble with unequal temperature should occur. There is no question that some method of mechanical stirring of the air inside the case would give better results, but the difficulty of additional weight and complication with possible vibration prohibit its use.

The temperature control so far as it has been tested works admirably. There is as before a slight drop in the temperature of the prism box when the external temperature drops rapidly, but that does not last long, and by applying the control in the afternoon, thoroughly ventilating the dome so that considerable of the cooling will have taken place, the temperature remains steady for the night.

Adjustment of the instrument.—After the instrument was completed there were several adjustments to be made before any measurable spectra could be obtained. The first of these was to set the slit at the principal focus of the collimator lens. This was done by Schuster's method of alternate focussing of collimator and observing telescope on the same spectral line, the prism being placed alternately to one side and the other of the position of minimum deviation. This method gives satisfactory results, successive values agreeing within two or three-tenths of a millimetre and the mean of several being taken. The prism was easily set to minimum deviation for the line *Fe*, 4325·9. This particular line was chosen on acount of the very irregular results given by the line H_β in the numerous measures of β Orionis, and the consequent determination to shift the central line towards the violet in the new instrument. The measures above referred to show that more accordant results are obtained with the lines to the violet end of the spectrum than with H_β, and as resolving power, purity, and linear dispersion are all greater there, this should result in a further increase in accuracy. The camera focus is determined in precisely the same way, as with the previous instrument, by making adjacent spectra through the refracting edge and base half of the prisms, and determining the focus by the continuity of the lines. A slit is cut in the side of the spectrograph box into which a semicircular diaphragm can be

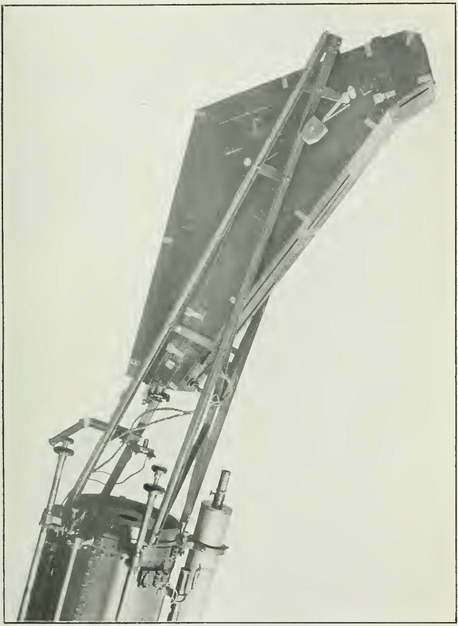


Fig. 5—New Single-Prism Spectrograph, ready for use.

placed and rotated, so as to occult first one and then the other half of the light pencil. The inclination of the plate, determined of course at the same time, is about 16°·5, the same as with the first objective of this type.

A very curious and at the same time very useful property of the new spectrograph is the constancy of focus of the system for different temperatures. With the two previous instruments, the focal setting increased with increase of temperature about ·012mm. per degree centigrade. Between the temperatures of 0° and 20°, all so far tested in the new spectrograph, the camera setting remains unchanged at 27·69 as determined by a number of careful tests. This with the absolute constancy and rigidity of the new instrument is a point of very great value in obtaining accurate results, as it obviates the necessity of testing the focus each time the instrument is used with the possibility of mistakes in the determination of the true setting. It is difficult to explain why there should be this difference, although it is probably due to the fact that the parts connecting camera objective and plate are of steel in the new instrument instead of brass, whose coefficient of expansion is greater. At any rate the combination of brass collimator tube, whose setting is unchanged, and steel camera tube gives settings for camera focus constant at all temperatures so far observed. If the collimator tube had been steel or the camera tube brass, there would have undoubtedly been a change in the setting with change of temperature.

The New Spectrograph in practice.—As stated above the instrument was only completed in the beginning of March, and consequently has not been in use long enough to enable its advantages and disadvantages to be fully determined. There is, however, no question that spectra of better quality for measurement will be obtained with it than with the single-prism form of the previous instrument in which the lines were occasionally, especially with the longer exposures somewhat blurred and diffuse, due to flexure or temperature change or both. As will be seen later, flexure in the new instrument is absent, and owing to its compact form any temperature changes should have much less effect on line displacements. As a matter of fact the temperature regulation is much better with the new instrument and no spectra yet obtained, even with very long exposure, show any trace whatever of diffuseness of the lines. Again, the constancy of the camera focus is another factor tending to better results, as one is always sure of the true focus and no fear of systematic displacements due to poor focus can arise.

Tests have been made similar to those of last year, on the relative freedom from accidental and systematic errors of spectra made at different slit-widths. These show, that on the whole in early type stars with this instrument more accurate values are obtained with a slit about 0·051mm. wide than with slits narrower or wider. The comparative exposures required with the new instrument at slit-width 0·051mm. and the previous single-prism instrument at slit-width 0·038mm., which gives about the maximum accuracy obtainable with it in early type stars, shows an advantage, so far as can be at present determined, of about 25 per cent for the new instrument. To offset this, however, it must be stated that, owing probably to the increased absorption of the larger prism, the intensity of the spectrum at the violet end is appreciably less and for equal intensity of the K line, sometimes required, most of the advantage will be lost. In the case of stars in which the extreme violet is not required, however, there is a considerable saving in time and increase in output by the use of the new instrument. This loss in the violet may be due possibly to other causes than absorption of the prism, such as in the guiding or the position of the corrector and form of the colour curve, and if such is the case, and tbis will be shortly tested, it may to a great extent be overcome.

Careful tests of the flexure of the new instrument have been carried out showing exceedingly satisfactory results. The method of testing was to attach the spectrograph to the telescope, the latter being pointed to the meridian. If the telescope is turned in declination pointing first to the south and then to the north horizon, it is evident that the spectrograph will have rotated in its own plane through 180°, and there will have been induced in it the maximum possible double flexure. In these two positions spectra were made through a suitable slit diaphragm, the one used for focussing in which the adjacent spectra touch each other being the best, as any displacement of the line between the two exposures will at once be evident. Three sets of exposures of the comparison spark were made on the one plate, by sliding the camera back in its ways between exposures, two for flexure and one with the spectrograph stationary for comparison. Examination of these plates showed no measurable flexure. In some of the lines a very slight displacement could just be detected under high power magnification, but this if due to flexure was quite beyond measurement. As a matter of fact, on the plate being given to Mr. Harper with the request to select from the three the spectrum in which no movement had occurred, he found it impossible to determine which spectra were affected by flexure. As the flexure present during any reasonable exposure can only be a small fraction of that given by the method above described, it is quite evident that the spectra will be absolutely free from any line displacement due to flexure of the spectrograph. It may be of interest to state that flexure tests made of the instrument with the counterbalancing weights removed, and with consequently only two points of support, also showed remarkable freedom from flexure. Although the flexure was slightly more perceptible it was again quite immeasurable, showing the great stability and rigidity of the form of construction adopted.

The previous single-prism spectrograph showed when first constructed a flexure of about ·035mm., equivalent to a velocity of 70km. per second. When tested at the same time as the new one it was found the flexure had increased to nearly ·060mm., equivaleut to over 100km. per second. As a displacement of the sharp comparison lines equivalent to a velocity of two or three kilometres would be measurable, it is at once seen how much more stable the new instrument is. It is, so far as I can learn, more stable than any other single-prism spectrograph in existence.

The new single-prism instrument, owing to its greater aperture and its design, is necessarily heavier than the three-prism spectrograph and some changes were necessary in the arrangement of the counterweights for balancing. As will be seen from Figs. 2 and 5, the centre of mass is considerably to the left of the optical axis, and in order to properly balance in declination, weight would have to be added to the opposite side of the tube near the object glass. Consequently rods for carrying weights were attached to both north aud south sides of the tube near the objective, and the telescope can now be easily placed in good balance whatever attachmeut is used.

A counterweighted stand for attaching and detaching the new spectrograph, and for carrying it when not in use is provided. It is of quite similar construction to that used with the previous instrument, and allows the spectrograph to be fastened to the telescope in about a minute. With the separate relay box and set of plug contacts, both spectrographs may be maintained at constant temperature, and the change from one prism to three prisms or vice versa made in two or three minutes without disturbance of the temperature regulation in either case.

There will now be given the results of the tests of the new 'Single Material' and the 'Ross Special Homocentric' lenses, and, for completeness, the whole paper, as it will later be published in the Astrophysical Journal, will be given.

CAMERA OBJECTIVES FOR SPECTROGRAPHS.

It is well known that the camera objectives in general use in stellar spectrographic work have a very limited field of good definition, not exceeding in general 2°, which covers, in the usual dispersion of three prisms, about 200 tenth-metres. While this is a sufficient range for spectra of the second type, which are rich in lines, it is not sufficient for early-type spectra which may contain only one or two lines in this region, and in which, consequently, the errors of measurement will be high. As practically the whole photographic region of the spectrum, H_β to K, may be obtained in one exposure with either refractor or reflector, it is evident that a considerable gain in the measurable material in such spectra would be obtained, without increase in exposure time, if a camera lens giving a considerably wider field were available.

Various attempts at the solution of this problem have been made, of which the most successful known to me is that described by Hartmann.* This objective made by Zeiss, known as the 'Chromat,' is constructed of the same material as the prisms, and is composed of two simple meniscus elements, one positive, one negative, separated by a small air space. As there is no chromatic correction the spectra are brought into focus by inclining the plate towards the violet about 16° from the normal to the axis with a dispersion of three prisms. According to Hartmann this objective gives a flat field of 14°. A Zeiss 'Chromat' has been in use in Ottawa for considerably over a year, entirely fulfilling expectations and giving, after slightly increasing the separation of the elements, the whole field used, from H_β to H_δ (about 8°), almost absolutely flat with excellent definition. There can be no doubt that the field would extend farther if necessary.

Unfortunately, as was learned upon inquiry from Zeiss, this type of objective cannot be successfully made of a larger angular aperture than about $f12$. This was confirmed by the performance of a shorter focus lens of the same type (aperture ratio $f8$) constructed by Brashear which gave inferior definition. More recently, however, Ross Limited, London, have designed and constructed especially to conform to our requirements a lens similar in form to their 'Homocentric,' consisting of four separated elements, but following the principle of the 'Chromat' in being entirely made of the prism material and consequently requiring inclination of the plate to bring the spectrum into focus. This lens, which will be more fully discussed later, gives, at an aperture ratio of $f5{\cdot}6$, excellent definition and a flat field. The above remarks apply to a dispersion of three prisms for which this type is especially adapted. If it were used with one prism, in addition to the limitations as to aperture, the plate inclination required (about 50°) would be inconvenient and practically inadmissible in radial velocity work.

There are consequently required short-focus objectives giving a flat field with three prisms, and objectives giving a flatter field than the regular triplet with a single prism. This need, together with what had already been accomplished by Hartmann and Zeiss, was laid before the J. A. Brashear Co. who, with their usual willingness, put their best efforts at our disposal and, in collaboration with Prof. Hastings, produced two eminently successful objectives. In both of these the employment of one kind of glass only is followed, although not, as in the 'Chromat,' of the same material as the prisms, and the consequent chromatic differences in focus are overcome by inclining the plate. The objective first produced, to which they have given the name 'Single Material' is composed of two widely separated positive elements of crown glass of the lowest dispersion and is especially adapted for use with one prism, giving exquisite definition and a field flat within 0·1mm. over the whole visible and considerably into the ultra-violet spectrum. The other is similar to the 'Chromat' in form but made of light crown glass, giving also a flat field and good definition with three prisms with a plate inclination of only slightly over half that of the 'Chromat.'

The limiting aperture ratio of the former of these objectives is about $f8$, of the latter $f12$, so that evidently they can not supply the need of short-focus lenses of $f6$ or thereabouts for either single or three-prism work.

The only prospect of success in this respect seemed to lie in some of the modern anastigmat photographic lenses, and a number of different makes were accordingly obtained for trial. The definition of several of these, though good enough for ordinary

* Zeitschrift für Instrumentenkunde, September, 1904.

photographic work, would not stand the critical test of spectrum photography owing probably to some residual spherical aberration. Two, however, the Ross 'Homocentric' and the Zeiss 'Tessar,' gave good definition and the forms of their fields were accordingly determined.

It may not be out of place to give a brief description of the method employed in determining the fields of the ten lenses tested. The dispersion for eight of them was produced by the Ottawa spectrograph, having the following optical constants:—Hastings 'Isokumatic' collimator objective of 35mm. aperture and 525mm. focus; one or three prisms of Jena glass O. 102, angles 63° 50′ each; ray at minimum deviation λ4415. Two of the objectives were tested with a new single-prism spectrograph having 'Isokumatic' collimator of 51mm. aperture and 763mm. focus, O. 102 prism of angle 63° 30′, ray at minimum λ4325.

The positions of focus in different parts of the field were determined by a modification of Hartmann's method* of extra-focal exposures. By means of a revolvable semi-circular diaphragm behind the collimator lens and an occulting diaphragm in front of the slit, a narrow strip of spectrum, photographed through the half of the prisms near the refracting edge, was placed between and touching two narrow strips made through the base half of the prisms. Evidently, when the plate is in the focus of the camera lens for any particular line in the spectrum, the adjacent portions of this line will be continuous, while, if not in focus, the central section will be displaced to red or violet of the outside sections, the direction and magnitude of this displacement giving a measure of the position of the focal point for the line in question. Two such plates, one inside and one outside the focus, will suffice to determine the form of the field. In order to avoid the labour of measurement and computation and on account of the diffuseness of the lines and consequent inaccuracy of measurement, when the plate is more than a millimetre from the focus, I have generally preferred to make a number of spectra, by the method outlined above, at camera settings about 0·25mm. apart within and without the focus. Five of these have in general sufficed to determine the focal curve and, as the camera back can be moved laterally, they can all be made on one plate, thus allowing ready comparisons. Simple inspection of these spectra under a microscope or even by a hand magnifier enables the focus of any line to be determined to about 0·05mm. by observing at which of two successive spectra the central section has opposite displacements with respect to the outside sections. Interpolation to the above accuracy can then generally be made. This takes only one-tenth the time and is probably equally as accurate as the method of measureing the displacements and computing the distance from focus. I may say that the camera setting in our regular work is always determined in this way, enabling the plate to be certainly placed considerably within 0·1mm. of the true focus.

This method is probably open to the objection that it will not give the true focal point when the system has aberration, but it must be remembered that, to prevent systematic displacements in radial velocity work due to non-uniform illumination of the collimator objective, this method, which determines the focus by the absence of such displacement, is certainly the one that should be used. Moreover, in this case tests at full aperture, so far as the focus can be determined by definition, confirmed the results of the former method, and there is no reason to doubt the accuracy of the focal curves determined.

* Zeitschrift für Instrumentenkunde, 24, 1, 1904.

The following ten lenses, given in the order of procuring and testing, were tested for their curvature of field.

OBJECTIVES TESTED FOR FIELD.

Number	Objective.	Aperture.	Focal Length.	Tested with dispersion of
1....	Brashear Single Material.	45	525	1 Prism, 3 Prisms.
2....	Zeiss Chromat..	45	525	3 Prisms.
3 ...	Ross Homocentric.	40	254	3 Prisms.
4....	Zeiss Tessar	48	305	3 Prisms.
5....	Brashear Light Crown	45	525	3 Prisms.
6 ...	" Telescope Flint...	45	525	3 Prisms.
7...	" O. 102 ("Chromat")..	45	375	3 Prisms.
8....	" Triplet	57	480	New 1 Prism, 3 Prisms.
9 ...	" Single Material	57	457	New 1 Prism.
10...	Ross Special Homocentric	40	254	3 Prisms.

The form of field of each of the lenses is given in the accompanying figures where the horizontal lines represent differences of focus of one millimetre, the wave length and angular distance from the optical axis are shown by the vertical lines, and the diameters of the circles representing the observed points are 0·2mm. Wherever the curves are not horizontal indicates that the inclination of the plate holder required changing slightly, but this of course has no effect on the form of the field. In order to group the curves according to the type and purpose of the objectives, the order given in the above table has been changed and those of longer focus used with a dispersion of three prisms will be first considered (Fig. 6).

Brashear Single Material (No. 1.)

This consists of two simple converging lenses, the front double convex, the rear convex meniscus, of crown glass of lowest index, separated by nearly one-third the focal length. As will be seen later, this objective gives a beautiful field with one prism, but is strongly concave towards the lens with three prisms, with about the same curvature of field as the regular Hastings Triplet. The inclination of the plate towards the violet is slightly over 5°. Allowing deviation from focus of 0·1mm., slightly over 2° of field is usable.

Zeiss Chromat (No. 2).

This consists of two strongly curved meniscus elements of Jena glass O. 102, the front diverging, the rear converging and of about half the focus of the combination. When received it gave a field convex towards the lens as shown in the upper curve. When the separation between the elements was increased from 2·25 to 4·5mm. the field became almost absolutely flat over the whole 8°, giving at the same time excellent definition. Inclination of the plate towards the violet about 16°.

Brashear Light Crown (No. 5).

This is a lens of the same form as the 'Chromat' except that it is made of light crown glass. With the original separation the field was concave but became flat on decreasing the separation from 4·8 to 3·2mm. This change in separation resulted in loss of defining power. The objective was re-figured at the new separation and gave good definition and field flat over practically the whole range. Inclination of plate to the violet about 9°.

Brashear Telescope Flint (No. 6).

An objective similar to the previous one only made of telescope flint glass. The field was originally convex but became flat on increasing the separation from 4·8 to 7·9mm. Refiguring did not give so much improvement as in the light crown objective. Field is now practically flat. Inclination of plate to the violet is about 13·5°.

Brashear Triplet (Hastings) (No. 8).

This is a lens of the same type as used in the Mills, Bruce and Lowell spectrographs. The field is, as shown, strongly concave towards the objective with a usable portion, allowing deviation of 0·1mm., of about 2·5°. The definition at the centre of the field is about the same as in the 'Chromat,' but towards the margins even when in focus is much inferior.

All the above objectives are of relatively long focus, small angular aperture, about *f* 12, tested with dispersion of three prisms. Let us now examine the fields given by shorter focus objectives, using the same dispersion (Fig. 7).

Ross Homocentric (No. 3).

This standard photographic objective gives good definition but a strongly concave field. An increase in separation from 59 to 124mm. appears to flatten the field, but at the expense of defining power and the lens is not usable at the increased separation. Useful field is not more than 2°.

Zeiss Tessar (No. 4).

This objective was one of the standard form taken from the stock of Bausch and Lomb. It gives good definition and a field very slightly convex. This convexity is removed by an increase in separation from 41·0 to 41·7mm., but with a slight loss in defining power, so that it is probably preferable to use it at the normal separation. Another lens of the same series, aperture, and focus was tested, giving practically the same field but considerably poorer definition. This is of interest as showing the differences between the performance of two objectives presumably identical and indicates the desirability of specially selecting and testing the lens to be used from a number.

Brashear O. 102 ('Chromat') (No. 7).

This objective of the same type and material as the Zeiss Chromat but of larger angular aperture, gives a field nearly flat with a separation of 6·3mm., but with poor definition even after refiguring. This shows that this type can not be successfully constructed of larger aperture ratio than *f*11, say. Inclination of the plate to the violet about 16°.

Ross Special Homocentric (No. 10).

This objective was, by the kindness of the makers, Messrs. Ross, Limited, especially computed and constructed for us. It has an aperture ratio of *f*5·6, is of practically the same form as their Homocentric, but with all four elements of O. 102 glass. It gives beautiful definition and a field nearly flat, usable over 8°. Change of separation is without appreciable effect on the form of field. Inclination of plate to the violet about 16°.

Two types of objectives of medium and long focus have been tested with a dispersion of one prism (Fig. 8).

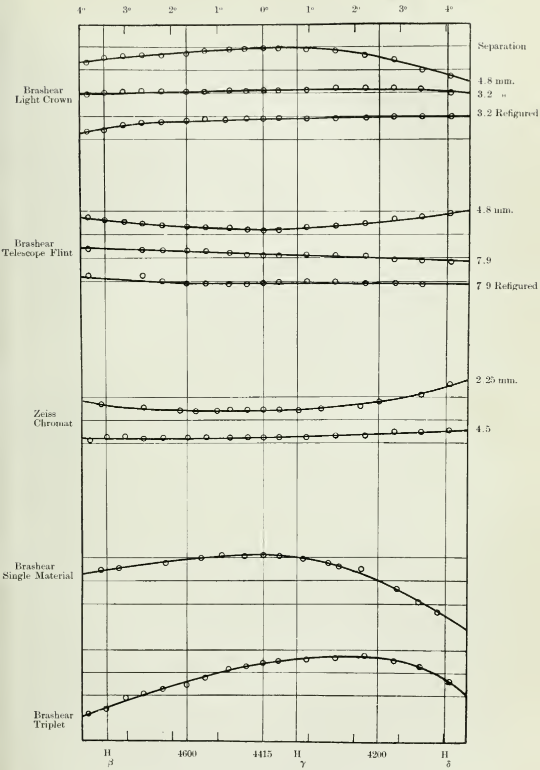


FIG. 6—Long Focus Objectives with three prisms.

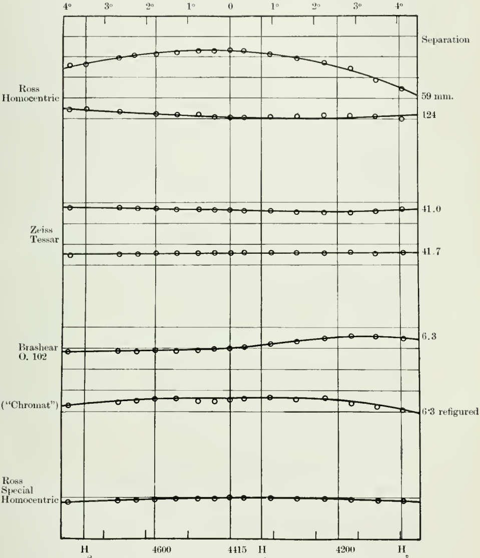


FIG. 7—Short Focus Objectives with three prisms.

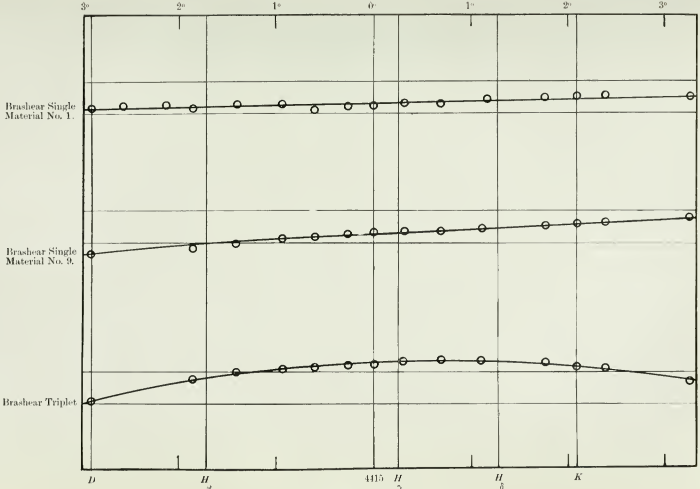


Fig. 8—Objectives tested with one prism.

Brashear Single Material (Nos. 1 and 9).

Both of these objectives, whose form was described above, are of the same type, No. 1 of an aperture ratio $f11{\cdot}5$; No. 9, $f8$. When used with three prisms they give the strongly concave field shown in Fig. 6, but with a single prism the field is almost absolutely flat over the whole range of visible and as far into the ultra-violet spectrum as the prism will transmit. The definition given is excellent and the objectives leave nothing to be desired for single-prism work. The inclination of plate to the violet is about 16°. I am glad to express here my appreciation of the efforts, as well as my admiration for the skill of Mr. McDowell in figuring these objectives. As both components are converging, the only means of removing the positive spherical aberration is by departure from spherical surfaces. While, as Mr. McDowell says, this was comparatively easy for No. 1, of the smaller angular aperture, it taxed even his skill to remove it entirely in the other, and it was only after a second trial and the use of a special device that the objective was finally made perfect.

Brashear Triplet (No. 8).

This, as with three prisms, gives a field concave towards the objective but with considerably less curvature. The usable field is somewhat over 2°. Definition good.

The final results of the investigation may be summarized as follows:—

For a dispersion of three prisms with a camera of fairly long focus two objectives are much superior to the others, the Zeiss 'Chromat' and the Brashear Light Crown. The former gives a flatter field and slightly better definition than the latter, but on the other hand the smaller plate inclination of 8° instead of 16° and the smaller absorption of the Brashear are an advantage. The definition of either of these is fully equal to the regular triplet in the centre of the field and much superior at the margins.

For short-focus lenses with three prisms both the Zeiss 'Tessar' and the Ross 'Special Homocentric' give good definition and flat fields. The Ross can be used of shorter focus than the Tessar, and gives exquisite definition, but the field of the Tessar is flatter and the plate is normal to the axis.

In single-prism work the Brashear 'Single Material' is much superior to the type of Triplet usually employed, both in definition and extent of field and can not be surpassed or even equalled for its purpose.

MEASUREMENT AND REDUCTION OF STELLAR SPECTRA.

With the exception of some plates measured on the spectro-comparator, which will be fully described below, all of the measurements have been made with the Toepfer microscope, and reduced by the modified Hartmann method previously described and explained. When the new single-prism spectrograph was brought into use it was found necessary to obtain tables, similar to those previously prepared, for the reduction of the spectrograms.

As before, plates of the comparison spectrum were made at three temperatures, as far separated as the time and season would permit, and these plates were measured. From these measures the constants of the Hartmann interpolation formula $\lambda - \lambda_0 = \dfrac{c}{s - s^0}$ were computed, using as the three standards different sets of lines, for the purpose of determining which would give the best agreement over the whole range of spectrum. It was not thought necessary, after the work of Mr. McLean, described in the 1907 report, to use the complete formula,

$$s_0 - s = \frac{c}{(\lambda - \lambda_0)^a},$$

as he showed that with the previous single-prism instruments, the best agreement was given when $a = 1$.

It was found that standards chosen at the middle and near the ends of the spectrum gave the best agreement on the whole and these, with the measures corresponding and the constants for the three temperatures, are given.

TABLE OF CONSTANTS.

Temp. C.	4864·943 s_1	4341·162 s_2	3930·450 s_3	s_0	log c	λ_0
2·8..	75·9840	50·9383	20·5074	176·9410	5·4249320	2229·851
8·6..	75·9851	50·9168	20·4543	176·9951	5·4250393	2230·595
15·6..	75·9557	50·8696	20·3763	176·9751	5·4248560	2231·943

Forming the differences between the s's and the log. of the ratio we have:

Temp. C.	$s_1 - s_2$	$s_2 - s_3$	$s_1 - s_3$	$\log \frac{s_1 - s_2}{s_1 - s_3}$
2·8......	25·0457	30·4309	55·4766	9·65462
8·6	25·0683	30·4625	55·5308	9·65459
15·6......	25·0861	30·4933	55·5794	9·65452

The changes in these differences and in the log. of the ratio are only about half those given with the other single-prism spectrograph. This is undoubtedly due to the fact that the camera setting remains unchanged with change of temperature in the new instrument, and, consequently, only the change in the angular dispersion appears, instead of that due to angular dispersion plus that due to increase in distance of the focal plane from the camera objective.

Averaging up the differences as far as possible, an increase of temperature of 1°C. increases $s_1 - s_3$ by ·008 revolution, and diminishes $\log.\frac{s_1 - s_2}{s_1 - s_3}$ by ·00001.

Forming an arbitrary series with these differences from the last two columns of the previous table, keeping them as close as possible to the observed values and computing 2nd and 3rd columns we have for differences of 10°.

Temp. C.	$s_1 - s_2$	$s_2 - s_3$	$s_1 - s_3$	$\log \frac{s_1 - s_2}{s_1 - s_3}$
−10..	25·0070	30·3675	55·3745	9·65475
0..	25·0376	30·4169	55·4545	9·65465
+10..	25·0681	30·4664	55·5345	9·65455
+20..	25·0985	30·5160	55·6145	9·65445

Again, taking the arbitrary equidistant values of s_2 for these four temperatures, which make the micrometer reading for the iron line at minimum deviation λ4325·9 as near as possible to 50·0000, we obtain the following values for s_1 s_2 s_3 and from them the three constants of the formula:—

Temp. C.	s_1	s_2	s_3	s_0	log c	λ_0
−10	75·9260	50·9190	20·5515			
0	75·9516	50·9200	20·5031	176·9129	5·4250327	2229·197
+10	75·9891	50·9210	20·4546	176·9736	5·4248342	2231·163
+20	76·0205	50·9220	20·4060	177·0327	5·4246277	2233·137

From these constants were computed the micrometer readings for all the star and comparison lines employed, and in addition the velocities corresponding to one revolution of the micrometer screw for each star line. This latter is obtained by differentiating the dispersion formula and applying Doppler's principle resulting in

$$v = \frac{299860}{\lambda} \cdot \frac{(\lambda - \lambda_o)^2}{c}$$

The velocities per revolution, as compared with those for the original single prism, are given for a few lines below to give some indication of the difference in dispersion.

Velocities per Revolution.

Temperature + 10°C.

Wave Length.	Old One Prism.	New One Prism.
4861·527	1454·4	1604·5
4713·308	1336·6	1473·7
4549·766	1209·0	1332·1
4481·400	1156·5	1273·9
4395·286	1091·1	1201·3
4340·634	1050·1	1155·8
4260·640	990·6	1089·9
4202·161	947·7	1042·3
4143·928	905·4	995·4
4101·890	875·2	961·9
4026·352	821·5	902·4
3970·177	728·1	858·3
3933·825	756·0	830·9

These velocities show that the new instrument has very approximately ten per cent less linear dispersion than the old. This, of course, is due almost entirely to the shorter focus camera lens used, as the prisms are nearly alike and the angular dispersion similar.

The Spectro-comparator.

The Spectro-comparator, which was briefly referred to in my last report, has not been used except on a few plates of β Geminorum more to test the capabilities of the instrument than for the purpose of obtaining definite measures of the velocity of this star. Before giving these measures, however, it may be well to shortly describe the instrument, its principle and the methods of measurement. These have been very fully described by its inventor, Dr. Hartmann, in the publications of the Astrophysical Observatory of Potsdam, Volume XVIII., Part 1, and consequently need not be gone into in great detail here.

The principle of measurement depends upon the direct comparison in a special form of double image microscope of the star spectrum, whose velocity is required with a standard spectrum of the sun, whose velocity at the instant the spectrum was made.

can be readily computed. The difference in the displacements of the star and the sun lines with respect to the same metallic comparison lines on each plate is measured by a micrometer screw, and this linear displacement can be at once converted into kilometres by multiplication by a known or easily computed constant. By adding to this radial velocity that of the sun with respect to the earth, with the proper sign, we obtain the velocity of the star with respect to the earth, and this can be readily reduced to the sun in the well known way.

The instrument of which a photograph is shown in Fig. 9 and diagrams in Figs. 10 and 11 was constructed by Zeiss in a very workmanlike manner. It consists essentially of a table T, Fig. 10, which carries at E_1 and E_2 the standard solar and the star spectrum respectively, and of a single ocular double objective microscope carried above the table on the bracket R, Fig. 11, which combines and compares the images of the two spectra.

The table T, which as Fig. 11 shows, is inclined at 45° to the horizontal for convenience in measuring, slides at its lower portion on the steel cylinder Z 35mm. diameter and at its upper part on the steel bar J. It is moved on these bearings over a range of 12cm. by rack and pinion of which the knurled wheel is shown at K and is clamped in any position, read off on the scale and vernier N, by the clamp screw near K. At the upper part of the table a carriage B_2 slides transversely in ways, adjustment being made by the screw G, while a secondary carriage A_2, having a slit 1cm. wide and 12cm. long, through which the star spectrum is illuminated by the plane mirror shown in Fig. 11 is oriented by the tangent screw D_2 and the opposing spring F_2, so that the spectrum, clamped on it may be placed parallel to the motion of the table T. The carriage B_1, which carries the standard or fundamental solar spectrum, has an orienting table A_1, adjusted by the screw D_1 and spring F_1, and slides in ways parallel to the motion of the table T. It is moved by means of the micrometer screw S of 0·5mm. pitch, having a range of movement slightly over 2cm. The head is divided into 100 parts so that the movement of the sun spectrum can be read direct to 0·005mm. and estimated to 0·0005mm.

The double microscope, Fig. 11, by which these two spectra are observed is supported by the bracket R on which the arm R_1 slides, moved by the screw H, the position being read on the scale W. The tubes carrying the objectives O_1 O_2 are attached at a fixed distance from one another to a plate L, movable in ways on the arm R_1 by the screw Q. At the upper ends of the objective tubes, which are provided with rack and pinion movement for focussing, are the prisms P_1 P_2, which reflect the light from the spectra on E_1 and E_2 to the compound prism P_3 P_4. On the hypothenuse of the prism P_4 is a surface silvered in the form shown in Fig. 12, and the two prisms are then

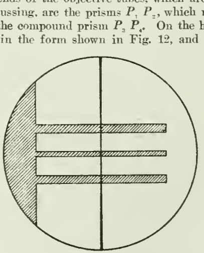


Fig. 12.

cemented together with Canada Balsam. The proper proportioning of the widths of the silver strips enables one to see, on looking through the eyepiece, a narrow strip of

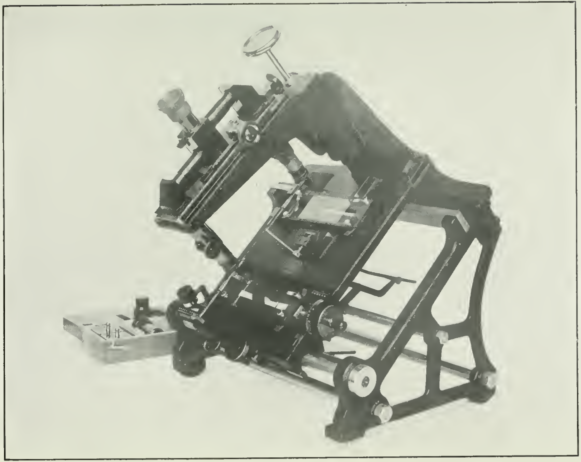


FIG. 9—Spectro-Comparator.

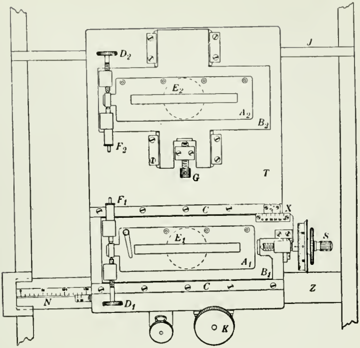

J
D2
E2
A2
B2
F2
G
T
F1
C
X
E1
S
A1
B1
C
Z
N
D1
K

FIG. 10.

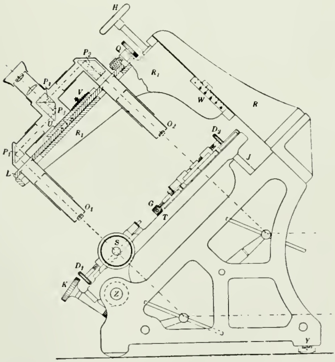

H
P2
Q
R1
P1
V
W
R
P1
U
R1
O2
D2
P1
J
L
O1
G
T
S
D1
K
Z
Y

FIG. 11.

star spectrum between and touching two strips of sun spectrum, and also on either side a narrow strip of the star comparison between and touching strips of sun comparison spectrum. The compound prism P_3 P_4, with the eyepiece, is carried on a slide U moved by rack and pinion V, so that the distance between the eyepiece and the objectives and consequently the magnification of the two spectra may be changed at will. This is to enable them, even though of different dispersions, to be made apparently identical in the field and hence readily and accurately comparable.

The adjustment of the spectra on the machine is a comparatively simple matter, only taking a few moments. The standard or fundamental solar spectrum usually made on a lantern or process plate in order to obtain sufficient contrast, is placed on its carriage, and clamped by a pair of spring microscope clamps. The carriage is then moved by the pinion K until the centre of rotation of the orienting arrangement is directly under the microscope 1, which is in this case at the reading 132·3 on the scale N.

The whole microscope system is now moved by the screw Q until the solar spectrum is centrally situated with respect to the central silver strip in the field. By moving the carriage back and forwards the spectrum can be rapidly oriented. The star spectrum may be similarly oriented while it is made central by the screw G. There then remains only to adjust the magnification of the separate spectra, the comparison lines of the two appear coincident in the whole extent of the field of view. By moving the ocular by the rack and pinion V, the magnification of one spectrum is increased and of the other decreased. This will evidently disturb the focus, but this can be easily corrected by adjusting the objectives O_1 and O_2 by their focussing screws seen in Fig. 9. This will again slightly change the magnification and the process may need to be repeated, but a little practice soon enables one to equalize the apparent dispersion very quickly.

Before making any measurements it is necessary to divide the fundamental solar spectrum into regions, indicated by small ink dots, and numbered for identification. These regions are so chosen that there is a slight overlapping of the field in adjacent regions with the magnification to be employed. The dots, which are brought under the wire in the measurement, are placed, as nearly as possible, in the centre of a group of good solar lines and at the same time so that the field includes a number of good comparison lines. The regions selected in a series of good fundamental solar spectra made on May 14, 1908, on Seed process plates are given in the following table. In addition in the third column of the table are given the velocities corresponding to one revolution of the micrometer screw. These velocities were computed from the measurement of lines on the fundamental spectrum by the micrometer screw of the comparator. These linear measurements were used to obtain the constants of the Hartmann formula, and from these constants the velocities corresponding to the wave length of each region were computed.

CONSTANTS OF FUNDAMENTAL SPECTRA, 1519-1526.

Exposed May 14, 1908.

No. of Region.	Wave Length.	Vel. per Rev. S.	No. of Region.	Wave Length.	Vel. per Rev. S.
1	4867·0	582·1	14	4374·5	364·2
2	4807·0	555·4	15	4346·5	352·1
3	4754·0	531·9	16	4322·8	341·8
4	4709·6	512·0	17	4298·2	331·1
5	4669·0	494·0	18	4273·3	320·4
6	4628·7	476·0	19	4249·9	310·4
7	4590·2	459·1	20	4226·8	300·6
8	4554·6	443·2	21	4206·0	291·7
9	4523·9	429·7	22	4184·3	282·1
10	4492·0	415·7	23	4157·2	271·2
11	4460·3	401·7	24	4139·5	263·4
12	4429·6	388·3	25	4117·8	255·7
13	4402·1	376·2	26	4099·0	246·7

$$\text{Log } f = \log. \frac{1}{2\Sigma\frac{1}{\delta}}$$

Region.	3	4	5	6	7
13	....	....	1·37646	1·42045	1·47137
14	....	....	1·32312	1·36175	1·40594
15	....	1·24332	1·27409	1·30846	1·34727
16	1·17577	1·20095	1·22877	1·25961	1·29412
17	1·13813	1·16116	1·18647	1·21436	1·24533
18	1·10239	1·12355	1·14671	1·17207	1·20008
19	1·06833	1·08786	1·10914	1·13236	1·15784
20	1·03576	1·05385	1·07349	1·09483	1·11815
21	1·00457	1·02139	1·03958	1·05928	1·08072
22	0·97452	0·99028	1·00710	1·02535	1·04514
23	0·94533	0·95996			
24	0·91718	0·93098			
25	0·88998	0·90283			
26	0·86348	0·87555			

The magnification of the two spectra may be varied between about 10 and 40 fold by means of two pairs of objectives and three oculars. Moreover, by suitably varying these the silver strips on the prism may be varied in apparent width to suit star spectra of different widths. It has been found that a magnification of about 20 seems to give better and easier measurements than either higher or lower powers, and it has generally been used, although tests have been made with different powers.

When the plates have been adjusted as described above, the line in the centre of the field is set on the dot towards the red end at which it is deemed advisable the measurement should begin. This is determined by the appearance of the star spectrum and of its comparison lines. It has not been generally taken lower down than No. 5 at wave length λ4669, as below that the comparison spectrum is not so good and no gain in accuracy would result. Towards the violet end the measurement is carried until the star spectrum becomes too weak for accurate comparisons, frequently about dot 20, wave length λ4227. However, in a well exposed star spectrum the measurement could be extended over the whole range on the plate from H_β to H_δ, although in my opinion nothing would be gained in accuracy by such procedure over that obtained by the use of a less number, say 12 or 15 regions. The measurement proceeds according to a regular scheme of alternation of star and comparison settings, so that at each region there are two settings on the star and two on the comparison lines, one by forward and one by backward rotation of the screw in each case. As soon as the measurement is completed, both star and fundamental spectra are reversed on the machine to overcome personality in the settings and the same regions are again measured.

It has been my experience that the most difficult part of the measurement is the determination of the point of coincidence of star and fundamental spectrum. Although with solar type stars of a considerable range in type, there is so little difference in the lines as to cause no trouble, nevertheless there are frequently apparently accidental irregularities in some of the lines in a region which render it difficult to determine the exact point of coincidence. The field extends over a considerable angle, and the eye can only observe at the most two or three lines at a time. These may be brought into the best coincidence, while lines in another part of the field may be better suited by a slightly different setting, and the best average is sometimes troublesome to obtain. These irregularities are chiefly due, I think, to irregular deposition of the silver grains in the comparatively coarse structure of the fast plates, to local distortions of the photographic film, to possibly non-uniform intensity of the star spectrum throughout its width and to other causes of a similar nature rather than to constant differences in the spectrum of star and sun. Such differences can be noted in the case of some lines, but these seem to be few compared with the accidental deviations observed. This difficulty does not exist to so great an extent with regard to the emission lines. Provided the comparison spectra are of nearly the same intensity, coincidences can be easily, quickly, and accurately obtained. The accidental deviations observed in the apparent positions of star lines serve to explain the comparatively high residual sometimes obtained in the direct measurement of good lines in solar type spectra.

After the measurement is completed the reduction of the separate measures to velocities is a simple matter. The difference in the settings for coincidence between emission and absorption spectra, multiplied by the velocity per revolution at the region under consideration gives the velocity at once. These differences are, however, tabulated for both positions of the plate, and the mean of the two for each region multiplied by the velocity factor gives the velocity for the region, while the velocity for the plate is obtained from the mean of the regions.

This considers all the regions as of equal weight, whereas such is not the case. In some parts of the spectrum the lines are more numerous or of better quality, and moreover as the dispersion increases, as we go towards the violet, greater weight should be given. There are then two courses open, to give weights according to the quality of the regions, increasing these as we go towards the violet, or to give weights proportional to the dispersion. The latter method is much simpler, and should give practically the same values as the more complex method and better values than the simple mean. Moreover, Hartmann has developed a very simple method of obtaining the velocity from the differences. If we call the differences with red to right d_1 and with red to left d_2, then the mean $d = \frac{1}{2}(d_1 + d_2)$, which multiplied by the velocity factor s, gives velocity sd for the region. Its weight is proportional to $\frac{1}{s}$, and hence the weighted mean velocity can be very simply represented by $\frac{\Sigma d}{\Sigma \frac{1}{s}}$. As $d = \frac{1}{2}(d_1 + d_2)$ we can avoid taking the means of the differences by changing it to $\frac{\Sigma d_1 + \Sigma d_2}{2\,\Sigma \frac{1}{s}}$. If we take the velocity values per revolution of the fundamental spectrum and form the expressions $\log\left(\frac{1}{2\,\Sigma \frac{1}{s}}\right)$ between all the regions which are likely to be used, the only procedure necessary to obtain the weighted mean velocity is to add all the differences together and add to the logarithm of the sum the tabulated value of the above expression. To the velocity of which this sum is the logarithm, must be added the computed radial velocity of the sum when the spectrum was made, and we have the radial velocity of the star with respect to the earth, which reduced for diurnal and annual motion will give us the velocity with respect to the sun.

As mentioned previously, only a few plates of β Geminorum made with the three-prism spectrograph have been measured, principally as a test of the capabilities of the instrument. It can practically be used only with spectra of the second and third classes, those with numerous well defined lines, allied to the spectrum of the sun. Our single-prism spectrograph has been almost entirely employed on stars of early type spectra, which can not be economically or accurately measured with the spectro-comparator. However, work on some solar type spectroscopic binaries with a short-focus camera on the three-prism spectrograph is about to start, and for the measurement of such spectra the comparator is especially suited.

One spectrum of β Geminorum No. 1373, of only moderately good quality, was selected as a test plate and has been measured fifteen times with different fundamental spectra, different arrangements of objectives and oculars and with two different ocular prisms.

The measures and their summary given below enable an estimate of the accuracy obtainable in measurement to be formed. Further ten additional plates of β Geminorum have been measured with constant conditions in the comparator, which enables an estimate to be formed of the instrumental errors to be expected in the making of the spectra. These also with a summary are given below:—

β GEMINORUM 1373.

Solar Standard 1360.

Observer } J. S. P.
Measurer }

Region.	d_1	d_2	d	V	v
7	·053	·049	·052	24·84	−0·06
8	47	48	48	22·18	+2·60
9	53	54	53	24·01	−0·77
10	55	51	53	23·53	−1·25
11	60	51	55	23·87	−0·91
12	50	48	49	20·58	−4·20
13	64	57	61	25·07	−0·29
14	65	65	65	26·32	−1·54
15	64	60	62	24·68	+0·10
16	64	62	63	24·57	−0·21
17	67	66	66	25·34	−0·56
18	72	73	73	27·45	−2·67
19	78	69	73	27·01	−2·23
20	79	74	76	27·51	−2·73
21	70	73	72	25·56	−0·78
22	74	73	73	25·33	−0·55
23	71	68	70	23·94	+0·84
24	76	71	73	24·38	+0·40
25	71	75	73	23·80	+0·98
26	87	78	82	25·91	−1·13
27	84	76	80	24·48	+0·30
28	85	90	88	26·40	+1·62
29	91	91	91	26·57	−1·79
30	87	71	79	22·51	+2·26
31	89	90	89	24·03	−0·75
	1758	1683	Mean	+24·78	....

$\Sigma d = 3441$

log = ·53668

log f = ·85865

log (Vs−Vo) = 1·39533

Vs−Vo = − 24·85

Vo = + 0·21

Va = − 21·97

Vd = − 0·16

V = + 2·93

$r = \pm$ 1·10

β GEMINORUM 1373.

SOLAR STANDARD 1461.

Observer } J. S. P.
Measurer }

Region	d_1	d_2	d	V	v
1	·049	051	·050	24·90	−0·32
2	49	51	50	24·21	+0·37
3	48	47	48	22·61	−1·97
4	48	51	49	22·56	−2·02
5	50	55	53	23·84	+0·74
6	54	51	52	22·85	+1·73
7	52	53	53	22·76	−1·82
8	57	57	57	23·88	+0·70
9	59	63	61	24·99	−0·41
10	64	62	63	25·21	−0·62
11	66	65	65	25·43	−0·85
12	68	65	66	25·25	−0·67
13	70	67	69	25·87	−1·29
14	73	70	71	26·04	−1·46
15	64	70	67	24·05	+0·53
16	68	73	71	24·94	−0·36
17	72	72	72	24·80	−0·22
18	74	72	73	24·60	−0·02
19	75	74	74	24·43	+0·15
20	76	82	79	25·55	−0·97
21	82	80	81	25·62	−1·04
22	78	80	79	24·47	+0·11
23	85	84	84	25·48	−0·90
24	78	87	83	24·68	−0·10
25	93	82	88	25·55	−0·97
	1652	1658	Mean......	+24·58	....

$\Sigma d = 3310$

log = ·51983
log f = ·87155
log $(V_s - V_o)$ = 1·39138

$V_s - V_o = + 24·63$
$V_o = + 0·52$
$V_a = - 21·97$
$V_d = - 0·16$

$r = \pm 0·71$

$V = - 3·02$

β GEMINORUM 1373.

SOLAR STANDARD 1461.

Observer } J. S. P.
Measurer }

Region.	d_1	d_2	d	V	v
3	·055	·051	·053	24·96	−1·06
4	45	52	48	22·10	+1·80
5	47	53	50	22·49	+1·41
6	50	47	49	21·53	+2·37
7	53	53	53	22·76	+1·14
8	49	51	50	20·95	+2·95
9	58	63	60	24·58	−0·68
10	64	62	63	25·21	−1·31
11	60	59	60	23·47	+0·43
12	65	61	63	24·10	−0·20
13	67	62	64	24·00	−0·10
14	68	72	70	25·68	−1·78
15	69	62	66	23·69	+0·21
16	79	65	72	25·29	−1·39
17	68	69	69	23·78	+0·12
18	68	76	72	24·26	−0·36
19	74	74	74	24·43	−0·53
20	74	72	73	23·61	+0·29
21	77	74	75	23·72	+0·18
22	78	79	78	24·16	−0·26
23	79	81	80	24·26	−0·36
24	88	83	86	25·57	−1·67
25	91	82	86	24·97	−0·07
	1526	1503	Mean......	+23·90	... .

Σd = 3029 log = ·48130

log f = ·89871

log (Vs − Vo) = 1·38001 r = ± 0·81

Vs−Vo = + 23·99
Vo = + 0·35
Va = − 21·97
Vd = − 0·16 V = + 2·23

β GEMINORUM 1373

Solar Standard 1462.

Observer, Measurer } J. S. P.

Region.	d_1	d_2	d	V	v
4	·049	·049	·049	22·56	−2·12
5	52	51	51	22·94	−1·44
6	53	54	54	23·73	+0·65
7	60	57	58	24·91	0·53
8	53	52	53	22·21	+2·16
9	64	57	60	24·58	−0·20
10	65	61	63	25·21	−0·83
11	67	64	66	25·82	−1·44
12	63	67	65	24·87	−0·49
13	68	69	68	25·50	−1·12
14	73	70	72	26·41	−2·03
15	67	64	65	23·34	−1·04
16	67	67	67	23·54	+0·84
17	68	73	71	24·47	−0·09
18	73	71	72	24·26	−0·12
19	69	70	69	22·78	−1·60
20	76	74	75	24·26	−0·12
21	83	83	83	26·25	−1·87
22	78	84	81	25·09	−0·71
23	79	79	79	23·96	−0·42
24	81	82	81	24·08	−0·30
25	89	87	88	25·59	−1·21
	1497	1485	Mean.	... −24·38	... ...

$\Sigma d = 2992$

log = ·47451

log f = ·91356

Log ($V_s - V_o$) = 1·38807

$V_s - V_o$ = − 24·44

V_o = + 0·54

V_a = − 21·97

V_d = − 0·16

V = + 2·85

r = ± 0·81

β GEMINORUM 1373.

SOLAR STANDARD 1462.

Observer } J. S. P.
Measurer }

Region.	d_1	d_2	d	V	v
1	·052	051	·051	25·40	−0·72
2	48	49	49	23·72	+0·96
3	55	50	52	24·50	+0·18
4	47	47	47	21·64	+3·04
5	50	54	52	23·39	+1·29
6	52	51	52	22·85	+1·83
7	60	54	57	24·48	+0·20
8	58	57	57	23·88	+0·80
9	61	62	62	25·40	−0·72
10	65	62	63	25·21	−0·53
11	64	61	63	24·65	+0·03
12	73	70	71	27·16	−2·48
13	74	66	70	26·25	−1·57
14	67	69	68	24·94	−0·26
15	65	67	66	23·69	+0·99
16	72	67	70	24·58	+0·10
17	70	69	69	23·77	+0·93
18	72	72	72	24·26	+0·42
19	74	74	74	24·43	+0·25
20	78	76	77	24·90	−0·22
21	84	79	81	25·62	−0·94
22	82	82	82	25·40	−0·72
23	85	79	81	24·57	+0·11
24	82	81	82	24·38	+0·30
25	94	87	90	26·13	−1·45
	1682	1636	Mean..	.... +24·68	......

Σd = 3318   log = ·52088
log f = ·87155
log (Vs−Vo) = 1·39243

Vs−Vo = + 24·68 r = ± 0·77
Vo = + 0·48
Va = − 21·97
Vd = − 0·16   V = 3·03

β GEMINORUM 1373.

SOLAR STANDARD 1462.

Observer } J. S. P.
Measurer }

Region.	d_1	d_2	d	V	v
3	053	·049	·051	24·03	+0·73
4	46	51	49	22·56	+2·20
5	55	52	53	23·84	+0·92
6	56	54	55	24·17	+0·59
7	47	55	51	21·90	+2·86
8	54	60	57	23·88	+0·88
9	62	61	61	24·99	−0·23
10	58	67	63	25·21	−0·45
11	59	68	63	24·65	+0·11
12	69	68	69	26·40	−1·64
13	72	67	69	25·87	−1·11
14	68	65	67	24·58	+0·18
15	70	64	67	24·05	+0·71
16	72	71	72	25·29	−0·53
17	72	74	73	25·15	−0·39
18	72	71	72	24·26	+0·50
19	78	77	77	25·42	−0·66
20	80	82	81	26·19	−1·43
21	85	80	82	25·94	−1·18
22	83	81	82	25·40	−0·64
23	88	85	86	26·08	−1·32
24	89	91	90	26·76	−2·00
25	89	84	85	25·26	−0·50
	1577	1577	Mean..	... −24·76	.. ..

Σd = 3154 log = ·49886
log f = ·89871
log (V_s-V_o) = 1·39757

V_s V_o = + 24·98 r = ± 0·79
V_θ = + 0·33
V_a = − 21·97
V_d = − 0·16 V = − 3·18

δ GEMINORUM 1373.

SOLAR STANDARD 1462.

Observer } J. S. P.
Measurer }

Region.	d_1	d_2	d	V	v
1	049	·047	048	23·91	+0·27
2	44	51	48	23·24	+0·94
3	50	51	50	23·55	+0·63
4	50	45	48	22·10	+2·08
5	53	51	52	23·39	+ ·79
6	54	56	55	24·17	+ ·01
7	60	59	60	25·76	−1·58
8	56	58	57	23·88	+ ·30
9	57	59	58	23·76	+ ·42
10	59	60	60	24·01	+ ·17
11	59	64	61	23·86	+ ·32
12	61	66	63	24·10	+ ·08
13	65	65	65	24·37	− ·19
14	66	68	67	24·58	− ·40
15	68	68	68	24·41	− ·23
16	60	64	62	21·77	+2·41
17	70	75	72	24·80	·62
18	70	77	74	24·94	− ·76
19	74	72	73	24·10	+ ·08
20	76	75	76	24·58	− ·40
21	82	74	78	24·67	− ·49
22	85	78	81	25·09	− ·91
23	85	78	82	24·87	− ·69
24	88	82	85	25·27	−1·09
25	89	90	89	25·84	−1·66
26	78	95	87	24·84	− ·66
	1707	1728	Mean..	....+24·18	....

Σd = 3435

log = ·53618
log f = ·84949
log (V_s-V_o) = 1·38567

V_s-V_o = + 24·30
V_o = + 0·33
V_a = − 21·97
V_d = − 0·16

r = ± 0·63

V = + 2·50

β GEMINORUM 1373.

SOLAR STANDARD 1462.

High Power Objective.
Low Power Ocular.

Observer } J. S. P.
Measurer }

Region.	d_1	d_2	d	V	v
3	053	·050	·051	24·03	+0·28
4	50	47	49	22·56	+1·75
5	53	50	51	22·94	+1·37
6	60	51	56	24·61	−0·30
7	57	53	55	23·62	+0·69
8	58	53	55	23·04	−1·27
9	59	57	58	23·76	+0·55
10	59	62	61	24·41	0·10
11	63	65	64	25·04	−0·73
12	66	73	69	26·40	−2·09
13	73	69	71	26·62	−2·31
14	73	64	69	25·31	−1·00
15	69	65	67	24·05	+0·26
16	71	66	68	23·88	+0·43
17	66	69	68	23·43	+0·88
18	72	70	71	23·93	+0·38
19	73	66	70	23·11	+1·20
20	75	77	76	24·58	−0·27
21	81	73	77	24·35	+0·04
22	87	74	80	24·78	0·47
23	80	73	77	23·35	+0·96
24	86	83	84	24·97	−0·66
25	97	85	91	26·42	−2·11
	1575	1495	Mean..	..+24·31	......

$\Sigma d = 3070$

log = 48714
log f = 89871
log $(Vs - Vo)$ = 1·38585

$r = \pm 0·74$

$Vs - Vo = + 24·32$
$Vo = + 0·33$
$Va = - 21·97$
$Vd = 0·16$

$V = - 2·52$

β GEMINORUM 1373.

SOLAR STANDARD 1465.

Observer. } J. S. P.
Measurer. }

Region.	d_1	d_2	d	V	v
3	·051	·055	·053	24·96	-0·90
4	48	50	49	22·56	+1·50
5	47	45	46	20·69	-3·37
6	48	51	49	21·53	+2·53
7	51	57	54	23·19	+0.87
8	51	48	50	20·95	+3·11
9	61	64	62	25·40	-1·34
10	63	57	60	24·01	+0·05
11	66	65	66	25·82	-1·76
12	68	67	67	25·63	1·57
13	67	63	65	24·37	-0·31
14	71	63	67	24·58	0·52
15	72	65	69	24·77	0·71
16	65	66	65	22·83	+1·23
17	72	68	70	24·12	-0·06
18	69	70	70	23·59	+0·47
19	72	70	71	23·43	+0·63
20	75	75	75	24·25	0·19
21	82	76	79	24·99	-0·93
22	83	82	82	25·39	-1·33
23	85	77	81	24·57	-0·51
24	89	84	87	25·87	-1·81
25	88	90	89	25·84	-1·78
	1544	1508	Mean...	+24·06	....

$\Sigma d = 3052$

log = ·48458
log f = ·89871
log ($V_s - V_o$) = 1·38329

$V_s - V_o = + 24·17$
$V_o = + 0·27$
$V_a = - 21·97$
$V_d = 0·16$

$r = \pm 1·02$

$V = + 2·31$

β GEMINORUM 1373.

Solar Standard 1468.

Observer / Measurer } J. S. P.

Region.	d_1	d_2	d	V	v
3	·054	·056	·055	25·91	−1·74
4	50	54	52	23·94	+0·23
5	49	50	50	22·94	+1 68
6	53	51	52	22·85	+1·32
7	55	56	55	23·62	+0·55
8	57	48	53	22·21	+1·96
9	57	61	59	24·17	0·00
10	65	66	65	26 01	−1·84
11	58	56	57	22 30	+1·87
12	66	64	65	24·87	−0·70
13	72	66	69	25·87	−1·70
14	72	67	69	25·31	−1·14
15	69	68	69	24·77	−0·60
16	72	68	70	24·58	0·41
17	67	63	65	22 39	+1·78
18	75	67	71	23·93	+0·24
19	73	70	71	23·44	+0·73
20	75	75	75	24·25	−0·08
21	80	82	81	25·62	−1·45
22	77	80	79	24·47	−0·30
23	75	79	77	23·35	+0 82
24	81	82	82	24·38	−0·21
25	86	89	87	25 26	−1·09
	1538	1518	Mean...	... +24·17	... ...

$\Sigma d = 3056$ log = ·48515

log f = ·89871

Log (V_s-V_o) = 1·38386

V_s-V_o = + 24·20 $r = \pm 0·80$

V_o = + 0·23

V_a = − 21·97

V_d = − 0·16 V = + 2·30

β GEMINORUM 1373.

SOLAR STANDARD 1517.

High Power.

Observer } Measurer } J. S. P.

Region.	d_1	d_2	d	V	v
4	·047	·046	·046	21·18	+2·79
5	45	50	48	21·59	+2·28
6	52	53	52	22·85	+1·12
7	55	56	55	23·62	+0·35
8	52	51	52	21·79	+2·18
9	59	60	59	24·17	−0·20
10	61	66	64	25·61	−1·64
11	62	62	62	24·25	−0·28
12	61	63	62	23·72	+0·25
13	63	66	64	24·00	−0·03
14	70	66	68	24·94	−0·97
15	66	70	68	24·41	−0·44
16	68	68	68	23·88	+0·09
17	72	68	70	24·12	−0·15
18	71	73	72	24·26	−0·29
19	73	71	72	23·77	+0·20
20	79	75	77	24·90	−0·93
21	77	85	81	25·62	−1·65
22	80	82	81	25·09	−1·12
23	78	84	81	24·57	−0·60
24	81	80	81	24·08	−0·11
25	87	86	86	24·97	−1·00
	1459	1481	Mean...	....+23·97	....

Σd = 2940

log = ·46835
log f = ·91360
log (Vs-Vo) = 1·38195

Vs-Vo = + 24·10
Vo = + 0·54
Va = − 21·97
Vd = − 0·16

$r = \pm 0·79$

V = + 2·51

β GEMINORUM 1373.

SOLAR STANDARD 1519.

Observer } J. S. P.
Measurer }

Region.	d_1	d_2	d	V	v
5	·047	·048	·048	23·71	+0·94
6	49	52	50	23 80	−0·85
7	50	54	52	23·87	−0·78
8	51	53	52	23·05	−1·60
9	53	54	54	23·20	−1·45
10	55	56	55	22·86	+1·79
11	61	59	60	24·10	−0·55
12	63	65	64	24 85	−0·20
13	68	70	69	25·96	−1·31
14	72	69	71	25·86	1·21
15	69	72	70	24·65	0 00
16	76	72	74	25·29	−0 64
17	81	75	78	25 87	−1 16
18	77	79	78	24·99	−0·34
19	83	81	82	25·45	−0·80
20	86	84	85	25·55	−0·90
21	92	85	89	25·96	−1·31
	1133	1128	Mean....	+24·65	

Σd = 2261

log = ·35430
log f = 1·03958
log (Vs − Vo) = 1·39388

Vs − Vo = + 24·77
Vo = + 0·41
Va = 21·97
Vd = − 0·16

$r = \pm 0·72$

V = +3·05

β GEMINORUM 1373.

SOLAR STANDARD 1520.

Observer } J. S. P.
Measurer }

Region.	d_1	d_2	d	V	v
5	·046	·048	·047	23·22	+1·70
6	53	51	52	24·75	+0·17
7	50	51	51	23·41	+1·61
8	59	57	58	25·71	−0·79
9	57	60	58	24·92	0·00
10	59	55	57	23·69	+1·23
11	64	64	64	25·71	0·79
12	68	68	68	26·40	1·48
13	72	70	71	26·71	−1·79
14	67	72	70	25·49	0·57
15	68	72	70	24·65	0·27
16	73	69	71	24·27	+0·65
17	73	73	73	24·17	+0·75
18	78	81	80	25·63	−0·71
19	83	81	82	25·45	−0·53
20	79	83	81	24·35	+0·57
21	88	84	86	25·09	−0·17
	1147	1139	Mean.	+24·92	. . . . .

$\Sigma d = 2286$

log = 35908
log f = 1·03958
log (Vs−Vo) = 1·39866

Vs−Vo = + 25·04
Vo = + 0·38
Va = − 21·97
Vd = − 0·16

$r = \pm$ 0·65

V = + 3·29

β GEMINORUM 1373

SOLAR STANDARD 1524.

Observer. } J. S. P.
Measurer. }

Region.	d_1	d_2	d	V	v
5	·050	·049	·049	24·21	+0·02
6	49	48	49	23·32	+0·91
7	47	47	47	21·57	+2·66
8	52	49	51	22·60	+1·63
9	58	53	55	23.63	+0·60
10	62	53	58	24·11	+0·12
11	64	63	63	25·31.	−1·08
12	63	63	63	24·46	−0.23
13	69	70	70	26·33	−2·10
14	68	73	70	25·49	−1·27
15	62	66	64	22·53	+1·70
16	67	72	70	23·93	+0·30
17	72	79	75	24 83	+0·60
18	72	76	74	23·71	+0 52
19	83	83	83	25·76	−1·53
20	82	82	82	24·65	−0·42
21	89	84	87	25·38	−1·15
	1109	1110	Mean...	...+24·23	....

Σd = 2219

log = ·34616
log f = 1·03958
log (V_s-V_o) = 1·38574

V_s-V_o = + 24·31
V_o = + 0.23
V_a = − 21·97
V_d = − 0·16

r = ± 0·84

V = + 2·41

β GEMINORUM 1306.

Observer. } J. S. P.
Measurer. }

Region.	d_1	d_2	d	V	v
3	·023	·020	·021	9·89	+0·47
4	22	22	22	10·13	+0·23
5	19	18	19	8·55	+1·83
6	24	21	23	10·11	+0·25
7	28	25	26	11·16	−0·80
8	25	23	24	10·06	+0·30
9	26	28	27	11·06	−0·70
10	22	24	23	9 20	+1·16
11	32	26	29	11·34	−0 98
12	28	24	26	9·95	+0·41
13	30	21	26	9·75	+0 61
14	26	30	28	10·27	+0·09
15	30	38	34	12 21	−1 85
16	26	26	26	9·13	+1·23
17	29	36	32	11·02	−0·66
18	27	25	26	8·76	+1·60
19	36	24	30	9·90	+0·46
20	38	31	35	11·32	−0·96
21	37	28	32	10·12	+0·24
22	36	32	34	10·53	−0·17
23	41	35	38	11·53	−1 17
24	40	37	39	11·59	−1 23
25	38	36	37	10·74	−0·38
	683	630	Mean...	....−10·36	....

Σd = 1313

log = ·11826
log f = ·89871
log (Vs-Vo) = 1·01697

Vs-Vo = + 10·40
Vo = + 0 33
Va = − 8·67
Vd = − 0·22

r = ± 0·63

V = + 1·84

β GEMINORUM 1417.

Observer } J. S. P.
Measurer }

Region.	d_1	d_2	d	V	v
3	061	·058	·059	27·79	+0·80
4	65	65	65	29·93	−1·34
5	59	58	59	26·54	+2·05
6	66	64	65	28 56	−0·03
7	67	65	66	28·34	+0·25
8	65	64	65	27·24	1·35
9	74	69	71	29·08	0·49
10	73	77	75	30·01	−1·42
11	75	76	76	29·73	1·14
12	77	76	76	29·08	−0·49
13	78	75	77	28·87	0·28
14	82	74	78	28·61	−0·02
15	78	79	78	28·00	+0·59
16	80	76	78	27·39	−1·20
17	79	77	78	26·87	+1·72
18	83	84	84	28·31	+0·28
19	85	85	85	28·06	+0·53
20	91	87	89	28·78	−0·19
21	96	96	96	30·36	1·77
22	96	96	96	29·73	−1·14
23	92	94	93	28·21	+0·38
24	94	100	97	28·84	0 25
25	105	98	101	29·32	−0·73
	1821	1793	Mean......	28·59	... .

Σd = 3615

log = 55811
log f = ·89871
log (V_s − V_o) = 1·45682

r = ± 0·68

V_s − V_o = + 28 63
V_o = + 0·33
V_a = − 27·36
V_d = − 0·19

V = + 1 41

β GEMINORUM 1424.

Observer / Measurer } J. S. P.

Region.	d_1	d_2	d	V	v
3	·063	060	062	29·21	0·07
4	61	61	61	28·08	1·06
5	62	63	62	27·89	1·25
6	66	63	65	28 56	+0·58
7	65	66	65	27 91	1·23
8	62	60	61	25·56	3·58
9	68	71	69	28 26	+1 88
10	72	74	73	29·21	−0·07
11	74	70	72	28 17	+0·97
12	70	82	76	29·08	0·06
13	73	82	78	29·25	0·11
14	78	83	80	29 34	0·20
15	77	83	80	28·72	−0·42
16	83	85	84	29·50	0 36
17	89	91	90	31·00	1·86
18	94	93	93	31·34	2·20
19	87	93	90	29 70	0 56
20	92	96	94	30 40	−1·26
21	90	94	92	29·10	−0 04
22	97	98	98	30·35	−1·21
23	90	96	93	28·21	+0·93
24	101	107	104	30·92	−1·78
25	106	103	105	30·48	1·34
	1820	1874	Mean	+ 29·14	....

$\Sigma d = 3694$

log = ·56750
log f = ·89871
log (Vs–Vo) = 1·46621

Vs–Vo = 29·26
Vo = + 0·33
Va = − 27·89
Vd = 0·12

V = + 1·58

r = ± 0·88

β GEMINORUM 1443.

Observer } J. S. P.
Measurer }

Region.	d_1	d_2	d	V	v
3	·061	·060	·061	28·76	+2·80
4	66	67	66	30·39	+1·17
5	66	65	66	29·69	+1·87
6	66	67	66	29 00	+2·56
7	68	75	72	30·92	−0·64
8	74	78	76	31·84	−0 28
9	80	77	78	31·95	−0·39
10	78	80	79	31·62	−0·06
11	79	83	81	31·69	−0·13
12	86	87	87	33·29	−1·73
13	87	82	84	31 50	+0·06
14	86	86	86	32·64	−1·08
15	85	88	87	31·23	+0.33
16	92	83	88	30 91	+0·65
17	93	94	93	32·05	−0·49
18	95	95	95	32 01	−0·45
19	92	94	93	30·70	+0·86
20	100	99	100	32·34	−0·78
21	104	96	100	31·63	−0·07
22	107	103	105	32·52	−0·96
23	108	106	107	32·45	−0·89
24	114	108	111	33 00	−1·44
25	118	114	116	33·67	−2·11
	2005	1987	Mean...	−31·56	

$\Sigma d = 3992$ log = ·60119

log f = ·89871

log ($Vs-Vo$) = ·49990

$Vs-Vo = +\ 31·62$ $r = \pm 0·84$

$Vo = +\ 0·33$

$Va = -\ 28·83$

$Vd = -\ 0·09$ $V = +\ 3·03$

β GEMINORUM 1452.

Observer } J. S. P.
Measurer }

Region.	d_1	d_2	d	V	v
3	·065	·062	063	29 21	+1·43
4	65	62	64	29·47	+1·17
5	66	65	65	29·24	+1·40
6	65	72	69	30·32	+0·32
7	74	68	71	30·49	+0·15
8	73	69	71	29·75	+0·89
9	70	78	74	30·31	+0·33
10	80	76	78	31·22	−0·58
11	79	72	76	29·73	+0 91
12	84	79	81	30·99	−0·35
13	88	87	88	33·37	−2·73
14	85	79	82	30 08	+0·56
15	88	95	91	32·67	−2·03
16	88	92	90	31·61	−0·97
17	93	87	90	31·00	−0·36
18	89	94	92	31·00	−0·36
19	93	89	91	30·04	+0·60
20	87	89	88	28·78	+1·88
21	98	98	98	31·00	−0·36
22	99	97	98	30·35	+0 29
23	99	105	102	30·94	−0·30
24	105	106	105	31·22	−0·58
25	108	111	110	31·93	−1·29
	1941	1932	Mean....	+30·64	....

Σd = 3873

log = ·58805
log f = ·89871
log (Vs−Vo) = 1·48676

r = ± 0·74

Vs−Vo = + 30 67
Vo = + 0·33
Va = − 29·19
Vd = − 0·11

V = + 1 70

β GEMINORUM 1460.

Observer	J. S. P.
Measurer	J. S. P.

Region.	d_1	d_2	d	V	v
3	065	064	·064	30·15	+1·91
4	68	63	66	30 39	+1·67
5	66	70	68	30·59	+1·47
6	66	66	66	29·00	+3·06
7	68	70	69	29 63	2·43
8	70	71	71	29·75	+2·31
9	76	80	78	31 95	−0·11
10	83	82	82	32·82	−0·76
11	85	83	84	32 86	−0 80
12	86	82	84	32·14	−0·08
13	90	83	87	32·62	−0·56
14	93	89	91	33·38	−1·32
15	94	88	92	33·03	0·97
16	93	89	91	31·96	+0·10
17	101	97	99	34 11	−2·05
18	92	92	92	31·00	+1·06
19	95	100	98	32·35	−0·29
20	102	105	103	33·31	−1·25
21	102	105	104	32·90	−0·84
22	102	108	105	32·52	−0·46
23	107	104	105	31·85	+0·21
24	117	119	118	35·08	−3·02
25	113	121	117	33·96	−1·90
	2034	2031	Mean. .	. . . . 32·06	. . . .

$\Sigma d = 4065$	$\log = ·60906$	
	$\log f = ·89871$	
	$\log (V_s - V_o) = ·50777$	
$V_s - V_o = + 32·19$		$r = \pm 1·14$
$V_o = + 0·33$		
$V_a = - 29·24$		
$V_d = - 0·09$	$V = + 3·19$	

β GEMINORUM 1472.

SOLAR STANDARD 1520.

Observer } J. S. P.
Measurer }

Region.	d_1	d_2	d	V	v
5	·053	·056	055	27·17	+3·94
6	61	63	62	29·51	+1·60
7	71	69	70	32·14	-1·03
8	67	67	67	29·69	1·42
9	70	73	71	30·51	+0·60
10	73	73	73	30·35	0·76
11	76	77	77	30·93	-0·18
12	77	80	78	30·29	0·82
13	83	86	85	31·98	0·87
14	89	87	88	32·41	-1·30
15	88	92	90	31·69	-0·58
16	95	93	94	32·13	-1·02
17	96	97	96	31·81	0·70
18	100	103	102	32·68	-1·57
19	104	102	103	31·97	0·86
20	104	103	104	31·26	-0·15
21	115	108	111	32·38	1·27
	1422	1429	Mean.	... +31·11	...

$\Sigma d = 2851$ log = 45500

log f = 1 03958

log (V_s-V_o) = 1 49458

$V_s - V_o = -31·23$ $r = \pm 0·94$

$V_o = +0·38$

$V_a = -29·41$

$V_d = -0·21$ $V = -1·99$

β GEMINORUM 1500.

SOLAR STANDARD 1519.

Observer }
Measurer } J. S. P.

Region.	d_1	d_2	d	V	v
5	·061	064	·062	30·63	+0·20
6	66	66	66	31·42	−0·59
7	64	64	64	29·38	+1·45
8	61	66	64	28·36	+2·47
9	73	69	71	30·51	+0·32
10	69	70	70	29·10	+1·73
11	77	78	77	30·93	−0·10
12	79	77	78	30·29	+0·54
13	86	78	82	30·85	−0·02
14	91	89	90	32·77	−1·94
15	87	80	84	29·58	+1·25
16	92	88	90	30·76	+0·07
17	100	92	96	31·79	−0·96
18	98	102	100	32·04	−1·21
19	104	106	105	32·59	−1·76
20	106	103	105	31·56	−0·73
21	112	104	108	31·50	−0·67
	1426	1396	Mean...	.....30·83	....

$\Sigma d = 2822$

log = ·45056
log f = 1·03958
log (Vs—Vo) = 1·49014

$r = \pm\ 0{\cdot}81$

Vs—Vo = + 30·91
Vo = + 0·41
Va = − 29·14
Vd = − 0·15

V = + 2·03

β GEMINORUM 1502

Observer } J. S. P.
Measurer }

Region.	d_1	d_2	d	V	v
3	059	·065	·062	29·21	+1·98
4	69	62	65	29·93	+1·26
5	65	65	65	29·24	+1·95
6	64	70	67	29·44	+1·75
7	67	68	68	29·20	+1·99
8	73	71	72	30·17	+1·02
9	82	76	79	32·36	−1·17
10	83	81	82	32·82	−1·63
11	79	80	80	31·30	−0·13
12	85	90	87	33 29	2·10
13	89	87	88	33·00	−1·81
14	80	86	83	30·44	+0·75
15	88	88	88	31·59	−0·40
16	90	85	88	30·91	+0·28
17	89	91	90	31·02	+0·17
18	89	91	90	30·33	+0·86
19	99	100	99	32·68	−1·49
20	100	100	100	32·34	−1·15
21	98	100	99	31·31	−0·12
22	108	102	105	32·32	−1·13
23	101	93	97	29·42	+1·77
24	108	114	111	33 00	−1·81
25	110	113	111	32·22	−1·03
	1975	1978	Mean......	+31·19	

Σd = 3953

log = ·59693
log f = ·89871
log (Vs − Vo) = 1·49564

Vs − Vo = + 31·31
Vo = + 0·33
Va = − 29·09
Vd = − 0·12

$r = \pm 0·93$

V = + 2·43

β GEMINORUM 1527.

SOLAR STANDARD 1520.

Observer } J. S. P.
Measurer }

Region.	d_1	d_2	d	V	v
5	047	053	050	24 70	+2·16
6	51	52	52	24·75	+2·11
7	55	58	56	25·71	+1·15
8	62	61	62	27·48	0·62
9	58	64	61	26·21	0·65
10	60	64	62	25 77	+1·09
11	69	65	67	26·91	0·05
12	66	72	69	26·79	0·07
13	74	73	73	27 46	−0·60
14	75	79	77	28 04	1 18
15	83	74	79	27 82	−0·96
16	85	82	83	28 37	−1·51
17	86	82	84	27·81	−0·95
18	87	79	83	26·59	−0·27
19	93	90	91	28·25	1·39
20	90	90	90	27·05	0·19
	1141	1138	Mean ..	.... +26·86	....

Σd = 2279

log = ·35774
log f = 1·07349
log (V_s-V_o) = 1·43123

V_s-V_o = + 26 99
V_o = − 0 38
V_a = 24·85
V_d = − 0·24

r = ± 0·77

V = − 2 37

SUMMARY OF COMPARATOR MEASURES OF β GEMINORUM 1373.

Solar Standard.	No. of Regions.	Velocity.	Residual O − C.	Probable error of Single Region.
1360	25	+2 93	−0·21	±1·10
1461	25	+3 02	0·31	0·71
1461	23	+2·23	+0·49	0·81
1462	22	+2·85	−0 13	0·81
1462	25	+3·03	0·31	0·77
1462	23	+3·18	0·46	0·79
1462 ...	26	+2·50	+0·22	0·63
1462	23	+2·52	+0·20	0·74
1465	23	+2·31	+0·41	1·02
1468 ..	23	+2·30	+0·42	0·80
1517	22	+2·51	+0·21	0·79
1519 ..	17	+3·05	−0·33	0·72
1520	17	+3·29	−0·57	0·65
1524	17	+2·41	+0·31	0·84

Mean velocity + 2 72. Mean P. E. ± 0·80.

Probable error of single measure = ± 0·24km.
Probable error of mean velocity = ± 0·065km.

SUMMARY OF MEASURES OF 11 PLATES OF β GEMINORUM.

Plate No.	No. of Regions.	Velocity.	Residual.	Probable error of Single Region.
1306	23	+1·84	+0·37	±0·63
1373		2·72	−0·51	0·80
1417	23	1·41	+0·80	0·68
1424	23	1·58	+0·63	0·88
1443	23	3·03	−0·82	0·84
1452	23	1·70	+0·51	0·74
1460	23	3·19	−0·98	1·14
1472	17	1·99	+0·22	0·94
1500	17	2·03	+0·18	0·81
1502	23	2·43	−0·22	0·93
1527	16	2·37	−0·16	0·77

Mean velocity + 2 21. Mean P. E. ± 0·83.

Probable error of plate = ± 0·40.
Probable error of mean = ± 0·12.

As the summaries and probable errors above show, the error of setting on a single region is on the average in the several measures of the plate No. 1373 ± 0·80km., and only slightly greater ± 0·83 for the other plates. Hartmann obtained a probable error of ± 0·67km., somewhat smaller than above. The difference may be due partly to his greater skill and experience in measurement and partly possibly to better quality of spectra. If a better spectrum than 1373 had been selected and it were measured with the best of the fundamental spectra, I have no doubt the probable error would be considerably diminished.

The measures of the 11 plates of β Geminorum give an indication of the systematic discrepancies to be expected in the production of the spectra, although some allowance should be made for accidental errors of measurement. A total range of nearly 1·8km. is shown and the probable error of a plate is ± 0·40km. These plates were made under average conditions, no special care being taken, and the plates are of average quality only. A systematic difference between these measures and other determinations by the old method of measurement at this, and other observatories of slightly over a kilometre + 3·5km. with micrometer microscope, + 2·2km. with comparator is present. These plates have only been measured by the comparator, and hence it cannot be determined yet whether this difference is in the plates or in the method of measurement, but the latter seems the more probable. It is interesting to note in this connection that there is a gradual and systematic increase in the velocity of the different regions from the red to the violet in all the star plates measured, but no explanation of the cause of this discrepancy can be offered. It is unquestionable that if this were removed the probable error of a single region would be materially reduced. Finally, it is probable that, as more experience is gained with the instrument, the accuracy of the measures will be considerably increased.

THE COELOSTAT TELESCOPE.

Although the optical and mechanical parts of this instrument have been ready for nearly two years, the shelter and connecting passage and tunnel were not finally completed until about July, 1908, and it was not possible to make any use of the installation until some time after that date. The spectrograph, which is described by Dr. DeLury in Appendix C, was erected and adjusted as soon as possible, but owing to the inferior quality of the grating, the work has been much handicapped.

The telescope itself performs admirably and as it has not yet been described, it seems desirable to mention here its principal features.

Essentially the optical parts of the installation consist of the coelostat mirror, which reflects the sun's light in a southerly direction to a secondary plane mirror, which in turn reflects the beam north to a concave mirror forming a solar image 80 feet south in the basement of the observatory building.

A general view of the coelostat and secondary mirror, and of the shelters and connecting passages for the beam is given in Fig. 13. The coelostat and secondary mirror are covered by a house on wheels, which can be easily rolled back (and is thus shown in the figure) by a convenient mechanism over the louvred passageway which contains the concave mirror. Between the latter and the basement of the Observatory is another ventilated passage and a tunnel. The house and passages are constructed of wood, covered with galvanized iron painted white, and all very thoroughly ventilated by galvanized iron louvres to prevent as far as possible temperature stratification or disturbance in the course of the beam. It would have been preferable to continue the ventilated passage along the whole course of the beam from the coelostat to the Observatory wall, but this was not possible on account of the necessity of a driveway. This difficulty was overcome by making a tunnel for the last 20 feet, or so, through which the beam passes to the focus. As the latter is usually five feet or so outside the wall, this leaves an unventilated distance of about 15 feet, which apparently has no very serious effect on the definition.

A general view of the telescope looking north is given in Fig. 14, and another view looking south towards the Observatory in Fig. 15. The coelostat has a plane mirror 20 inches in diameter which rotates on an axis, in or parallel to its plane, which is parallel to the axis of the earth and driven by clockwork at half the diurnal rate. The whole instrument is moved bodily east and west by the sheave and cable, shown in the figures, on cast-iron ways resting on a cement pier. The purpose of this movement is to enable the coelostat mirror to receive the sun light more nearly normally by placing it towards the west in the morning and the east in the afternoon. The ways are long enough to permit of sufficient movement to prevent any interception of the return beam from the concave, which passes under the secondary mirror.

The beam of sunlight from the coelostat mirror is reflected in a constant direction so long as the declination remains the same, but evidently any change in the declination of the incident light entails a similar change in the direction of the reflected light, and it is necessary to have a movable secondary mirror to receive this beam and direct it towards the image forming concave. This change of direction of the reflected beam, due to the change of declination of the sun, is provided for by attaching the mirror to a carriage rolling on ways in a north and south direction, the mechanism for changing the position of the secondary being identical with that used for moving the coelostat and the concave mirror, and being well shown in the figures. During the winter when the sun is low in the sky, the secondary has to be brought close to the coelostat, and in the summer away from it. The secondary mirror, also of 20 inches diameter, can be quickly adjusted in inclination by quick and slow motions so as to send the beam directly to the concave mirror.

The latter of 18 inches diameter and 80 feet focus is movable in the north and south direction over ways about 20 feet long, in order to be able to vary the position of the image for different purposes. It is also adjustable vertically and has slow motions provided for moving around a vertical and horizontal axis in order to place any desired part of the image, say, on the slit of the spectroscope or in any other required position. The beam of light from this mirror passes directly under the secondary mirror through the opening in its support, and is inclined downward $3\frac{1}{2}°$, the same inclination being given to the ways on which the concave mirror carriage moves. This inclination was adopted in order to enable the coelostat to be raised a little above

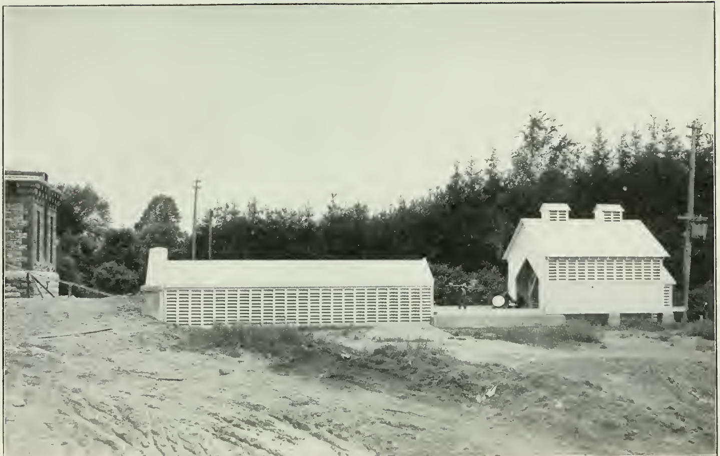


FIG. 13—Cœlostat House.

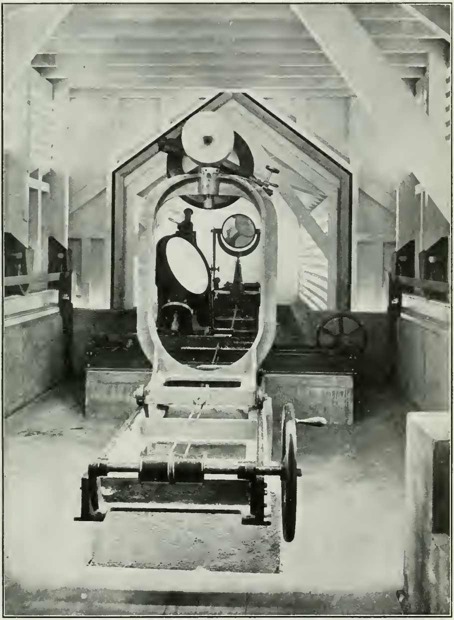


FIG. 14—Cœlostat Telescope Mechanism, looking north.

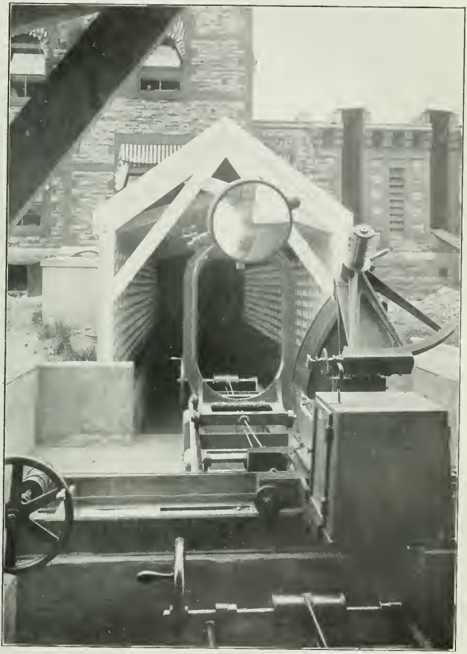


FIG. 15—Cœlostat Telescope Mechanism, looking south.

the surface of the ground, and to keep the beam some distance away from the roof of the tunnel.

The coelostat was made by the J. A. Brashear Co., in 1905, for eclipse purposes, and the secondary and concave mirrors in 1907. The designs and drawings for the remainder of the mechanical parts were made by myself, while the mechanism was constructed by the Victoria Foundry. It was found necessary, owing to the vibration of the secondary mirror support and carriage by the wind, to design one of a heavier pattern, which has been constructed by the same firm since the photographs were made, and entirely overcomes the difficulty.

The definition given by this equipment is much better than was expected from the somewhat unfavourable conditions, such as the low position of the coelostat, and the presence of the unventilated tunnel through which the beam passes. Its location north of the Observatory is also objectionable on account of radiation or convection from the building, affecting the beam between coelostat and sun. However, as the position of the installation was the only one available, we were forced to make the best of these adverse conditions and as the result shows successfully. In the early morning and the late afternoon when the mirrors are in their normal condition the definition is very good, but this is soon deteriorated by the irregular figure produced by the heating action of the sun on the mirrors. However, by keeping them shielded from the sun's rays except during actual use, this causes no especial difficulty in solar rotation work.

RADIAL VELOCITIES.

The work of determining the radial velocities of stars has been actively carried on during the last year, the addition to the staff enabling a considerable increase in the number of measurements made, and in the amount of computational work accomplished. So far as observing is concerned, however, the weather has not been as good as in the previous year. In April and May there were considerably fewer observing nights, many of them also being rendered practically useless by haze. June, July and August were good, but they were followed by three months in which very few useful spectra were obtained owing to continuous dense smoke at first and afterwards to cloudy weather. The remainder of the year has been of about average quality. There have been photographed in the year, 1,010 spectra, 18 sun for use with the spectrocomparator and 992 star spectra on 160 nights. Of these 218 have been made with the three-prism, 698 with the one-prism and 94 with the new one-prism spectrograph.

Of these spectra, 775 have been measured and reduced. Probably a number of spectra made previous to April 1, 1908, have also been measured during the past year, but we have no record of the exact number.

Detailed measures, which in this report have all been collected together at the end (Appendix E), have been made of 635 plates, of which 581 are used in obtaining the orbits of the five binary stars discussed below. The other 54 are measures of two stars whose orbits are not yet completed. The remaining 138 plates measured are chiefly of spectroscopic binaries under investigation, but they also include a number of plates of some early type stars not known to be binaries.

The five binaries discussed below with the number of plates used for each are:—

Star.	Right Ascension		Declination.		No. of Plates.
	h.	m.			
β Orionis	5	10	− 8°	19′	273
θ Aquilæ	20	06·2	− 1	7	54, + 43 in 1908
α Coronæ Borealis	15	30·4	+27	3	103
ε Herculis	16	56·5	+31	4	106
η Boötes	13	49·9	+18	54	45

The 34 measures of δ Aquilæ which follow are given for the reason that there seems little prospect of obtaining an orbit and little use, owing to the uncertainty of the results and the small range in velocity, in carrying the work on this star any further.

The binaries under observation here at present are given in the following table. In two of these stars τ Tauri, B.D. – 1° 1004, and ν Orionis, the work is well advanced, but on many of the others not much has yet been done:—

BINARIES UNDER OBSERVATION.

—	R.A.	Declination.	Mag.	Type.
	h. m.	° ′		
φ Persei	1 37	+ 50 11	4·3	I a 2
τ Tauri	4 36	+ 22 36	4·2	I b
ζ Camelopardalis	4 49·3	+ 53 35	4·7	VII a
B. D. – 1° 1004	5 36	– 1 11	5·1	I b
ν Orionis	6 1·8	+ 14 47	4·6	IV a.b
γ Geminorum	6 31·9	+ 16 9	2·9	VIII a
ω Ursæ Majoris	10 48·2	+ 43 43	4·7	I a 2
93 Leonis	11 43	+ 20 46	4·8	XII
γ Corvi	12 11	– 16 59	3·3	VI a
δ Herculis	17 11	+ 24 57	3·7	VII b
B.A.C. – 5890	17 21·3	– 5 0	4·8	XII
α Ophiuchi	17 30	+ 12 37	2·9	XIII b
γ Aquarii	22 16	– 1 53	4·1	VII a

The majority of these stars have, as will be noticed, early type spectra and in many of them the lines are very diffuse; consequently many plates are required before a satisfactory orbit can be obtained, an example of this being given in the preceding table of the binaries completed, where the average number of plates used is well over 100.

In the measures of stars not known to be binaries, those that were observed having in every case spectra of the hydrogen or helium type generally with diffuse lines, the following four stars were discovered to be variable in their velocity:—

NEW SPECTROSCOPIC BINARIES.

Star.	R. A.	Declination.	Mag.	Type.
	h. m.			
δ Herculis	17 11	+ 24 57	3·7	VII b
γ Aquarii	22 16·5	– 1 53	4·1	VII a
ι Andromedæ	23 33·2	+ 42 43	4·4	A
ξ Persei	3 52·4	+ 35 30	4·4	I b

In addition to the above, β Orionis is definitely announced as of binary character, but as it is more fully discussed later, nothing more need be said about it here.

δ *Herculis.*

Practically the only lines measurable in this spectrum are the hydrogen series, and these are very diffuse and difficult to measure. Consequently, the measures are subject to much uncertainty, and it was only after several plates had been obtained that its binary character was established. The velocities are as follows:—

Plate Number.	Date.	Velocity.	Plate Number.	Date.	Velocity.
	1907.			1908.	
839	June 12·79	− 27	1404	March 16·93	− 44
894	" 27·74	− 9	1480	April 13·83	− 73
929	July 9·66	− 35	1495	" 15·89	− 47
	1908.		1512	" 22·89	− 57
			1532	May 15·85	47
			1541	" 18·81	18
1392	March 8·89	− 59			

The variability in its velocity was discovered by Mr. Harper.

γ Aquarii.

This star is of the hydrogen type, having *Mg.* 4481, *Fe* 4549, *Ca* 3934, in addition to the hydrogen lines, and the measures are consequently much more reliable than the previous star. They are:

Plate Number.	Date.	Velocity.	Plate Number.	Date.	Velocity.
	1908.			1908.	
1745	July 29·86	− 18	1790	August 17·81	− 40
1770	August 5·81	− 8	1847	" 28·70	− 7
1779	" 7·81	+ 3	1858	" 31·77	+ 23

Its variability was discovered by Mr. Cannon.

ι Andromedæ.

The spectrum of this star is similar to that of γ Aquarii, having the hydrogen *Mg.* 4481, and *K* lines, although possibly not so well defined. Its variability was discovered by Mr. Cannon, and it was announced in the Journal of the Royal Astronomical Society of Canada, Vol. II., No. 5. I learned afterwards that it had been informally announced by Prof. Frost at the Put-in-Bay meeting of the Astronomical and Astrophysical Society of America. Although present at the meeting, I had taken no notes and had forgotten its announcement. The discovery here was consequently entirely independent. The velocities of all the plates measured here are given:

Plate Number.	Date.	Velocity.	Plate Number.	Date.	Velocity.
	1908.			1908.	
1772	August 5·87	6	1954	November 9·58	0
1781	" 7·87	− 11	1963	" 13·60	+ 14
1832	" 26·87	+ 12	1969	" 16·69	+ 29
1922	October 9·76	− 36	1971	" 20·59	− 13
1928	" 12·71	14	1977	" 21·53	+ 7
1939	" 19·63	6	1995	December 2·55	+ 1

ξ *Persei.*

The spectrum of this star is of the helium type, and is principally characterized by the extreme breadth and diffuseness of the lines. Frost and Adams, in 1903, published the measures of some plates which agreed well within errors of observation in giving it a positive velocity of 85km. per second. They surmised that later plates might show the velocity to be variable. Consequently, I thought it desirable to obtain a few plates here, and their measures by Mr. Cannon soon showed that the star was a binary. I have since learned personally from Prof. Frost that this had been a long time established by them. The following are all the velocities measured here:—

Plate Number.	Date. G. M. T.	Velocity.	Plate Number.	Date. G. M. T.	Velocity.
	1908.			1908.	
1946	October 30·37	+ 120	1974	November 20·83	− 45
1953	November 6·66	+ 143	1998	December 2·69	− 32
1958	" 9·77	− 54	1999	" 4·72	− 51
1964	" 13·65	− 2			

δ *Aquilæ.*

Mr. Parker has spent considerable time at work on δ Aquilæ without being able to obtain a period, and it looks as if the small range, combined with the poor quality of the spectrum, will prevent any orbit being determined. Mr. Parker has also been unfortunate in the other binary on which he has been engaged, τ Tauri, which has very bad lines in its spectrum and over which he has spent a great deal of time. He has, however, determined the period as nearly 1·5 days, but it has not been thought desirable to complete the work until further plates are secured next season. Consequently no measures of it will be given in this report, but a summary of the measures and some data concerning δ Aquilæ are given below, while the detailed measures are given in Appendix E.

This star ($\alpha = 19^h\ 20^m.5$, $\delta = 2^\circ\ 55'$) was discovered to be of variable velocity by Campbell and Curtis from observations made at the Lick Observatory in 1900-03.* Observations were begun upon it here in August, 1906, and since then some thirty-four plates have been measured and computed. δ Aquilæ is taken as the typical star in Group XI., according to Miss Maury's classification.† The principal lines in the spectrum are those of hydrogen, iron, magnesium and titanium. All, and especially those of hydrogen, are broad and not defined, the region measured being from $H\beta$ to λ 4005. These will be found in Table I. The range of resulting radial velocities, as seen in Table II. is not large (− 15 to − 47kms.), and, as yet the period cannot be determined from the curve of the present observations.

* L.O.B., 1903, A. J. XVIII., 306.

† Annals Harvard College Observatory, Vol. 28.

TABLE I.

Principal lines measured in δ Aquilæ.

Wave-Length.	Element.	Wave-Length.	Element.
4861·527	H	4274·922	Ti & Cr
4549·766	Fe & Ti	4271·760	Fe
4534·139	Ti	4260·640	Fe
4501·448	Ti	4246·996	Y
4481·400	Mg	4227·010	Fe
4443·976	Ti	4216·351	Fe
4404·927	Fe	4198·494	Fe
4395·286	Ti, V, Zy.	4143·928	Fe
4374·905	Ti	4102·000	H
4340·634	H	4071·901	Fe
4325·939	Fe	4063·756	Fe
4320·992	Sc	4045·975	Fe
4282·722	Fe	4005·429	Fe

TABLE II.

Table of Observations of δ Aquilæ.

Plate.	Date, G. M. T.	Velocity.
368	1906, August, 6·73	−41·8 kms.
377	" 15·65	45·2
382	" 24·65	45·1
390	Sept. 10·64	25·0
399	" 27·61	29·0
413	Oct. 23 57	37·7
803	1907, May, 31·79	29·9
818	June, 10·80	42·8
904	July, 2·76	19·5
923	" 8 75	28·0
930	" 9·68	15·6
938	" 10·68	18·5
966	" 25·68	16·5
980	Aug. 3·61	25·7
982	" 5·68	29·4
1034	Sept. 6·65	25·4
1049 (a)	" 18·58	25·9
1049 (b)	" 18·58	28·0
1543	1908, May, 18·83	21·9
1550	" 22·85	40·1
1575	June, 3·83	28·2
1575	" 3·83	31·6
1584	" 5·85	35·5
1633	" 24·77	29·5
1642	" 26·78	39·8
1650	" 27·75	40·9
1660	July, 3·77	21·9
1678	" 8·75	36·4
1690	" 10·77	26·1
1695	" 11·77	34·6
1703	" 13·78	47·0
1753	" 31·69	30·7
1754	" 31·72	39·1
1768	August, 5·75	29·7
1783	" 15 73	31·9
1837	" 27·62	−39·5

THE ORBIT OF β ORIONIS.

As was mentioned in my report of last year, under a description and discussion of the effect of slit-width on the errors of setting, this star showed such a difference in the mean velocities obtained on two nights (mean of 10 plates on March 20, 24·9km.; mean of 12 plates on March 24, 20·6km.) as to lead to a strong suspicion of the variability of its velocity. This suspicion was strengthened by plates obtained on other nights up to April 13, 1908, and it was decided on account of its brightness and its interesting history to follow it closely as soon as it again came into position where it could be observed.

The radial velocity of β Orionis was first determined at Potsdam by Vogel and Scheiner* in the years 1888-1891, in the beginning of photographic determinations of radial velocity. From their measures of the 14 plates, velocities varying between about + 3 and + 34kms. per second were obtained. They suspected a variation in the star's velocity due to orbital motion, but were unable to obtain evidence of its periodicity, and the accuracy of these early measures was scarcely sufficiently high to decide the question. The next published measures of the star's velocity were by Frost and Adams† from plates obtained in 1901-1902. They found values ranging between + 14·9 and + 23·4km., but they attributed this range to the character of the lines in the star's spectrum and concluded that their results showed no indication of variability in velocity. The measures of 5 plates of β Orionis obtained at the Lick Observatory‡ indicate a range of 10km. from + 15 to + 25km., in its velocity, but Campbell and Curtis in discussing these measures attribute this range to the small number of lines available, to their poor quality, and to over-exposure of some of the negatives. They consider that proper exposure would considerably reduce the observed range, and conclude that their results do not give any evidence of variability of velocity. However, a recent personal communication from Prof. Campbell informs me that they have suspected variation, but owing to press of their regular programme have not followed up the matter.

There seemed to be no question of the smallness of the range in velocity, if any, and it was evident that the only hope of obtaining anything definite, considering this and the fairly large accidental errors of a velocity determination owing to the character of the lines of the spectrum, was to obtain several plates on each night the star was observed and use their mean velocity as the velocity of the star at their mean epoch. As the star is bright, a spectrum can be obtained in ten minutes or less with the three-prism spectrograph, and in about two minutes with the one-prism. Consequently not much time is required to obtain half a dozen plates and unless the period is very short no error due to change of phase can enter. The probable error of a night's observation will by this means be considerably reduced and a much better chance obtained of determining its period of variation.

Plates were accordingly obtained whenever possible until the star became inaccessible in April, 1908, and observations were continued during the present season until March 23, 1909. Owing to the very smoky and cloudy weather last fall, very few plates were obtained until December. In all 273 plates, obtained on 54 nights, have been used in this discussion. Of these 150 were made with a dispersion of three prisms, 123 with one prism. The investigation on slit-width in the last report showed that lower probable errors were obtained with the higher dispersion and it was used wherever possible. However, the star was also observed with the one-prism spectrograph when our programme would not permit the use of three prisms. Three-fourths of the observations and all the measurements were made by myself in order to avoid as far as possible any chance of systematic discrepancies.

*Potsdam Publications, Band VII., p. 146.
† Publications of the Yerkes Observatory, 2, 61.
‡ Lick Observatory Bulletin No. 70.

The star β Orionis is of the helium type, Miss Maury's VI.c, and has fairly well defined lines of hydrogen and helium, the magnesium λ 4481 and the calcium *H* and *K*. It also contains lines due to silicon, oxygen and carbon and a few faint metallic lines. In my early measures for slit-width effect eight lines were measured in the three-prism plates and seven in the single-prism plates.

Lines measured in β Orionis.

Three-Prism Plates.	One-Prism Plates.
4862 *H*	4862 *H*
4481 *Mg*	4481 *Mg*
4472 *He*	4472 *He*
4388 *He*	4341 *H*
4341 *H*	4102 *H*
4131 *Si*	4026 *He*
4128 *Si*	3934 *Ca*
4102 *H*	

It was found, however, that lower probable errors were obtained where the three best lines λ 4481, 4472, 4341 only were used than when more or all of the measured lines were discussed. Consequently in the later plates only the three lines mentioned above have been measured and in general four comparison lines, thus considerably lightening the labour. Considerable difference in the quality of the negatives for measurement, even when taken under, so far as could be judged, identical conditions, has been noticed; this difference seems to lie principally in the character of the lines themselves. They are sometimes sharply defined and symmetrical, at others not so sharp and apparently stronger at one side. Sometimes also the contrast between them and the continuous spectrum appears considerably diminished. These changes seem almost too marked to be due entirely to instrumental or photographic effects, and one would be inclined to attribute part at any rate to changes in the spectrum. No evidence can be found, however, of any dependence of this quality of the lines upon the phase of the orbit.

In the measurements the lines were weighted according to their apparent quality and the weighted mean velocity used. In combining the separate plates on each night they were also weighted, partly according to their quality and partly according to the internal agreement of the measures, and finally the resultant mean velocity for the night was similarly weighted for use in the grouping and discussion.

The record of the observations and the individual plate measures are given in Appendix E, where all the measures are collected together, while a summary of the velocities, &c., is given in the following table:—

β ORIONIS.

SUMMARY OF MEASURES.

Plate Number.	Date.		G.M.T.	Julian Date.	Velocity.	Residual.
	1908.					
1241 a	January	20	15·02	2,417,961·63	+23·3	+ 2·4
1241 b	″	20	15·06	961·63	+20·9	0·0
1241 c	″	20	15·10	961·63	+25·4	+ 4·5
1242 a	″	20	15·12	961·63	+23·7	+ 2·8
1242 b	″	20	15·15	961·64	+25·9	+ 5.0
1242 c	″	20	15·18	961·64	+19·7	− 1·2
1243 a	″	20	15·24	961·64	+21·3	+ 0·4
1243 b	″	20	15·27	961·65	+23·5	+ 2·6
1243 c	″	20	15·30	961·65	+24·8	+ 3·9
1244 a	″	20	15·43	961·66	+24·5	+ 3·6
1244 b	″	20	15·47	961·66	+16·5	− 4·4
1244 c	″	20	15·50	961·66	+26·4	+ 5·5
1245 a	″	20	15·52	961·66	+25·0	+ 4·1
1245 b	″	20	15·54	961·66	+21·8	+ 0·9
1245 c	″	20	15·56	961·66	+20·5	− 0·4
1247 a	″	20	16·15	961·68	+23·8	+ 2·9
1247 b	″	20	16·17	961·68	+31·3	+10·4
1247 c	″	20	16·19	961·68	+19·0	− 1·9
1248 a	″	20	16·25	961·68	+11·6	− 9·3
1248 b	″	20	16·27	961·68	+ 5·8	−15·1
1248 c	″	20	16·29	961·68	+36·1	+15·2
1249 a	″	20	16·35	961·69	+14·0	− 6·9
1249 b	″	20	16·37	961·69	+16·0	− 4·9
1249 c	″	20	16·39	961·69	+24·2	+ 3·3
1285 a	″	27	15·45	968·68	+15·3	− 5·8
1285 b	″	27	15·51	968·66	+19·2	− 1·9
1285 c	″	27	15·57	968·67	+17·9	− 3·2
1286 a	″	27	16·03	968·67	+21·3	+ 0·2
1286 b	″	27	16·09	968·67	+18·7	− 2·4
1286 c	″	27	16·15	968·67	+24·3	+ 3·2
1289 a	″	27	17·13	968·72	+18·1	− 3·0
1289 b	″	27	17·17	968·72	−19·9	− 2·3
1289 c	″	27	17·21	968·72	+27·8	+ 6·6
1290 a	″	27	17·24	968·73	+15·6	− 5·6
1290 b	″	27	17·28	968·73	+21·6	+ 0·4
1290 c	″	27	17·32	968·73	+16·1	− 5·1
1405.	March	20	11·51	2.418,021·50	+23·1	− 1·4
1406.	″	20	12·07	021·50	+24·3	− 0·2
1407.	″	20	12·21	021·51	+21·4	− 3·1
1408.	″	20	12·32	021·52	+24·9	− 0·4
1409.	″	20	12·46	021·53	+28·0	− 3·5
1410.	″	20	13·00	021·54	+23·3	− 1·2
1411.	″	20	13·12	021·55	+23·5	− 1·0
1412.	″	20	13·27	021·56	+24·9	+ 0·4
1413.	″	20	13·47	021·57	+27·5	+ 3·0
1414.	″	20	13·57	021·58	+26·9	+ 2·4
1426.	″	24	12·03	025·50	+19·2	− 2·9
1427.	″	24	12·15	025·51	+21·1	− 1·0
1428.	″	24	12·23	025·52	+19·2	− 2·9
1429.	″	24	12·36	025·52	+21·6	− 0·5
1430.	″	24	12·42	025·53	+18·8	− 3·3
1431.	″	24	12·52	025·53	+18·6	− 3·5
1433.	″	24	13·16	025·55	+17·5	− 4·6
1434.	″	24	13·32	025·56	+19·3	− 2·8
1435.	″	24	13·39	025·57	+16·1	− 6·0
1436.	″	24	13·46	025·57	+17·2	− 4·9
1437.	″	24	13·56	025·58	+18·7	− 3·4
1438.	″	24	14·07	025·58	+18·0	− 4·1
1439.	″	30	12·19	031·51	+14·4	− 4·1
1440.	″	30	12·29	031·52	+14·4	− 4·1
1441.	″	30	12·38	031·53	+14·5	− 4·0
1442.	″	30	12·49	031·53	+17·0	− 1·5
1448.	April	3	12·16	035·51	+24·9	+ 1·5
1449.	″	3	12·28	035·52	+27·9	+ 4·5
1450.	″	3	12·40	035·53	+32·2	+ 8·7
1451	″	3	12·53	035·53	+27·1	+ 3·6

β ORIONIS.

SUMMARY OF MEASURES—*Continued.*

Plate Number.	Date.	G.M.T.	Julian Date.	Velocity.	Residual.
	1908.				
1457	April 4	12·19	2,418,036 51	+29·9	+ 5·0
1458	" 4	12·28	036·52	+27·4	+ 2 5
1459	" 4	12·37	036·53	+27·0	+ 2·1
1469	" 13	12·10	045·51	+21·3	− 2·0
1470	" 13	12·22	045·52	+25·0	+ 1·7
1471	" 13	12·34	045·52	+24·8	+ 1·5
1873	September 7	21·52	192·92	+28·2	+ 2·2
1874	" 7	22·10	192·93	+27·1	+ 1·1
1935	October 13	21·19	228·90	+18·3	− 0·2
1936	" 13	21·48	228·91	+17·0	− 1·5
1937	" 13	22·19	228·93	+17·5	− 1·0
1938	" 13	22·47	228·95	+14·3	− 4·2
1978	November 21	18 24	267 77	+17·0	− 4·2
1979	" 21	18 43	267·78	+17·3	− 3·9
1980	" 21	19·05	267·79	+24·5	+ 3·3
1981	" 21	19·33	267·81	+25·0	+ 3·8
1984	" 28	16·05	274·67	+21·0	+ 0·9
1985	" 28	16·34	274·69	+22·7	+ 2·6
1986	" 28	17·08	274·71	+20·5	+ 0·4
1987	December 1	17·53	277·75	+16·4	− 8·9
1988	" 1	18·18	277·76	+20·9	− 4·4
1989	" 1	18·36	277·77	+16·1	− 9 2
1990	" 1	18·52	277·78	+23 1	− 2·2
2003	" 5	16·10	281·67	+22·6	− 3·1
2004	" 5	16·22	281·68	+25·1	− 0·6
2005	" 5	16·38	281·69	+25·6	− 0·1
2006	" 5	16·53	281 70	+27·5	+ 0·8
2054	" 21	15·24	297·64	+21·5	− 0 6
2055	" 21	15·29	297·65	+21·9	− 0·2
2057	" 21	16·54	297·70	+25·7	+ 3·6
2058	" 21	17·00	297·71	+22·0	− 0·1
2065	" 22	17·38	298 73	+28 1	+ 4·0
2066	" 22	17·52	298 74	+21·7	− 2·4
2067	" 22	18·02	298·75	+23·1	− 1 0
2068	" 22	18 14	298 76	+23 2	− 0·9
2070	" 23	14 01	2 9·58	+20·9	− 4·3
2071	" 23	14·41	299·61	+26·8	+ 1·6
2072	" 23	15·08	299·63	+23·5	− 1 7
2073	" 23	15·20	299·64	+21·2	− 4 0
2075	" 26	15·50	302·66	+25·6	− 0 4
2076	" 26	16·00	302·67	+25·9	− 0 1
2077	" 26	16·09	302·67	+22·5	− 3·5
2078	" 26	16·18	302·68	+22 0	− 4 0
2079	" 27	14·07	303·59	+33·2	+ 7·6
2080	" 27	15·12	303·64	+29·7	+ 4·1
2082	" 31	15·19	307 64	+22·7	− 1·0
2083	" 31	15·23	307·64	+24 7	+ 1·0
2084	" 31	15·29	307·65	+23·0	− 0·7
2085	" 31	15·57	307·67	+20·5	+ 2·8
	1909.				
2092	January 6	16·49	2,418,313·70	+19 1	− 0·7
2093	" 6	16·53	313 70	+19·6	− 0 2
2094	" 6	17·13	313·72	+18·5	− 1·3
2095	" 6	17·16	313·72	+21·2	+ 1·4
2105	" 7	12·49	314·53	+16·8	− 2 4
2106	" 7	13 01	314·54	+21·9	+ 2·7
2107	" 7	13·04	314·54	+12 8	− 7 1
2108	" 7	13·07	314·54	+20·7	+ 1·5
2111	" 7	16·27	314 69	+19·2	0·0
2112	" 7	16·37	314 69	+16 6	− 2·6
2114	" 7	16·56	314·71	+17·8	− 1·4
2117	" 8	15·48	315·66	+18·9	+ 0·2
2118	" 8	15·52	315·66	+20·3	+ 1 6
2122	" 12	11·55	319·50	+26·5	+ 4 5
2123	" 12	11·59	319·50	+26 0	+ 4·0

β ORIONIS.

SUMMARY OF MEASURES—*Continued.*

Plate Number.	Date.	G.M.T.	Julian Date.	Velocity.	Residual.
	1909.				
2124	January 12	12·09	2,418,319·51	+20·5	− 1·5
2125	" 12	12·12	319·51	+21·3	− 0·7
2126	" 12	12·15	319·51	+27·2	+ 5·0
2127	" 12	12·18	319·51	+25·5	+ 3·5
2128	" 13	15·36	320·65	+30·2	+ 6·1
2129	" 13	15·41	320·65	+15·7	− 8·4
2130	" 13	15·46	320·66	+28·8	+ 4·7
2141	" 15	14·54	322·62	+18·6	+ 7·3
2142	" 15	15·11	322·63	+24·5	− 1·4
2143	" 15	15·15	322·63	+27·2	+ 1·3
2144	" 15	15·19	322·64	+21·8	− 4·1
2151	" 16	12·25	323·52	+31·4	+ 5·3
2152	" 16	12·36	323·52	+27·6	+ 1·5
2153	" 16	12·44	323·53	+34·4	+ 8·3
2154	" 16	12·52	323·53	+40·9	+14·8
2155	" 16	12·59	323·54	+33·0	+ 6·9
2156	" 16	13·12	323·55	+35·8	+ 9·7
2157	" 17	13·48	324·57	+29·9	+ 3·9
2158	" 17	13·56	324·58	+26·2	+ 0·2
2161	" 18	12·41	325·53	+37·1	+11·5
2162	" 18	12·46	325·53	+31·3	+ 5·7
2163	" 18	12·51	325·53	+28·3	+ 2·7
2164	" 18	13·06	325·54	+35·8	+10·2
2165	" 18	13·10	325·55	+31·2	+ 5·6
2166	" 18	13·14	325·55	+30·5	+ 4·9
2177	" 26	10·36	333·44	+24·6	+ 3·4
2178	" 26	10·51	333·45	+17·8	− 3·4
2179	" 26	10·56	333·46	+24·9	+ 3·7
2180	" 26	11·01	333·46	+23·5	+ 2·3
2181	" 26	11·11	333·47	+22·4	+ 1·2
2182	" 26	11·16	333·47	+16·2	− 5·0
2183	" 26	11·21	333·47	+20·5	− 0·7
2184	" 28	11·21	335·47	+16·3	3·6
2185	" 28	11·25	335·48	+22·2	+ 3·3
2186	" 28	11·29	335·48	+14·2	− 5·7
2187	" 28	11·41	335·48	+14·3	− 5·6
2188	" 28	11·44	335·49	+10·6	− 9·3
2189	" 28	11·47	335·49	+18·4	− 0·9
2195	" 29	12·53	336·54	+14·9	− 4·3
2196	" 29	12·57	336·54	+17·9	− 1·3
2197	" 29	13·01	336·54	+26·4	+ 7·2
2198	" 29	13·05	336·54	+22·1	+ 2·9
2201	" 30	12·29	337·52	+14·0	− 4·7
2202	" 30	12·41	337·53	+17·3	− 1·4
2203	" 30	12·45	337·53	+25·0	+ 6·3
2204	" 30	12·48	337·53	+14·2	− 4·5
2205	" 30	15·47	337·66	+21·0	+ 2·3
2206	" 30	16·04	337·67	+22·6	+ 4·1
2207	" 30	16·24	337·68	+22·3	+ 3·8
2211	" 31	17·16	338·72	+19·8	+ 1·2
2212	" 31	17·20	338·72	+23·2	+ 4·6
2213	" 31	17·24	338·73	+16·6	− 2·6
2214	" 31	17·29	338·73	+16·6	− 2·0
2215	February 2	11·14	340·47	+24·8	+ 4·6
2216	" 2	11·23	340·48	+23·1	+ 2·9
2217	" 2	11·26	340·48	+23·6	+ 3·4
2218	" 2	11·29	340·48	+22·5	+ 2·3
2219	" 2	11·41	340·49	+16·5	− 3·7
2220	" 2	11·45	340·49	+21·5	+ 1·3
2236	" 6	12·29	344·52	+18·2	− 7·7
2239	" 6	12·50	344·53	+20·0	− 5·9
2240	" 6	12·52	344·53	+21·0	− 4·9
2241	" 6	16·12	344·68	+21·9	− 4·0
2242	" 6	16·43	344·70	+19·1	− 6·8
2243	" 7	15·11	345·63	+21·0	− 5·1
2244	" 7	15·25	345·64	+21·9	− 4·2

β ORIONIS.

SUMMARY OF MEASURES.—*Continued.*

Plate Number.	Date.	G M.T.	Julian Date.	Velocity.	Residual.
	1909.				
2245	February.. 7	15·37	2,418,345·65	+18·0	− 8·1
2249	" 8	13·32	346·56	+31·6	+ 5·2
2250	" 8	13·36	346·56	+25·9	0·0
2251	" 8	13·41	346·57	+21·8	− 4·1
2252	" 8	14·01	346·58	+17·6	− 8·3
2253	" 8	14 05	346·58	+24·1	− 1·8
2254	" 8	14·09	346.59	+23·3	− 2·6
2265	" 10	12·07	348·50	+29·6	+ 4·4
2266	" 10	12·12	348·51	+23·3	− 1·9
2267	" 10	12·16	318·51	+16·9	− 8·3
2268	" 10	12·21	348·51	+12·8	−12·4
2269	" 10	12 33	348·52	+20·3	− 4·9
2270	" 10	12·37	348·53	+23·0	− 2·2
2272	" 11	11 26	349 48	+18·9	− 5·8
2273	" 11	11·32	349.48	+33·4	+ 8·7
2274	" 11	11·35	349·48	+30·8	+ 6·1
2275	" 11	11·38	349·49	+19·7	− 5·0
2276	" 11	11·46	349·49	+17·3	− 7·4
2277	" 11	11·49	349·49	+23·5	− 1·2
2278	" 13	12·27	351·52	+22·2	− 1·4
2279	" 13	12·49	351·53	+22·0	− 1·6
2280	" 13	12·53	351·54	+21·4	− 2·2
2284	" 20	12·29	358·52	+17·7	− 1·4
2285	" 20	13·05	358·54	+22·6	+ 3·5
2286	" 20	15·12	358·63	+19·8	+ 0·7
2288	" 21	12·51	359·53	+21·0	+ 2·3
2289	" 21	13·07	359 54	+18·2	− 0·5
2290	" 21	13·17	359·55	+18·4	− 0·3
2291	" 21	13·27	359.56	+18·7	0·0
2292	" 22	12·02	360·50	+19·7	+ 1·1
2293	" 22	12·15	360·51	+25·1	+ 6·5
2294	" 22	12·30	360·52	+20·2	+ 1·6
2295	" 22	12·45	360·53	+20·2	+ 1·6
2309	" 27	11·35	365·48	+22·0	− 3·4
2311	" 28	11·56	366·50	+22·2	− 3·8
2312	" 28	12·07	366·50	+22·0	− 4·0
2313	" 28	12·18	366·51	+23·7	− 2·3
2314	" 28	12·27	366·52	+25·3	0·7
2315	" 28	12·39	366·53	+22·4	− 3·6
2316	" 28	12·50	366·53	+22·8	− 3·2
2317	March.... 2	11·05	368·46	+25·9	0·0
2318	" 2	11·19	368·47	+24·4	− 1·5
2319	" 2	11·29	368·48	+24·2	− 1·7
2320	" 3	11·36	368·48	+21·6	− 4·3
2364	" 13	12·12	379·51	+18·6	− 1·1
2365	" 13	12·24	379·52	+18·4	− 1·3
2366	" 13	12·36	379·52	+20·3	+ 0·6
2367	" 13	12·46	379·53	+17·6	− 2·1
2368	" 13	12·57	379·54	+19·3	− 0·4
2372	" 15	11·45	381·49	+16·9	− 1·8
2373	" 15	11·56	381·50	+20 5	+ 1·8
2374	" 15	12·05	381·50	+17·6	− 1·1
2375	" 15	12·13	381·51	+18·9	+ 0·2
2376	" 15	12·21	381·52	+16·2	− 2·5
2386	" 18	11·42	384·49	+19·5	1·1
2387	" 18	11·52	384·50	+20·0	− 0·6
2388	" 18	12·02	384·50	+21·7	+ 1·1
2389	" 18	12·12	384·51	+21·0	+ 0·4
2390	" 20	12·16	386·51	+22·2	− 2·1
2391	" 20	12·26	386·52	+18·3	− 6·0
2392	" 20	12·38	386 53	+23·4	− 0·9
2393	" 20	12·48	386·53	+21·9	2·4
2394	" 20	12·58	386·54	+23·1	− 1·2
2397	" 21	13·38	387·56	+23·9	− 1·6
2398	" 21	13·48	387·57	+25·2	− 0·3
2399	" 21	14·00	387·58	+24 8	− 0·7

β ORIONIS.

SUMMARY OF MEASURES—*Continued.*

Plate Number.	Date.		G.M.T.	Julian Date.	Velocity.	Residual.
	1909.					
2400	March	21	14·14	2,418,387·59	+25·5	0·0
2402	"	22	11·51	388·49	+26·0	0·0
2403	"	22	12·02	388·50	+25·0	− 1·0
2404	"	22	12·13	388·51	+21·1	− 4·9
2405	"	22	12·35	388·52	+21·2	− 4·8
2420	"	23	11·46	389·49	+23·1	− 3·0
2421	"	23	11·57	389·50	+24·4	− 1·7
2422	"	23	12·05	389·50	+25·9	− 0·2
2423	"	23	12·13	389·51	+26·2	+ 0·1
2424	"	23	12·27	389 52	+25·5	− 0 6
2425	"	23	12·38	389·53	+25·7	− 0·4

In the preceding table are given the plate number, the Greenwich mean and Julian dates, the weighted mean velocity for the plate, and finally the residual obtained by scaling from the final velocity curve. The velocities on each night were obtained by taking the weighted means of the plate velocities, the weights being assigned, as before stated, partly on the basis of apparent quality, partly according to the internal agreement of the measures. In the following table of mean velocities are given various data concerning the observations of each night, as the date, Julian date, velocity, phase, the number of plates, the dispersion used, the weight assigned and finally the residual obtained by scaling from the curve:—

β ORIONIS.

SUMMARY OF MEAN VELOCITIES PER NIGHT.

Date.	Julian Date.	Mean Velocity.	Mean Phase.	No. of Plates.	Spectrograph.	Weight.	Residual.
1908.							
Jan. 20....	2,417,961·65	22·3	0·65	24	I L	16	+1·40
" 27 ...	968·71	19·7	7·71	12	III S	6	−1·50
March 20....	2,418.021·54	24·9	16·74	10	III L	10	+0·45
" 24....	025·54	20·6	20·74	12	"	6	−1·47
" 30....	031·52	15·1	4·82	4	"	6	−3·46
April 3 .	035·52	27·3	8·82	4	"	4	+3 87
" 4....	036·52	28·2	9·82	3	"	3	+3·28
" 13....	045·52	24·2	18·82	3	"	3	+0·93
Sept. 7....	192·92	27·1	12·92	2	"	2	+1·10
Oct. 13 ...	228·92	16·8	5·12	4	"	5	−1·76
Nov. 21....	267·79	22·3	0·19	4	"	3	+1·08
" 28....	274 69	21·4	7·09	3	"	2	+1·32
Dec. 1 ...	277·77	20·1	10 17	4	"	1	−5·19
" 5....	281·69	25·9	14·09	4	"	2	−1·36
" 21....	297·68	23·0	8·18	4	I L	2	+0·85
" 22. ..	298·75	24·0	9·25	4	III L	2	−0·10
" 23...	299·63	23·8	10·13	4	"	2	−1·43
" 26....	302 67	24·6	13·17	4	"	3	−1·36
" 27....	303 65	31·4	14·15	2	"	2	+5 77
" 31....	307 65	24·2	18·15	4	I L	2	+0·56
1909.							
Jan. 6....	313·71	19·6	2·31	4	I L	2	−0·20
" 7....	314·62	17·9	3·22	7	I & III	4	−1·34
" 8. ..	315·66	19·6	4·26	2	I L	1	+0·87
" 12...	319·50	24·7	8·10	6	"	3	+2·70
" 13....	320·66	24·9	9·26	3	"	1	+0·77
" 15...	322·62	24·0	11·22	4	"	1	−1·93
" 16 ...	323·53	33·4	12·13	6	"	3	+7·30
" 17....	324·57	28·1	13·17	2	"	1	+2·15
" 18....	325·54	32·4	14·14	6	"	3	+6·78
" 26....	333·47	21·3	0·17	7	"	4	+0·08
" 28 ..	335·49	16·7	2·19	6	"	2	−3·18
" 29. ..	336·54	19·7	3·24	4	"	1	+0·46
" 30 ...	337·61	20 0	4·31	7	I & III	5	+1·28
" 31....	338·72	18·3	5·42	4	I L	2	−0·29
Feb. 2 ...	340 49	21·5	7·19	6	"	4	+1·30
" 6....	344·59	20·7	11·29	5	I & III	3	−5·26
" 7....	345·64	20 0	12·34	3	III L	2	−6·08
" 8. .	346·57	24·7	13·27	6	I L	2	−1·23
" 10....	348 52	21·0	15·22	6	"	1	−4·17
" 11....	349·49	23·9	16·19	6	"	1	−0·83
" 13 ...	351·53	21·9	18·23	3	III L	3	−1·71
" 20....	358·57	19·4	3·37	3	"	2	−0·36
" 21.. .	359·55	19·2	4 35	4	"	3	+0·49
" 22....	360·52	20·0	5·32	4	"	3	+1·43
" 27 ...	365·48	22·0	10·28	1	"	1	−3·38
" 28 ...	366·53	22·8	11·33	6	"	4	−3·18
March 2...	368·47	23·4	13·27	4	"	2	−2·52
" 13...	379·53	18·8	2·43	5	"	5	−0·91
" 15 ...	381·50	18·0	4·40	5	"	3	−0·68
" 18....	384·50	20·55	7·40	4	"	3	−0·04
" 20 ...	386·53	22·2	9·43	5	"	4	−2·15
" 21....	387·57	24·85	10·47	4	"	3	−0·68
" 22...	388·51	23·3	11·41	4	"	2	−2·69
" 23....	389·51	25·1	12 41	6	"	4	−0·97

It was not difficult to trace periodic changes in the velocities thus determined, and comparatively early in the present season the period was found to be very nearly 21·90 days. The Potsdam observations, however, did not group themselves satisfactorily with this period, and owing to their probably inferior accuracy were not considered. The Yerkes observations showed a fairly satisfactory arrangement, although there were some discrepant single plates, due possibly to accidental errors of setting on the rather broad lines of the spectrum, or to another cause to be referred to later on. The Lick observations, extending over seven years, followed the velocity curve determined as closely as could be expected, although as there are only five plates this agreement may be accidental. It was found, however, that a period of 21·87 instead of 21·90 days was required to bring the Lick observations forward to ours.

Although some discrepancies are to be expected on account of the small range in velocity and the relatively high errors of measurement, still it was felt that all the irregularities noted could not be explained on the above grounds. Consequently, although sufficient evidence had been secured of the binary character of β Orionis and sufficient data to obtain the elements of the orbit by the end of January, it was deemed desirable to continue the observations in the hope of finding a clue to some of the anomalies. The later observations revealed some peculiar and interesting features in the star's motion which served, if not to explain the cause of the irregularities, at least to indicate a reason for their existence.

The phase of minimum velocity due January 30-31 followed prediction, but the succeeding maximum, due February 6-7, although present, was of much lower amplitude than those previously obtained. The curve already drawn showed a range of velocity between about + 17 and + 29km. The maximum of February 6 reached only about 23km., and the succeeding minima and maxima until the end of the observations were as follows:— + 19·5, + 23·0; + 18·5, + 24·5; 19·0, + 24·5. All of these values, as well as the previous ones, depend upon several plates, and there is no doubt in my mind that they indicate, if not a change in the amplitude of the velocity curve, certainly some progressive shift in the position of the absorption maximum of the lines measured due to some physical cause in the star's atmosphere. If it is a change in the amplitude of the motion, it may be due to the presence of a third body and will probably be periodic. If an epoch of low amplitude occurred in 1901-1902 this, together with the fact of their only making one plate per night and the consequently higher accidental errors, would form a sufficient explanation why Frost and Adams with the high accuracy of their work were unable to find any periodicity in the motion. Furthermore, a change in the amplitude is probably accompanied by changes in the other elements of the orbit, which may account for the slight change in the period requisite when the Lick observations are brought up to the same epoch as those at Ottawa.

If all the Ottawa observations are plotted continuously on cross-section paper, they form a curve somewhat similar to the trace given by two beating tuning forks. It shows curves similar to the velocity curve of Fig. (16) periodically repeated with gradually increasing amplitude, then with a sudden diminution followed by another gradual increase. The observations have not been sufficiently continuous or extended to decide whether this variation in amplitude is periodic, and in any case the very small range combined with the comparatively poor quality of the spectrum for measurement would render such a determination difficult and uncertain even if a very large number of plates were obtained.

I have, therefore, thought it preferable now, as all these successive curves have, so far as can be determined, the same form, to consider the variations in amplitude as accidental or, if you like, as due to errors in measurement; and to obtain a mean curve and from it the elements of the orbit by grouping together into normal places the mean velocities obtained on the 54 nights under discussion. The period chosen was that mentioned above, 21·90 days, which best suited our own and the Lick observations and which under the conditions cannot probably be improved upon. The initial phase T_0 was taken as Julian day 2,417,961·0. The basis of grouping into the normal places was the phase, the total difference in phase in the nights in a group being kept generally less than half a day, except in three groups where the velocity changes but slowly.

25a p. 222

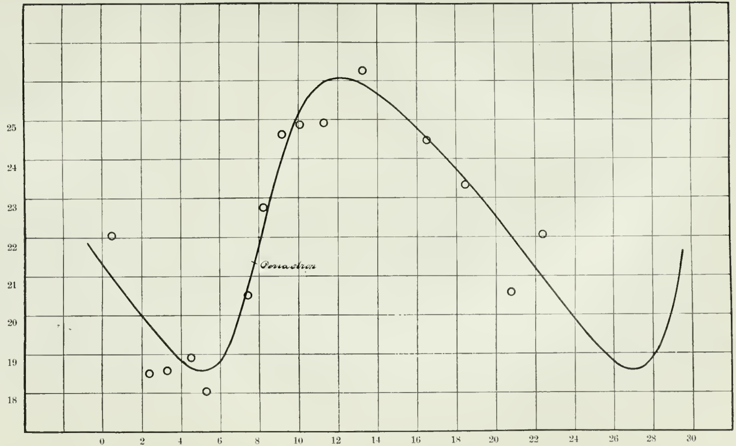


FIG. 16—Velocity Curve of β Orionis.

These normal places with other data are given in the table below, and the places themselves are indicated by circles on the velocity curve Fig. (16) corresponding to the final elements.

NORMAL PLACES β ORIONIS.

No.	Mean velocity.	Mean phase.	No. of nights.	No. of plates.	Total diff. of phase.	Weight.	Weight used in solution.	Residual O-C
1 .	22·06	0·444	3	35	0·48	17	3/4	+1 02
2 ..	18·51	2·350	3	15	0·24	9	1/3	−1 24
3....	18·59	3·266	3	14	0·15	7	1/4	−0 60
4....	18·92	4·481	5	22	0·59	17	3/4	+0·27
5.....	18·06	5·240	3	12	0·30	10	1/3	−0·47
6....	20·51	7·427	4	25	0·62	15	2/3	−0·10
7 .	22 76	8·200	2	10	0·27	5	1/4	+0·61
8...	24·63	9·160	4	16	0·63	11	1/3	+0·65
9....	24 90	10·024	4	10	0·46	7	1/4	−0·26
10....	24·91	11·265	6	31	* 1·66	16	1/3	−1·10
11	26·28	13·253	10	39	1·81	23	1	+0·34
12 ..	24 49	16·567	3	22	1·52	12	1/2	−0·05
13 .	23 34	18 431	3	10	0·67	8	1/3	−0 17
14	20 60	20 740	1	12	0·00	6	1/4	−1·48

With these normal places and by the graphical method developed by you, described in last year's report, the elements given below were readily determined, with which the observations seemed to agree closely. However, owing to the considerable differences in the weight of the normal places, which could not very well be allowed for in a graphical solution, and to the advantages demonstrated by previous experience, it was felt desirable to apply a least squares correction to these elements.

For coefficients of the corrections the equations developed by Lehmann-Filhés* were used, and from these and from the ephemeris obtained from the normal places and preliminary elements, the following observation equations were derived. All of the elements except the period, which was considered as closely determined as possible from the range of velocity present and the short interval used, were included in this solution and an unknown of coefficient unity for the velocity of the system was added.

OBSERVATION EQUATIONS β ORIONIS.

x $\delta\gamma$	y δK	z $K\delta\omega$	u $K\delta e$	v $\frac{K\mu\delta T}{(1-e^2)^{\frac{3}{2}}}$	V	Weight.	s
1·000	−0·505	−0·698	+0 892	+0·892	−1·51	3/4	−0·071
"	−0·851	−0·408	−0·859	−0·601	−0·74	1/3	−1·937
"	−0·975	−0·190	+0·523	+0·384	−0·20	1/4	+0·942
"	−1·052	+0 178	−0·223	+0·015	−0·42	3/4	−0·507
"	−1·020	+0·443	−0·528	−0·249	+0·56	1/3	+0·206
"	−0·464	+1·104	−0 598	−0·911	+0·19	2/3	−0·325
"	−0·138	+1·189	+0·140	−0·996	−0·83	1/4	+0·365
"	+0·267	+1·141	+0·924	−0·948	−1·18	1/3	+1·204
"	+0·569	+0·977	+0·845	−0·784	−0·33	1/4	+2·277
"	+0 876	+0·565	+0·519	−0·372	+0·80	1/3	+3·388
"	+0 941	+0·071	−0·486	+0 122	−0·31	1	+1·338
"	+0·588	−0·575	−0·869	−0·774	−0·16	1/2	+1·078
"	+0 267	−0·755	−1·366	+0·948	−0 10	1/3	−0 194
"	−0·183	−0·798	−0·460	+0·991	−1·16	1/4	+2·630

* A. N., No. 3242.

From these observation equations the following normal equations were obtained:—

$$
\begin{aligned}
6.833x - 0.558y + 1.110z - 0.041u + 0.213v - 1.132 &= 0 \\
-0.558x + 3.755y + 0.085z - 0.466u - 0.192v + 0.185 &= 0 \\
+1.110x + 0.085y + 3.284z + 0.192u - 3.072v - 0.211 &= 0 \\
-0.041x - 0.466y + 0.192z + 3.363u - 0.202v - 1.192 &= 0 \\
+0.213x - 0.192y - 3.072z - 0.202u - 3.118v - 0.009 &= 0
\end{aligned}
$$

From the elimination there resulted the following values of the unknowns with their probable errors:—

$$
\begin{aligned}
&x \text{ or } \delta\gamma &&= +.1721 && \pm .1584 \\
&y \text{ or } \delta K &&= +.0212 && \pm .2096 \\
&z \text{ or } K\delta\omega &&= -.0157 && \delta\omega = -.0042 = -0.24^\circ \pm 3.48^\circ. \\
&u \text{ or } K\delta e &&= +.3604 && \delta e = +.0961 \pm .0587 \\
&\iota \text{ or } \frac{K\mu\delta T}{(1-e^2)^{\frac{3}{2}}} &&= 0 && \delta T = 0
\end{aligned}
$$

When these are applied to the preliminary values we obtaiu:

ELEMENTS OF β ORIONIS.

Name.	Symbol.	Preliminary.	Corrected.
Eccentricity	e	0·20	0·296 ± ·059
Half-Amplitude	K	3·75	3·771 ± ·210 km.
Longitude of Apse	ω	255°	254° 76 ± 3° 48
Periastron Passage	T	7·80	J. D. 2,417,968·80
Period	U	21·90	21·90 dys.
Velocity of System	γ	−22·444	+22·616 ± ·158 km.
Projection of Semi-axis	$a \sin \iota$	1,100,500	1,108,900 km.
Maximum Velocity	N_1	+26·0	−26·09 km.
Minimum Velocity	N_2	−18·5	−18·55 km.

It will be noticed that except for the eccentricity the changes in the elements are very small and a comparison between the residuals from the corrected ephemeris and from substitution in the observation equations shows that the solution is satisfactory enough, as there are none greater than ·25km. It was not deemed necessary to make a second solution considering the assumptions made in combining the observations. That the solution has improved the elements was shown at once on comparing the curves and is also evident by the reduction of Σpvv from 3·88 to 3·16.

The probable error of a normal place of unit weight is ± 0·40km. The probable error of a night obtained by scaling from the curve is ± 1·80. The probable error of a plate obtained with a dispersion of three prisms is ± 1·98km.. with dispersion of one prism ± 3·22km. and including all the plates ± 2·62km. If, as was done, the observations are divided into two sets—those before and those after January 29, 1909, when the sudden change in amplitude was noticed—and separate curves and elements are obtained roughly for these sets, the probable error of a night reduces to ± 1·37km. with a proportional reduction in the probable errors of single plates, and this would probably be not much greater than 1km. if the amplitude remaiued constant. For the two sets mentioned above, it may be of interest to compare the maximum and minimum velocities. Those of the first set are + 17 and + 29 and of the second + 19 and + 23·5.

This solution must, however, owing to the peculiar behaviour of the star, be regarded as preliminary only. It is ouly when many more observations have beeu secured and the star has been closely followed for some time that any more definite idea of the nature of the changes taking place may possibly be obtained, and it is proposed in the future to follow it as closely as the other work on hand will permit.

I have the honour to be, sir.

Your obedient servant,

J. S. PLASKETT.

APPENDIX A.

ORBITS OF θ AQUILÆ, ϵ HERCULIS, AND η BOÖTIS.

W. E HARPER.

THE ORBIT OF θ AQUILÆ.

The star θ Aquilæ ($\alpha = 20^h\ 06^m{\cdot}2$, $\delta = -\ 1°\ 07'$, photographic magnitude 3·6) was discovered to be a spectroscopic binary by M. Deslandres* in 1902. From the twenty-six plates secured he obtained a period of 16·7 days and eccentricity about 0·6. As the results obtained by him were regarded as only provisional, the star was placed on our observing list here in May, 1907, when the single-prism spectrograph was ready for use. In all forty-five measurable plates were secured that year and from these, preliminary values of the elements were obtained.† For convenience of reference these are given here:

$P = 17{\cdot}17^d$
$\gamma = -\ 26{\cdot}7^{km}$
$e = 0{\cdot}725$
$\omega = 20°$
$T = $1907, Oct. 2·15 G.M.T.
$=$ J. D. 2,417,851·15
$a \sin i = 8{,}455{,}500^{km}$

As unfavourable weather prevented the securing of spectrograms in all its phases, particularly near the time of periastron passage, work was resumed on it this year with the object of filling up any gaps in the curve. Fifty-two spectrograms were secured this year and these have been combined with those of last year to determine the orbit. Some half-dozen plates of last year in which the agreement among the various lines was not all that could be desired were remeasured, but only two, Nos. 924 and 959, were changed in velocity appreciably. Plates 1038 and 1050 which had not been measured last year are also added.

Four of the plates Nos. 1001, 1100, 1101 and 1794 were made with the three-prism spectrograph, whose linear dispersion at $H\gamma$ is 10·1 tenth-metres per millimetre. The balance were all made with the single-prism spectrograph which at $H\gamma$ has a linear dispersion of 30·2 tenth-metres per millimetre and gives the whole visible spectrum in sharp focus. The region used for velocity determinations is that lying between and including $H\beta$ and K. The plates used were Seed 27.

The spectrum is of the type VIIa, and in the portion used the Mg line (λ 4481) and K (λ 3933) are best defined. The hydrogen lines are fairly well measurable, especially $H\gamma$, the line λ 4549 is fairly sharp as are also the silicon lines. In addition to those given in Table I. some faint metallic lines also appear in some of the plates. The velocities corresponding to one revolution of the micrometer screw (0·5mm. pitch) are also attached.

* Bulletin Astronomique XX., 129, 1903.

† Journal of the Royal Astronomical Society of Canada I., 357, 1907.

TABLE I.

LINES IN θ AQUILÆ.

Element.	Wave-Length.	Velocity per Revolution.
H	4861·527	1451
Fe	4549·642	1204·
Mg	4481·400	1151·
H	4340·634	1044
Fe	4233·328	964
He	4143·928	898
Si	4131·047	889
Si	4128·211	887
H	4101·890	868·
H	3970·177	774·
Ca	3933·825	749·

Practically all the plates made have been used in the discussion, even although one or two have not been of the best quality, No. 865 being a case in point. In the preliminary curve for this year ($P=17{\cdot}120$) No. 873 gave an abnormally high residual (− 28km.) and following out a suggestion of Mr. J. S. Plaskett, to whom I am much indebted for help during this work, the result was omitted from consideration in the least-square solution, as an excessive residual tends to distort the elements out of all agreement with the mean values, as obtained from the remaining observations.

The following table gives all the data of the plates, the phase being reckoned from periastron, Julian Day 2.417.731.504, using the period finally determined, 17·112 days.

TABLE II.

MEASURES OF θ AQUILÆ.

Plate No.	Julian Date.	Phase.	No. of lines.	Wt.	Velocity.	Residual.
	1907.					
803	2,417,727·814	13·425	4	5	24	0·2
819	737·787	6·284	4	5	− 39	+ 3·1
841	739·836	8·333	4	5	− 38	0·4
854	741·813	10·310	4	5	− 42	− 5·9
865	747·778	16·275	1	2	+ 45	+16·0
905	759·777	11·162	5	4	− 40	− 5·2
924	765·777	0·050	5	4	+ 30	−19·5
931	766·711	0·984	7	5	− 30	+ 9·8
942	770·703	4·976	4	4	− 40	+ 5·7
946	773·713	7·986	3	3	− 43	− 5·0
959	777·764	12·037	5	3	− 40	− 7·8
969	784·760	1·921	4	4	− 40	− 1·8
1001	798·660	15·821	5	4	+ 19	+ 6·2
1012	801·692	1·741	4	3	− 39	− 2·0
1013	803·573	3·622	6	4	− 51	− 4·1
1027	815·630	15·679	3	3	+ 10	+ 1·1
1028	815·669	15·718	2	5	+ 11	− 1·0
1033	825·612	8·549	4	3	− 38	− 0·6
1038	831·635	14·572	4	2	− 8	− 3·6
1043	833·673	16·610	7	3	+ 55	+10·5
1050	837·614	3·438	4	4	− 47	− 0·4
1072	849·543	15·367	5	4	+ 3	+ 1·3
1073	849·559	15·383	4	5	+ 4	+ 2·1
1074	849·589	15·413	6	5	− 7	− 9·4
1080	850·502	16·326	3	2	+ 28	− 2·6
1081	850·521	16·345	5	3	+ 33	0·8
1082	850·548	16·372	6	4	+ 30	3·8
1085	850·613	16·437	8	5	+ 25	−10·5
1086	850·642	16·466	5	3	+ 36	− 1·0
1089	851·528	0·240	5	4	+ 18	−12·0
1091	851·570	0·282	3	2	+ 28	− 0·2
1092	851·589	0·301	5	2	+ 23	− 2·6

TABLE II.

MEASURES OF θ AQUILÆ—*Continued.*

Plate No.	Julian Date.	Phase.	No. of lines.	Wt.	Velocity.	Residual.
	1907.					
1093..	2,417,851·605	0·317	5	3	+ 26	+ 2·6
1094..	851·625	0·337	2	1	+ 12	− 9·0
1100..	867·510	16·223	1	1	+ 28	+ 1·7
1101..	867·574	16·287	3	3	+ 33	+ 4·0
1106..	874·535	6·135	4	2	− 44	+ 1·4
1128..	884·437	16·038	5	5	+ 16	− 4·0
1129.	884·452	16·052	5	5	+ 32	+11·6
1146.	896·500	10·988	4	2	− 35	− 2·8
1149..	898·448	12·936	3	1	− 31	− 3·4
1150..	898·526	13·014	5	3	− 20	+ 7·2
1154..	899·445	13·933	4	3	− 18	+ 1·8
1155..	899·458	13·946	3	2	− 30	−10·0
1157..	903·529	0·905	3	3	− 33	+ 3·9
	1908.					
1533..	2,418,077·871	4·126	5	3	50	− 3·0
1544..	080·873	7·128	2	2	− 37	+ 3·0
1576..	096·857	6·000	3	3	− 48	− 5·0
1583..	098·821	7·964	5	3	− 31	+ 7·0
1604..	105·814	14·943	7	3	− 11	− 5·0
1605..	105·843	15·000	6	3	− 15	−10·0
1626..	115·774	7·805	7	4	− 29	+ 9·3
1634..	117·824	9·855	7	5	− 29	+ 7·5
1643..	119·821	11·852	6	5	− 30	+ 3·0
1651..	120·781	12·812	9	5	− 32	− 4·0
1659..	126·729	1·648	2	2	− 36	− 0·5
1679..	131·785	6·704	5	3	39	+ 2·0
1691..	133·812	8·731	5	3	− 41	− 4·0
1696..	134·799	9·718	5	4	− 34	+ 2·5
1704..	136·818	11·737	6	2	− 33	± 0·0
1708..	137·764	12·683	5	4	− 26	+ 3·3
1716..	138·809	13·728	7	5	− 19	+ 2·5
1727..	148·687	6·494	5	5	− 37	+ 4·6
1730..	149·735	7·512	5	4	− 39	± 0·0
1731..	149·755	7·562	5	3	− 41	− 2·2
1732..	150·760	8·597	5	3	− 33	+ 4·3
1733..	150·840	8·617	2	2	− 41	− 3·8
1735..	151·743	9·551	6	3	− 43	− 6·5
1736..	151·756	9·564	2	1	30	+ 6·5
1747..	153·740	11·547	5	3	31	+ 3·0
1755..	154·744	12·551	5	2	− 31	− 1·0
1756..	154·764	12·571	5	3	− 26	+ 4·0
1762..	159·619	0·316	7	3	− 35	+10·0
1766..	159·687	0·384	4	3	− 33	+13·0
1767..	159·722	0·419	5	3	+ 16	+ 3·0
1769..	159·784	0·481	3	2	± 0	− 8·0
1776..	161·708	2·395	4	2	− 41	+ 1·5
1777..	161·740	2·443	7	4	− 39	+ 4·0
1789..	171·763	12·458	5	3	− 21	+ 9·0
1794..	173·697	14·392	5	3	− 24	10·0
1799..	174·635	15·328	8	2	± 0	− 1·0
1800..	174·658	15·351	6	2	− 2	− 3·0
1801..	174·695	15·398	6	3	+ 7	+ 4·5
1807..	175·581	16·273	6	2	+ 29	− 1·0
1808..	175·605	16·297	7	2	+ 26	3·0
1810..	175·645	16·337	5	2	+ 22	−10·0
1811..	176·645	0·228	5	3	+ 35	+ 4·0
1812..	176·664	0·247	5	1	+ 39	+10·0
1813..	176·681	0·264	7	2	− 35	+ 6·0
1814..	177·659	1·242	6	4	30	− 1·5
1815..	177·680	1·263	8	4	− 33	− 4·0
1822..	178·702	2·285	7	5	35	+ 7·0
1835..	181·584	5·165	5	4	− 49	− 3·0
1864..	188·678	12·259	8	5	− 33	− 1·7
1875..	193·529	0·000	5	4	+ 51	− 2·6
1876..	193·570	0·040	5	4	− 51	+ 1·0
1878..	2,418,196·625	3·094	5	4	− 48	− 2·0

The observations of 1907 and 1908 were grouped separately and the period which suited best was 17·120 days. The phases for this period were computed, being reckoned from an initial epoch T_0, Julian Day 2,417,727, the date of the first observation. The observations of the two years were now combined and grouped into 18 normal places. Weights were assigned to these groups depending not only upon the sum of the weights of the individual plates, but upon the number of nights involved. The maximum weight was taken as 5. In the weighting of the individual plates, not only the quality of the plate *per se*, but the agreement among the various lines was taken into account. The groups are given in Table III.

TABLE III.
NORMAL PLACES.

Mean Phase.	Mean Velocity.	Wt.	Mean Phase.	Mean Velocity.	Wt.
1·09	−22·3	3	5·49	−31·3	2
2·13	−11·7	1	6·47	−38·2	3
2·66	− 0·7	3	7·96	−48·9	2
3·09	−13·3	1	9·46	−44·5	1
3·42	−24·9	2	10·73	−40·5	2
3·72	−34·3	3	12·05	−36·4	2
4·31	+51·0	1	13·93	−37·4	5
4·54	−33·6	1	16·28	−33·0	2
4·72	+22·5	3	17·05	−26·7	3

Using the graphical method* of Dr. King, various values of e and ω were tried, those finally decided upon as suiting the grouped observations best being $e = \cdot 680$, $\omega = 20°$, $K = 49$km. and time of periastron passage, T, 4·30 days from initial epoch. Thus for preliminary elements we have:

$P = 17{\cdot}120$ days
$e = 0{\cdot}680$
$\omega = 20°$
$T =$ Julian Day 2,417,731·30
$K = 49$km.
$\gamma = -\ 25{\cdot}3$km.

With these elements it was decided to make a least-square solution for the normal places. Using the differential equation of Lehmann-Filhés†

$$\delta\left(\frac{dz}{dt}\right) = \delta\gamma + (\cos u + e\cos\omega)\,\delta K + \left[\cos\omega - \frac{\sin u\ \sin v}{1-e^2}\cdot(2+e\cos v)\right]K\,\delta e$$
$$-\ [\sin u + e\sin\omega].\ \ K\,\delta\omega - \sin u\,(1+e\cos v)^2\,(t-T).\ \frac{K}{(1-e^2)^{\frac{3}{2}}}\cdot\ \delta\mu$$
$$+\ \sin u\,(1+e\cos v)^2\,\frac{K}{(1-e^2)^{\frac{3}{2}}}\cdot\ \mu.\ \ \delta T$$

eighteen observation equations were formed, connecting the six unknowns with the residuals between the observed and computed values of the velocity. To make the observation equations homogeneous the following substitutions were made:—

$x = \delta\gamma$
$y = \delta K$
$z = 10{,}000\delta\mu$
$u = 100\delta e$
$v = 10\delta T$
$w = 10\delta\omega$

* Astrophysical Journal, XXVII., 125, 1908.
† Astronomische Nachrichten 3242.

There result the following normal equations:—

$$\begin{aligned}
40{\cdot}000x + 9{\cdot}571y - 15{\cdot}914z - 11{\cdot}075u + 5{\cdot}696v + 4{\cdot}981w + 18{\cdot}200 &= 0\\
+16{\cdot}015y - 19{\cdot}340z - 13{\cdot}924u + 6{\cdot}444v + 2{\cdot}043w - 6{\cdot}419 &= 0\\
+242{\cdot}697z + 11{\cdot}554u - 327{\cdot}008v + 255{\cdot}472w + 14{\cdot}267 &= 0\\
+19{\cdot}651u - 4{\cdot}122v + 1{\cdot}212w - 4{\cdot}459 &= 0\\
+486{\cdot}538v - 372{\cdot}234w - 36{\cdot}352 &= 0\\
+413{\cdot}976w - 102{\cdot}105 &= 0
\end{aligned}$$

Whence the corrections to the first approximations:

$\delta\gamma = -0{\cdot}6$ km.	$\delta e = +\ {\cdot}011$
$\delta K = +2{\cdot}1$ km.	$\delta T = +\ 134$ days.
$\delta P = -\ {\cdot}004$ days.	$\delta\omega = 5^\circ{\cdot}27$

The resulting elements with their probable errors, as determined at a later stage, are:

$P = 17{\cdot}116$ days	$\pm\ {\cdot}008$ days.	Final elements (simple solution).
$e = 0{\cdot}691$	$\pm\ {\cdot}017$	
$\omega = 25^\circ{\cdot}27$	$\pm\ 2^\circ{\cdot}1$	
$T =$ J. D. 2,417,731·434	$\pm\ {\cdot}100$ days.	
$K = 51{\cdot}1$ km.	$\pm\ 3{\cdot}20$ km.	
$\gamma = -25{\cdot}9$ km.	$\pm\ 0{\cdot}64$	
$A = 83{\cdot}0$ km.		
$B = 19{\cdot}2$ km.		

The residuals from the curve using these corrected values of the elements seemed themselves to lie on a curve, which repeated itself approximately twice during the period of the principal star and having an amplitude of about 8 km. The way the residuals from the observed velocities grouped themselves was not mere chance, there was no doubt that there was some secondary disturbance. The assumption was therefore made that there was a third body whose period was commensurable with the period of the principal star, it going through all its phases in half the time required for that of the principal star. The orbit of the third body was considered circular and the secondary curve taken to cross the primary from above at a time T', Julian Day 2,417,732·634. Taking K' as 4km. and considering θ as the angle at any time from T' the extra terms in the differential equation are:

$$-\sin\theta\,\delta K' + \frac{2\pi}{P'}\cdot K'.\ \cos\theta.\ \delta T'.$$

Correcting now our values of the computed velocity for each of the eighteen normal places by an amount representing that due to the third body we have a new set of eighteen observation equations connecting the eight unknowns. In these equations, for sake of homogeneity, we put

$$\begin{aligned}
x &= \partial\gamma\\
y &= \partial K\\
z &= \frac{100\ K}{(1-e^2)^{\frac{1}{2}}}\cdot\partial\mu &&= 13525{\cdot}67\ \partial\mu\\
u &= K\ .\ \partial e\\
v &= \frac{K}{(1-e^2)^{\frac{3}{2}}}\cdot\mu\ .\ \partial T &&= 49{\cdot}355\ \partial T.\\
w &= K\ .\ \partial\omega\\
y' &= \partial K'\\
v' &= \frac{2\pi}{P'}\ .\ K'\ .\ \partial T' &&= 2{\cdot}937\ \partial T'.
\end{aligned}$$

There result the following normal equations:—

$$\begin{array}{rrrrrrrrrr}
40{\cdot}000x & +9{\cdot}394y & -16{\cdot}283z & -22{\cdot}704u & +3{\cdot}111v & +0{\cdot}405w & +7{\cdot}526y' & +3{\cdot}349v' & +33{\cdot}400 & =0 \\
 & +15{\cdot}353y & -19{\cdot}924z & -28{\cdot}003u & +3{\cdot}284v & +0{\cdot}016w & +11{\cdot}548y' & +2{\cdot}222v' & -50{\cdot}734 & =0 \\
 & & +176{\cdot}184z & +20{\cdot}361u & -62\ 767v & +43{\cdot}949w & -7{\cdot}554y' & -27{\cdot}991v' & -30{\cdot}492 & =0 \\
 & & & +82{\cdot}772u & -2{\cdot}485v & +0{\cdot}072w & -22{\cdot}165y' & 4\ 273v' & -102{\cdot}683 & =0 \\
 & & & & +24{\cdot}411v & -17{\cdot}105w & -0{\cdot}687y' & +9{\cdot}534v' & -3\ 337 & =0 \\
 & & & & & +17.037w & +2{\cdot}279y' & -10{\cdot}776v' & +9{\cdot}934 & =0 \\
 & & & & & & +20{\cdot}463y' & +1{\cdot}950v' & +54{\cdot}446 & =0 \\
 & & & & & & & +19{\cdot}533v' & -1{\cdot}088 & =0
\end{array}$$

Whence the following corrections are obtained:—

$\delta\gamma = -0{\cdot}01$ km.	$\delta T = +{\cdot}020$ days.
$\delta K = -1{\cdot}4$ km.	$\delta\omega = +0°{\cdot}12$
$\delta P = -{\cdot}0017$ days.	$\delta K' = -1{\cdot}3$ km.
$\delta e = +{\cdot}007$	$\delta T' = +{\cdot}159$ days.

The resulting values of the elements with their probable errors, as determined at a later stage, are:

$P =$ 17·114 days	$\pm$ ·008 days		First approximation (solution (with secondary oscillation.)
$e =$ 0·698	$\pm$ ·017		
$\omega =$ 25°·39	$\pm$ 2°·45		
$T =$ J. D. 2,417,731·464	$\pm$ ·092 days.		
$K =$ 49·7 km.	$\pm$ 3·31 km.		
$\gamma = -25{\cdot}91$ km.	$\pm$ 0·66 km.		
$T' =$ J. D. 2,417,732·793	$\pm$ ·349 days.		
$K' =$ 2·7 km.	$\pm$ 1·02 km.		
$A =$ 81·04 km.			
$B =$ 18·36 km.			

The size of the corrections in some of the elements, and the fact that the residuals (computed—observed) as obtained direct were not in all cases in close agreement with those obtained from the differential equation, *i.e.*, by substituting the values of the corrections in the observation equations, made another solution necessary. The values of ω and γ were, however, considered established as the corrections were very small and the remaining six unknowns were, with the last elements as the basis, formed anew into eighteen observation equations. In these equations

$$y = \delta K.$$

$$z = \frac{100\,K}{(1-e^2)^{\frac{3}{2}}}\,\delta\mu \quad = \quad 13534{\cdot}86\,\delta\mu.$$

$$u = K\,.\,\delta e$$

$$v = \frac{K}{(1-e^2)^{\frac{3}{2}}}\cdot\mu\,.\,\delta T = \quad 49\ 6906\,\delta T.$$

$$y' = \delta K'.$$

$$v' = \frac{2\,\pi}{P}\cdot K'.\delta T' \quad = \quad 1{\cdot}9825\,\delta T'.$$

There result the following normal equations:—

$$\begin{array}{rrrrrrr}
14{\cdot}733y & -19{\cdot}889z & -28{\cdot}221u & +3{\cdot}499v & +11{\cdot}503y' & +{\cdot}938v' & +1{\cdot}153=0 \\
 & +174{\cdot}454z & +23{\cdot}938u & -61{\cdot}517v & -10{\cdot}663y' & -26{\cdot}344v' & +17{\cdot}185=0 \\
 & & +87{\cdot}120u & -4{\cdot}059v & -23{\cdot}403y' & -2{\cdot}458v' & +7{\cdot}668=0 \\
 & & & +23{\cdot}708v & +{\cdot}794y' & +9{\cdot}359v' & -9{\cdot}616=0 \\
 & & & & +21{\cdot}411y' & +1{\cdot}290v' & +1{\cdot}868=0 \\
 & & & & & +18{\cdot}584v' & -4{\cdot}992=0
\end{array}$$

Whence the corrections:

$\delta K = -0{\cdot}02$ km.	$\delta T = +0{\cdot}039$ days.
$\delta P = -0{\cdot}0022$ days.	$\delta K' = -0{\cdot}05$ km.
$\delta e = +0{\cdot}0037$	$\delta T' = +0{\cdot}080$ days.

The corrected values of the elements with their probable errors, as determined at this stage, are:

$P =$	17·1121 days	$\pm$ ·005 days	Second approximation (solution with secondary oscillation).
$e =$	0·6943	$\pm$ ·013	
$\omega =$	25°·39		
$T =$	J. D. 2,417,731·503	$\pm$ ·070 days	
$K =$	49·68 km.	$\pm$ 2·28 km.	
$\gamma =$	− 25·91 km.		
$T' =$	J.D. 2,417,732·873	$\pm$ ·416 days	
$K' =$	2·65 km.	$\pm$ 0·86 km.	
$A =$	80·84 km.		
$B =$	18·52 km.		

This solution should have been sufficient, but when substituting directly in the observation equations and comparing the residuals with those obtained in the ordinary way, there was one fairly large difference 0·40km., two were 0·30km. and the rest varied between 0·0 and 0·2 km. Furthermore, the probable errors of some of the quantities, particularly K, seemed too large. It was decided then to compute the probable errors corresponding to the previous corrections made. They are collected in the accompanying Table IV.:—

TABLE IV.

SUMMARY OF CORRECTIONS.

Elements.	Preliminary Values.	First Corrected Values.	Second Corrected Values.	Third Corrected Values.
P	17·120d	17·116d ± ·008	17·114d ± ·008	17·112d ± ·005
e	0·680	0·691 ± ·017	0·698 ± ·017	0·6943 ± ·013
ω	20°	25°·27 ± 2°·1	25°·39 ± 2°·45	
T	J. D. 2417731·30	...731·434 ± 100	...731·464 ± ·092	...731·503 ± ·070
K	49·0 km.	51·1 km. ± 3·20 km.	49·7 km. ± 3 31 km.	49·68 km. ± 2·28 km.
γ	25·3 km.	− 25·9 km. ± 0·64 km.	− 25·91 km. ± 0·66 km.	
		Assumed.		
T'		2417732·634	...732·793 ± ·343	...732·873 ± ·416
K'		4·0 km.	2·7 km. ± 1 02 km.	2·65 km. ± 0·86 km.
Σpvv	485 km.	292 km.	254 km.	235 km.

The values for P, γ, T' and K' were now considered determined. The probable errors, especially those in K, did not seem to be as low as they should be. As the probable error in ω in the later determination was larger than in the preceding one, it was thought advisable to take e, ω, T and K and see if by another solution lower probable errors would be had, and a better agreement between the ephemeris and equation.

As before, for the sake of homogeneity, let

$$x = \delta K$$
$$y = K\delta e \quad = 49 \cdot 68\ \delta e$$
$$z = K\delta\omega \quad = 49 \cdot 68\ \delta\omega$$
$$u = \frac{K}{(1-e^2)^{\frac{3}{2}}} \cdot \mu\delta T = 48 \cdot 9307\ \delta T.$$

And the resulting normal equations are:

$$14{\cdot}480x - 28{\cdot}036y - {\cdot}077z + 3{\cdot}931u - 3{\cdot}236 = 0$$
$$85{\cdot}688y + {\cdot}387z - 3{\cdot}660u + 4{\cdot}604 = 0$$
$$17{\cdot}243z - 17{\cdot}072u - 1{\cdot}533 = 0$$
$$24{\cdot}149u + {\cdot}080 = 0$$

from which corrections result as follows:—

$\delta K = +\ 0{\cdot}29$km.
$\delta e = +\ 0{\cdot}0009$
$\delta\omega = +\ 0^\circ{\cdot}1743$
$\delta T = +\ 0{\cdot}0013$ days

The final elements, taking into account the secondary oscillation, are then as follows. The Allegheny results as discussed later are, for purposes of comparison, given here:—

	OTTAWA.	ALLEGHENY.	
P =	17·112 ± ·005.	17·117 ± ·0042	Final elements (solution with secondary oscillation.)
e =	0·695 ± ·010	0·685 ± ·011	
ω =	25°·57 ± 1°·54	17°·53 ± 1°·58	
T =	J. D. 2,417,731·504 ± ·024	1907, Aug. 28, ·697 ± ·034 dys.	
K =	49·97 km. ± 1·35 km.	44·69 km. ± 1·15 km.	
γ =	− 25·91 km. ± 0·66	− 30·10 km.	
A =	81·31 km.	73·88 km.	
B =	18·63 km.	15·50 km.	
$a \sin i$ =	8,452,100 km.	7,665,000 km.	
P' =	8·556 days	8·558 days.	
T' =	J.D. 2,417,732·873 ± ·416	1907, Sept. 9, ·176 ± ·368 days	
=	time when secondary crosses primary from above.		
K =	2·65 km. ± 0·86	2·39 km. ± 0·77 km.	
$a' \sin i'$ =	311,800 km.	281,000 km.	

What seems peculiar is that the least-square solution diminished the period in each case, although from a comparison of the 1907 and 1908 observations, when plotted the period would seem to be fixed about 17·120 days. The successive approximations in each case decreased the sum of the squares of the residuals, as seen from Table IV. The final approximation gave $\Sigma pvv = 238{\cdot}3$km., practically the same as the previous one. The agreement, however, between the equation and ephemeris is much improved, the greatest difference being 0·27km.; the average 0·15km. and the probable errors are much lower. Table V. contains the phases for the normal places, reckoned from periastron with the period finally adopted, 17·112 days; the corresponding velocity with its weight, and the residuals as computed directly.

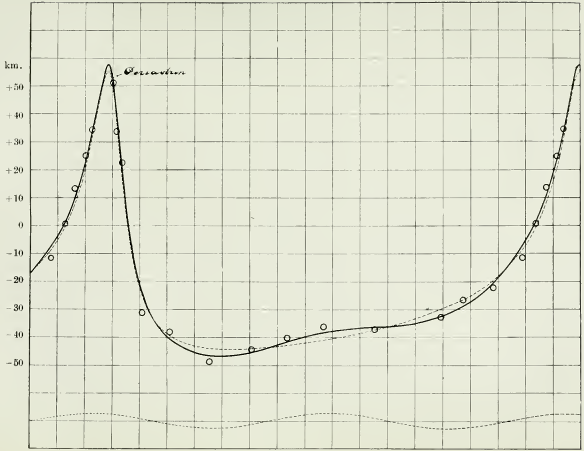


FIG. 17—Final Velocity Curve of θ Aquilæ.

TABLE V.

NORMAL PLACES.

No.	Mean Phase from T	Mean Velocity.	Wt.	Residuals C – O
1	13·810	–22·33	3	+1·85
2	14·871	–11·75	1	+4·21
3	15·378	+ 0·66	3	+0·85
4	15·740	+13·33	1	–3·21
5	16·143	+24·87	2	–1·55
6	16·385	+34·34	3	–0·44
7	0·019	+51·00	1	+0·38
8	0·166	+33·60	1	+4·75
9	0·346	+22·48	3	–3·03
10	1·102	–31·31	2	+5·95
11	2·107	–38·20	3	–3·16
12	3·533	–48·93	2	+1·93
13	5·070	–44·50	1	–1·17
14	6·357	–40·50	2	–1·53
15	7·694	–36·42	2	–2·39
16	9·527	–37·38	5	+0·36
17	11·932	–33·00	2	+0·07
18	12·713	–26·74	3	–2·31

The curve representing the final elements is shown in Fig. 17, the dotted lines being the velocity curves of the primary and secondary components and the heavy continuous line the resultant of these two. The final solution reduces the quantity Σpvv of the residuals for the normal places from 485 to 238·3. The least-square solutions, with the assumption of a secondary disturbance, seem, therefore, to have materially improved the values of the elements. The probable error of a normal place of weight unity as determined by $r = \pm \cdot 6745 \sqrt{\frac{\Sigma pvv}{n - \mu}}$ where n is the number of normal places and μ the number of unknowns is $\pm$ 2·75km. The probable error of a plate as derived from the residuals in last column, Table II., which are scaled directly from the curve is for the 1907 observations $\pm$ 4·5km., and for those of 1908 $\pm$ 3·5km. Grouping the two years together the probable error of a plate is $\pm$ 4·0km.

Previous Observations.

There remains a discussion of M. Deslandres' observations of 1901 and 1902. These were tried in connection with our 1907 observations to determine the period more accurately than could be done by using our own alone. The only period which suits Deslandres' observations alone is the one which he suggests, viz., 16·7 days. If the two observations of 1901 were omitted the other observations will give a better curve when a period of 17·112 days is used. Fig. 18 shows Deslandres' observations using his period of 16·7 days. Fig. 19 shows his 1902 observations using our period of 17·112 days. He suggested an eccentricity of about 0·6; such a value for e with K = 45 km. and ω = 27°, gives a curve represented by the broken line in Fig. 18, while a similar value for K and ω, with an eccentricity 0·4 is represented in the continuous curve and appears to suit the observations as well as, if not better, than the other. The velocities he gives as relative only; I have added 14 km. to each to bring them into agreement with the general run of mine.

As his measures depended upon one line only, λ 4481, and among themselves gave a more or less uncertain determination of the elements, I decided in my preliminary determination to confine myself to our own observations. Now that a definite solution has been secured, it is well to look at them anew. For convenience the data is reproduced here, the tenth of a day being assumed. As stated before, 14km. is added to each velocity determination. The phase with the period 16·7 days is reckoned from the date of first observation of 1902, being Julian Day 2,417,964·4, the phase with the period 17·112 days is reckoned from my own periastron time.

M. DESLANDRES' OBSERVATIONS.

Julian Date.	Phase P = 16·7.	Phase P = 17·112	Velocity.
2,415,568·5	4·7	10·221	+ 11
583·5	3·0	8·109	+ 34
964·4	0·0	12·545	− 2
969·4	5·0	0·433	− 36
971·4	7·0	2·433	− 46
982·4	1·3	13·433	− 6
989·4	8·3	3·321	− 40
2,416,010·4	12·6	7·209	− 39
011·4	13·6	8·209	− 36
012·4	14·6	9·209	− 43
015·4	0·9	12·209	− 25
020·4	5·9	0·097	− 22
029·3	14·8	8·997	− 31(?
040·3	9·1	2·885	− 46(?
047·3	16·1	9·885	− 24
048·3	0·4	10·885	− 7
052·3	4·4	14·885	+ 39
054·3	6·4	16·885	− 44
057·3	9·4	2·773	− 48
069·3	4·7	14·773	+ 10
071·3	6·7	16·773	− 26
072·3	7·7	0·661	50
076·3	11·7	4·661	− 47
086·3	5·0	14·661	+ 2
088·3	7·0	16·661	− 15
2,416,095·3	14·0	6·549	− 54

It is rather hard to say how best to make use of these early observations. Though the measures are liable to accidental errors of considerable magnitude they may, owing to the interval of some six years which has elapsed between the two series of observations, have an important bearing on whether or not any changes in the elements have taken place during that time. Our 1908 observations seemed to be slightly greater positive than the velocities for 1907 for the corresponding phase. This may have been accidental, the difference being at most less than 2 km. If the absolute velocities of Deslandres' observations were known, it would decide whether the velocity of the system has been changing or not during these six years.

If his two observations of the year 1901 are as they appear in his paper, we must conclude that the period has been changing during the interval. If we omit these two and use the remaining twenty-four of 1902 with our elements we get what appears on the face of it to be a much better agreement of the observations with the curve. There is one discrepancy. The observations fall short of the curve by a common amount, 1·5 days. The number of periods elapsed between the two epochs is in round numbers 125. By increasing the period $\frac{1\cdot5}{125}$ or ·012 days, this would be remedied, but while this value of 17·124 days would not make much difference in Deslandres' observations, the least-square solution in our own shows it to be improbable. Here is a suggestion: Is it not probable that the presence of the third body will cause a rotation of the line of apsides similar to that caused by the sun and moon on the earth? A motion of the apse line in the direction of ω decreasing and at the uniform rate of $\frac{\cdot012}{17\cdot112} \times 360°$ or 0°.2524 per period would account for this discrepancy. This motion, if it exists,

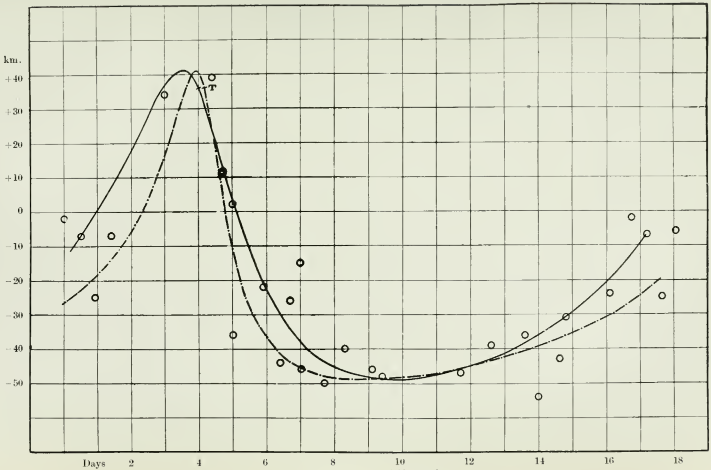


FIG. 18—M. Deslandres' Observations.

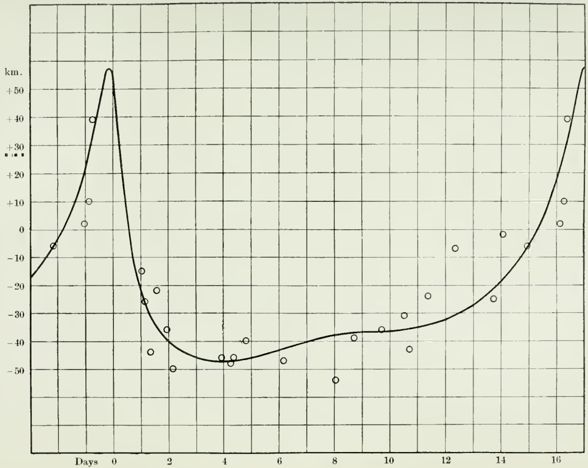


FIG. 19—Deslandres' 1902 Observations.

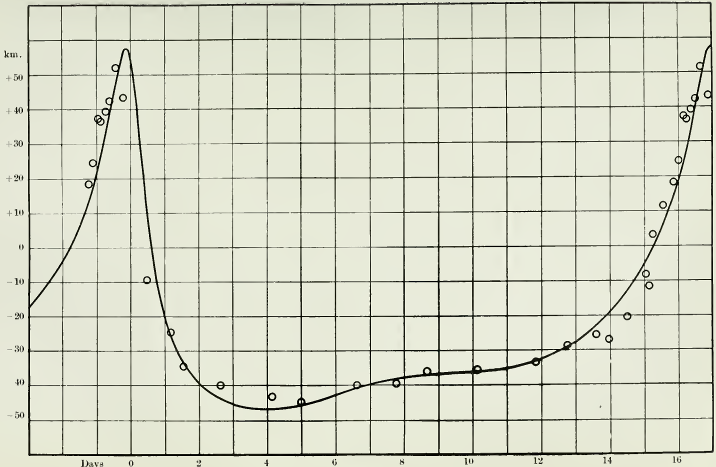


FIG. 20—Allegheny Observations. Ottawa Curve.

would, in addition to decreasing ω and consequently the slope of the curve near periastron, also cause the maximum positive velocity to increase and the maximum negative velocity to decrease numerically.

These questions seem to call for further work on the star at some future time. I do not think the data is sufficient at present to make any definite assertion regarding any change in the elements themselves.

Additional Note on the Allegheny Determination of the Orbit.

Since the foregoing was completed, No. 7 of Vol. I. of the Publications of the Allegheny Observatory has come to hand, containing the orbit of this same star as determined by Mr. Robert H. Baker. It is possibly the first case where two observers, working with different instruments and entirely independent of each other, have completed a discussion of an orbit at about the same time.

A comparison of the results is interesting. In some cases the agreement is remarkable, for instance the secondary oscillation; in other cases the agreement is not what might be expected. Speaking generally, I may say the reason for the differences exists in the observations themselves, the values Mr. Baker has determined suiting his observations best, while the same may be said of our own. There is a gap in the Allegheny observations near periastron passage. The first normal place, phase 0·16 days, depends upon two plates made the same night, the weights of the plates being about one-half the average weight assigned to a plate. The next normal place falls at phase 0·88 days and depends on two plates made on separate nights. These have relatively low weights also. In this interval of 0·7 days additional observations might, and I feel safe in saying, would tend to change the form of the curve. Our observations for phase 0·16 days depend upon one plate made in 1907 and three made in 1908, the plates being a little below the average weight. We have observations, however, for phase 0·34 days depending upon five plates made in 1907 and four made in 1908, the plates being all of average quality, and it is at this point that additional observations would be an advantage to the Allegheny data.

Looking at the results more in detail we see that Mr. Baker's value for γ is about 4km. more negative than ours. The greater positive velocities secured here, account in a measure for this. There may be an explanation also if the velocity of the system be changing, as suggested previously. The bulk of Allegheny observations were made in 1907, while ours are about equally distributed over 1907 and 1908. There is a minor cause in the assumed wave-lengths of the lines used, causing a systematic difference in the two series of velocities. The wave-lengths given in the first part of my report are those at present universally accepted: those given in Mr. Baker's work are sometimes greater, sometimes less, but on the whole would yield a velocity more negative than would those in use here.

The differences are indicated in the accompanying table:—

Line.	Difference in Velocity.	Line.	Difference in Velocity.
λ 4549	0·7 km.	λ 4131	− 1·2 km.
4481	− 0·9 "	4128	− 2·4 "
4340	1·7 "	3933	+ 2·8 "
4233	− 6·3 "		

On the average a difference of from 1 to 2 km. would be thus accounted for. In certain stars, by examining the trend of the residuals of the various lines and changing their assumed wave-lengths accordingly, a better agreement among the lines themselves can be secured, but unless there are valid reasons therefor it would seem better to retain a constant set of values. Mr. Baker no doubt has good reasons for the change, and the question of absolute velocity is not the most important one.

The probable error of an average plate here is $\pm$ 4·0, at Allegheny $\pm$ 3·3. The Seed 23 plates used at Allegheny have an advantage over those used here as, being of a finer grain, the spectrum lines would be easier to measure. Our greater number of observations around periastron ought to have much weight, however, in the consideration of the differences between the two results.

The Allegheny observations, with a correction for T to bring the times of periastron passage into coincidence, and the addition of 3 km. to each velocity, being a systematic difference, are plotted in Fig. 20, the curve shown representing the elements as determined here. A glance suffices to show that such a curve does not suit the observations as well as their own curve, and it would seem, therefore, that some further work on the subject would be necessary to explain the discrepancies.

THE SYSTEM OF ε HERCULIS.

$\alpha = 16^h\ 56^m\cdot5,\ \delta = 31°\ 4'.$

This star was announced as a spectroscopic binary by both the Lick and Yerkes astronomers in 1903. The two plates secured at Lick showed both the Mg. and H_γ lines as broad and diffuse. On the three plates secured at Yerkes, Adams noticed evidences of the composite nature of the spectrum.

Work was commenced on the star here May 24, 1907, and up to the present some one hundred spectrograms have been secured. After quite a number of these had been measured, the period was found to be in the neighbourhood of four days. The observations seemed to group themselves into four sets, showing that the period was very close to the integral number. Thus quite an interval elapsed before observations were secured in the intermediate phases.

When in 1908 the curve was fairly complete an attempt was made to bring up the five early observations so as to determine the period with greater accuracy. The period which suited our 1907 and 1908 observations best was 4·012 days. The early observations, made about the same date in 1903, required an increase in the period of ·0034 days. As the Lick observations were based on the Mg line alone and the Yerkes were for the brighter component and were regarded as provisional only, it was decided to confine our attention to our 1907 and 1908 plates alone.

Keeping the two years separate these were grouped into eighteen normal places. When an attempt was made by the graphical method of Dr. King to obtain preliminary values of the elements it was found that no simple elliptic curve would suit. Having previously found in θ Aquilæ that the assumption of a secondary disturbance due to the presence of a third body would account very well for deviations in the oscillation curve, a similar assumption was made in regard to this star. Here, however, the residuals from the most suitable elliptic curve seemed to repeat themselves thrice in the period of the main star. It was therefore assumed that there was this third body, if so we may speak of it, revolving about the bright star in a period one-third that of its primary, the two in turn revolving about the other component of the system. This was the theory first acted upon.

After a great many trials the set of elements which gave a resultant curve in best agreement with the observations were the following:—

P = 4·012 days
e = ·10
K = 56 km.
ω = 210°
T = J. D. 2,417,721·512
γ = − 28.15 km.
K' = 12 km.
T' = J. D. 2,417,722·162
= time where secondary crosses primary from above.

With these elements a set of eighteen observation equations were formed connecting the eight unknown elements with the residuals. These were transformed into normal equations and the solution gave the following corrections to the elements accepted as preliminary. The new values are also given:—

Elements.	Corrections.	Corrected Values.
P	+ ·00065 days	4·01265 days
e	− ·030	·070
K	+ ·237 km.	56·237 km.
ω	− 18°·35	191°·65
T	− ·178 days	J.D.2417721·334
γ	−1·04 km.	− 29·19 km.
K'	+ ·262 km.	12 262 km.
T'	+ ·015 days	J.D.2417722·177

The new set of elements decidedly improved the agreement as is indicated by a decrease in the sum of the squares of the residuals from 1044 to 715, over thirty per cent. When, however, the residuals were computed directly and compared with those obtained by substitution in the observation equations the differences in most cases were larger than they should be, showing that another solution was necessary. Such a solution has as yet not been made.

Before the work had been carried thus far, observations had been made on the star in 1909. To bring these into agreement with the curve the period would need to be increased to 4·023 days; this period if used would utterly destroy the agreement of the first two years. It seemed then that the period was a varying quantity.

At this stage it was decided to review the plates for evidences of the spectrum of the other component. From time to time in measuring, notes had been made regarding any evidences of duplicity, with corresponding velocities, but now the plates were examined critically with this object in view. Out of the hundred odd plates only six showed the doubling of the lines. Two of them showed $H\gamma$ doubled, two $H\delta$ doubled and two both $H\delta$ and K. The instrument used in almost every case was the single-prism spectrograph which has a dispersion at $H\gamma$ of 30·2 tenth-metres per millimetre. At $H\delta$ the instrument should theoretically resolve lines differing in wave-length by 1·2 tenth-metres. This corresponds to a velocity of 90 km. per second. In practice, however, owing to various causes, a separation corresponding to a much greater difference in velocity would be necessary before the lines could be seen as doubled. The maximum separation found to exist is approximately 160 km. Hence, we can understand how such a small percentage of the plates showed the duplicity of the lines. In the case of these six plates the velocities corresponding to the two components are tabulated in the column of remarks, Table II.

In Vol. I., No. 13 of the Allegheny Publications, which came to hand while the plates were being reviewed, Mr. Robert H. Baker discussed the spectroscopic components of 2 Lacertæ. His blended curve being very similar to that of ϵ Herculis, it seemed possible that the systems might be similar and that his explanation might answer in the case before us. The velocities, while very rough approximations at best, were plotted for each component and elements were obtained for the components as follows:—

Elements.	Brighter component.	Fainter component.
Maximum pos. vel	+ 64 km.	+ 40 km.
Maximum neg. "	− 138 "	− 96 "
K	101 "	68 "
e	·15	·15
ω	210°	30°

Physical conditions in the system itself might serve to explain the curious form of the curve, but the two previous theories have much more evidence to support them. The change in the period, if real, would lend strength to the theory of a disturbing satellite. The presence of this third body would tend to cause the line of apsides to rotate, varying the form of the curve and consequently the elements.

Tables I. and II. give all the data of the plates. The residuals for each plate are scaled directly from the curve; the other columns are self-explanatory. Table III. gives the eighteen normal places, the phases being reckoned from the final periastron. The curve, Fig. 21, represents the corrected values of the elements on the assumption of a disturbing body; the dotted lines representing the primary and the secondary, and the heavy continuous one the resultant of the two.

Further work on the star is necessary. Spectrograms of the star at times of maximum velocities are now being secured on plates of fine grain, and it is hoped that some further evidences of the doubling of the lines will thus be secured.

TABLE I.

EARLY OBSERVATIONS OF ε HERCULIS.

Julian Date.	Phase.	Velocity.	Residual.	Observatory.	Remarks.
2,416,235·687	3·046	58	....	Yerkes.	....
242·718	2·052	− 43	....	"	....
259·910	3·193	− 70	....	Lick.	Mg. line.
262·827	2·098	− 34	....	"	"
272·664	3·910	− 22	....	Yerkes.	....
616·680	2·837	− 24*	....	Lick.	Mg. line, not very good.
658·849	·867	− 31*	....	"	Mg. line.

* Kindly communicated by Professor Campbell.

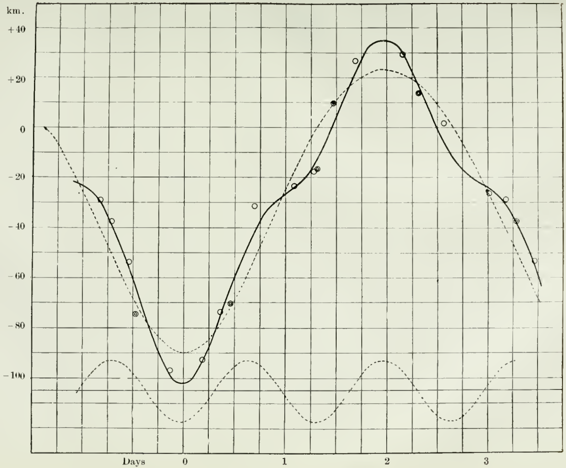


Fig. 21—Velocity Curve of Herculis.

TABLE 11.

OTTAWA MEASURES OF ε HERCULIS.

No. of Plate.	Julian Date.	Phase.	Velocity	Wt.	Residual.	Remarks.
	1907.					
786........	2,417,721·767	0·433	−55·6	5	1·6	
801........	728·735	3 388	−81·4	4	−18 0	
810.... ...	736·812	3·440	−83·7	4	5·0	
816........	738·741	1·356	+12·7	5	+11·0	
827.	739·652	2·267	+17·8	4	8·5	
838	740·774	3·389	−61 7	5	+ 1·0	$H\gamma$ 128 and − 19
847.......	741·767	0·370	−83·2	5	−24·0	
851.... ...	742·738	1·341	+ 7·0	6	+ 6·0	
862.. . . .	748·692	3 282	−34·5	5	+15·0	$H\gamma$ 111 and − 15_2
871........	749·757	0·270	−65·7	5	+ 5·0	
881........	753 669	0·234	−80·4	3	− 6·0	
893.. .. .	755·688	2·253	+ 4·0	3	− 7·0	
913	762·679	1 219	−21·2	2	−11·0	
920........	766·666	1·195	−17·5	7	− 6·0	
928...... ..	767·635	2 162	+ 9·0	5	−10 0	Metallic lines seen.
937........	768·622	3 149	−39·0	4	2·0	
952 ...	776·673	3·175	−57·6	4	−18·0	
957........	778·693	1·182	− 7·0	7	+ 6·0	
976........	790·722	1·173	−26 8	5	−12 8	
979	792·562	3·013	+15·4	6	....	Mg − 125_1 and + 55_3
987....	795·732	2·170	+ 6·2	3	−12·0	
1018.	811·660	2·048	−30·6	3	+ 2·6	
1062. .	2,417,840·609	2·908	− 2·9	2	+22·0	
	1908.					
1391...... .	2,418,010·868	0·623	−28·6	6	+ 8 0	
1403......	017·904	3·647	−100·9	6	− 9·0	$H\delta$ − 110_1 and + 28_1
1483	045·900	3·555	−90·7	3	− 8·2	λ 4713 gives + 158
1494	047·861	1 502	+38·5	7	+22 0	
1511......	054·856	0·472	−37·0	7	+12·4	
1531	077·813	3·367	−74·0	7	−14·0	
1540	080·767	2·307	+ 6·1	6	+ 1 0	
1545.....	082·708	0·236	−74·0	5	+ 1·5	
1547...... .	084·770	2·298	−28·5	2	−34·5	
1567..	094·813	0·303	−83 1	3	−14·0	
1573...... .	096 747	2·237	−11·0	6	−23·5	K intense to red.
1582.....	098·778	0·255	−65·6	5	+ 6·6	
1603	105·774	3·239	−46·2	4	0·0	
1625 ...	115·733	1 159	−13·8	5	+ 0·7	
1630.......	117·691	3 117	−31·0	8	+ 3·5	
1640......	119·710	1·124	+ 6·1	2	+23·0	Depends on Mg alone.
1648	120·715	2·129	+24 8	6	+ 3·4	
1653......	124·676	2·077	+20·0	6	− 5·5	
1658........	126·680	0·069	−99 5	3	− 7 0	
1661.....	126·820	0·208	−86·1	5	− 8·7	
1666	129·730	3·119	−27·0	7	+ 8 0	
1675....	131·658	1 034	−14·5	6	+ 6·8	
1676.....	131 688	1·064	−22·2	6	− 2·2	λ 4267 gives +128.
1682..... .	132·716	2·092	+31·2	6	+ 6 2	$H\delta$ − 80 and + 70
1685.....	133·609	2·966	−27·9	6	0·0	K − 14 and + 62.
1686...... .	133·649	3·026	−36·0	5	− 6 6	Metallic lines.
1693.... .	134·707	0·071	−108·0	5	−16·0	All lines def. on violet.
1699.... . .	136·679	2·042	+26·0	4	− 2·6	
1707... ..	137·737	3·100	−43·6	8	− 9 6	
1712....	138 708	0·059	−81 1	5	+ 8·1	
1713.. ...	138 739	0·088	−65·8	6	+24 5	
1719.... ..	139 725	1·075	−13·8	6	+ 6·0	
1720.. .	145·708	3·047	−23·7	7	7·0	
1723	147·583	0·908	−23·8	9	+ 2·2	
1728. .. .	148 722	2·047	+23·9	6	+ 5·9	
1729.... ...	149·707	3·033	−17·6	8	+12·2	
1734... .	151·716	1·028	−27 8	5	− 6·3	
1737........	152·598	1·911	+34·3	8	− 0·5	$H\delta$ 84 and + 58
1738...	152·631	1·944	+34·7	5	+ 0·7	K − 115_2 and 32_3
1743... . .	152·753	2·066	+40·2	4	+13·2	
1746... ..	153·712	3·026	−22·3	3	+ 7·0	
1751..... ..	154·653	3·967	−82·5	5	+11·2	

TABLE II.

Ottawa Measures of ε Herculis.—*Continued.*

No. of Plate.	Julian Date.	Phase.	Velocity.	Wt.	Residual.	Remarks.
	1908.					
1757	2,418,154·795	0·096	−94·3	5	− 4·8	
1760	155·701	1·001	−22·1	3	+ 0·4	
1761	159·586	0·873	−28·6	8	− 2·2	
1774	161·649	2·937	−24·0	7	+ 2·5	
1782	169·701	2·964	−35·0	7	− 8·7	
1793	173 612	2 862	−47·8	5	−14·1	
1818	178·585	3·843	−92 4	7	+ 4·2	
1838	181·660	2·904	−24·0	7	0·0	
1844	182·588	3·811	−98·9	8	− 2·8	
1853	185·578	2·790	− 6·1	5	+16·0	
1866	189·604	2 804	−20·1	4	+ 2·0	
1903	216·550	1·660	+11·2	4	−19 0	
1905	217·516	2·627	+21·0	5	+37·8	
1906	217·556	2·667	−10·0	5	+ 8·0	
1917	220·531	1·628	+18·1	2	− 9·1	
1926	227·593	0·665	−26·8	4	+ 8·3	
1961	259·440	0 411	−70·3	4	−14·2	
1983	272 422	1·356	−30·9	5	−33·0	
1993	278·461	3·382	−30·0	5	+29·0	
	1909.					
2263	2,418,346 923	3·629	−43 5	...	...	
2264	346·958	3·664	−39·3	...	...	
2305	360·899	1 554	−18·3	...	...	
2306	360·942	1·597	−16·4	...	...	
2327	369 883	2·512	+49·5	...	...	
2328	369·935	2·564	+12·5	...	...	
2370	379 788	0 379	−78 0	...	...	
2371	379·808	0·399	−54 3	...	...	
2384	381·814	2·405	+36·4	...	...	
2385	381·833	2·424	+38·4	...	...	
2454	397·836	2 376	+30 0	...	...	
2455	397·861	2 401	+29·8	...	...	

TABLE III.

Normal Places.

No.	Phase from T.	Mean Velocity.	Weight.	Residual O − C.
1	0·337	−70·22	2	− 6 72
2	1·187	−16·57	2	− 4·00
3	1 348	+ 9·59	1	+ 8·65
4	2·183	+13·26	2	− 4·34
5	3·168	−37·65	2	+ 0·46
6	3·404	−74·53	1	−11·49
7	0·571	−31·63	1 5	+ 9 40
8	0·952	−23·75	3·5	+ 0·67
9	1·152	−17·80	3	− 2·87
10	1·570	−26·96	1	+ 4·53
11	2·034	+29·16	5	− 0·23
12	2·442	+ 1·16	2	+ 6·97
13	2·889	−26·60	4	− 2·61
14	3·062	−28·98	5 5	+ 1·78
15	3·340	−53·30	1·5	+ 2·20
16	3·747	−96·50	2·5	+ 1·45
17	0·048	−92·52	2·5	+ 1·26
18	0·235	−73·35	3	+ 1·84

THE SPECTROSCOPIC BINARY η BOÖTIS.

This star ($\alpha = 13^h\ 49^m{\cdot}9$, $\delta = +\ 18°\ 54'$, photographic magnitude 3·8) was announced as a spectroscopic binary by Moore in L. O. B. 70, 1905. The thirteen measures given extended over the years 1897, 1899, 1901, 1903, 1904 and 1905. Of these, four were approximate, the remaining nine definite. Besides these measures there were available the recently published measures*, six in all, by Kustner of the Bonn Observatory.

Work was commenced on the star here June 25, 1906, and from that time until the date of the last plate mentioned, March 20, 1909, forty-five plates were secured. The determination of the orbit depends then on these sixty-four plates, thirteen of the Lick Observatory, six of the Bonn and the remaining forty-five of our own.

Some objection might be taken to the grouping of observations from different observatories in view of the possibility of a systematic difference in the results used, but it has been deemed expedient by the writer to use these early observations in conjunction with our own to make a preliminary determination of the orbit. Meanwhile plates of the star in the required phases will continue to be made with the new three-prism spectrograph, and when all phases are complete, which cannot be before January, 1910, a new determination of the elements will be made using our three-prism plates alone. The comparison of results ought to be worth the extra labour involved.

The star is of solar type, XIV*a* according to Miss Maury's grouping, and thus permits of accurate velocity determination. As a rule about fifteen lines were measured on each plate. The plates up to No. 752 were made with the Universal spectroscope, and were reduced by means of the Hartmann interpolation formula. From that time the plates were made with either the new single or the three-prism spectrograph, and were reduced from tables used here in which the micrometer settings for zero displacement of the lines are tabulated. Eleven were made with the former, twenty-one with the latter. The plates used were Seed 27. Our own plates made at the commencement of our work are weighted one-half; later plates with the Universal spectroscope, the single-prism plates, most of those made at Bonn, as well as those of 1897 and 1899 made at Lick, are weighted unity, while the later plates of Lick Observatory and our own new three-prism plates are weighted three.

The following tables contain all the data of the plates. The phases are reckoned from the period and periastron finally adopted and the residuals are scaled directly from the curve representing the final elements:—

OBSERVATIONS AT LICK OBSERVATORY.

Julian Date.	Phase.	Velocity.	Weight.	Residual.
2,413,959·8	192·9	− 0·6	1	−0·4
4,035·7	268·8	− 2·	1	+2·3
4,036·7	269·8	− 4·	1	+0·3
4,057·6	290·8	− 2·	1	+3·4
4,693·8	431·6	− 2·2	1	+3·4
5,524·6	271·7	− 4·9	3	−0·4
6,259·6	16·1	+ 6·9	3	−0·1
6,542·6	299·1	− 8·2	3	−2·4
6,571·6	328·1	− 4·9	3	+1·9
6,603·6	360·1	− 7·6	3	−0·1
6,646·6	403·1	−10·	3	−2·8
6,658·6	415·1	− 7·3	3	−0·6
6,850·9	112·1	+ 5·5	3	+0·1

* Astrophysical Journal, 27-5-1908.

OBSERVATIONS AT BONN OBSERVATORY.

Julian Date.	Phase.	Velocity.	Weight.	Residual.
2,416,258·4	14·9	+ 7·6	3	+0·7
6,595·5	352·0	− 2·2	1	+5·2
6,608·5	365·0	− 4·2	1	−3·3
6,994·4	255·6	− 3·4	1	−0·4
7,234·7	0·6	+ 6·2	1	+1·5
7,369·4	138·3	+ 3·9	1	−0·4

OTTAWA OBSERVATIONS.

Plate Number.	Julian Date.	Phase.	Velocity.	Wt.	Residual.
308	2,417,387·7	153·6	− 0·2	0.5	2·5
313	389·6	155·5	0·0	0·5	− 2·2
318	391·6	157·5	+ 1·8	0·5	− 0·3
326	396·6	162·5	− 1·7	0·5	− 3·4
333	398·6	164·5	− 1·6	0·5	− 3·2
366	429·6	195·5	− 0·4	0·5	0·0
372	431·6	197·5	− 4·7	0·5	− 4·2
657	643·8	409·7	− 5·6	1·0	− 1·3
670	655·8	421·7	− 6·9	1·0	− 0·6
691	669·7	435·6	−10·2	1·0	− 5·0
731	685·8	451·7	− 3·8	1·0	− 0·5
739	692·7	458·6	− 4·5	1·0	− 2·3
752	703·6	469·5	+ 0·7	1·0	− 0·9
760	710·7	476·6	− 0·1	3·0	− 1·2
764	716·7	482·6	+ 2·9	3·0	+ 0·7
769–771	718·7	484·6	+ 2·5	2·0	− 0·2
774	719·6	485·5	+ 3·2	1·0	+ 0·4
779	720·6	486·5	+ 0·6	1·0	− 2·4
793	725·7	491·6	+ 5·7	1·0	− 1·7
797	727·6	493·5	+ 5·1	1·0	− 0·8
812	737·6	8·1	+ 7·2	1·0	+ 1·4
868	748·6	19·1	+ 5·0	1·0	− 2·4
891	754·6	25·1	+ 5·7	1·0	− 2·3
918	765·6	36·1	+ 6·8	1·0	− 1·8
950	775·6	46·1	+ 5·3	1·0	3·5
972	789·6	60·1	+11·4	1·0	− 2·8
990	795·6	66·1	+ 9·0	3·0	0·6
1231	955·9	226·4	− 3·3	1·0	− 1·1
1294	968·8	239·3	− 3·8	3.0	− 0·9
1307	970·9	241·4	− 3·5	3·0	− 0·4
1332	989·9	260·4	− 5·2	3·0	− 1·2
1357	996·8	267·3	− 7·1	3·0	− 2·7
1446	2,418,031·9	302·4	− 7·5	3·0	− 1·6
1513	066·8	337·3	− 6·7	3·0	− 0·3
1557	085·7	356·2	− 8·7	3·0	− 1·3
1553	087·7	358·2	− 6·6	3·0	− 0·8
1621	115·6	386·1	− 6·0	3·0	− 1·0
1663	129·6	400·1	− 7·4	3·0	− 0·1
1710	138·6	409·1	− 6·8	3·0	− 0·2
1792	173·5	444·0	8·6	3·0	4·3
1867	192·5	463·0	0·3	3·0	− 1·2
2115	315·0	96·2	+ 8·6	3·0	+ 1·7
2209	337·8	113·0	5·2	3·0	− 0·2
2283	355·8	131·0	+ 6·0	3·0	+ 2·1
2396	386·7	161·9	+ 2·8	3·0	+ 1·0

The observations when plotted gave a period about 492 days. Using this period they are combined into twenty-one groups, no group including observations of different periods. Preliminary elements were determined by the graphical method* of Dr.

* A. J., 27-2-1908.

King and, using these, twenty-one observation equations of the form of Lehmann-Filhés were formed. They were then transformed into the following normal equations, where for sake of homogeneity these substitutions were made:

$$x = \delta\gamma$$
$$y = \delta K$$
$$z = K.\delta e$$
$$u = K.\delta\omega$$
$$v = 1000.\ \frac{K}{(1-e^2)^{\frac{1}{2}}} \cdot \delta\mu$$
$$w = \mu.\ \frac{K}{(1-e^2)^{\frac{3}{2}}} \cdot \delta T.$$

The normal equations are:—

$$\begin{array}{rrrrrrrl}
16\cdot000x - 11\cdot974y & + 1\cdot830z & + 19\cdot935u & - 2\cdot354v & - 20\cdot565w & + 6\cdot260 & = 0 \\
54\cdot535y & - 14\cdot444z & + 2\cdot376u & - 13\cdot460v & - 7\cdot212w & - 28\cdot055 & = 0 \\
 & 57\cdot796z & - 2\cdot404u & - 4\cdot352v & + 3\cdot883w & - 19\cdot760 & = 0 \\
 & & 59\cdot931u & - 13\cdot104v & - 62\cdot528w & - 4\cdot652 & = 0 \\
 & & & 45\cdot343v & + 14\cdot515w & + 40\cdot046 & = 0 \\
 & & & & 69\cdot129w & + 7\cdot200 & = 0
\end{array}$$

The solution of these equations gave as corrections:

$\delta\gamma$ = − ·02 km.
δK = + ·43 "
δe = + ·050
$\delta\omega$ = − 1°·025
δP = + 3·32 days
δT = − .520 "

The sum of the squares of the residuals for the normal places was reduced from 186·1 to 122·7, and the agreement between equation and ephemeris residuals was considered satisfactory. These are given in the accompanying table of normal places:

NORMAL PLACES.

No.	Mean Phase.	Mean Vel.	Wt.	Residual.	Equation-Ephemeris.
1	255·5	−2·15	4	+1·64	−0·13
2	431·6	−2·20	1	+3·41	−0·08
3	271·7	−4·90	1	−0·33	−0·26
4	15·5	+7·25	6	+0·28	−0·08
5	333·0	−6·90	16	+0·02	−0·56
6	112·1	+5·50	3	+0·11	+0·14
7	255·6	−3·40	1	+0·39	−0·03
8	0·6	+6·20	1	+1·50	−0·13
9	138·3	+3·90	1	+0·45	−0·29
10	435·5	6·20	5	−0·96	+0·01
11	417·7	−7·60	9	−0·98	−0·01
12	480·8	+1·63	11	−0·21	+0·03
13	463·0	−0·30	3	+1·19	+0·12
14	0·9	+6·00	3	+1·25	−0·04
15	48·1	+7·65	8	−1·17	+0·02
16	111·4	+6·60	9	+1·16	+0·02
17	161·9	+2·80	3	+1·02	0·00
18	169·5	−0·97	3	−2·23	0·00
19	238·4	−3·60	7	−0·70	−0·32
20	276·7	6·60	9	−1·81	−0·02
21	359·4	7·00	12	+0·49	−0·06

The probable error of a plate as determined from the last two columns of the table, giving the data of the plates and using the formula $r = \pm \cdot 6745 \sqrt{\frac{\Sigma pvv}{\Sigma p - 1}}$ is $\pm$ 1·04 km. per second. The curve, Fig. 22, is plotted from the corrected elements given in the following table. These are considered close approximations to the true values until observations in all phases of the star have been secured with the three-prism spectrograph when a final determination will be made:—

ELEMENTS OF ORBIT.

Elements.	Graphical.	Corrected.
Period P	492 days.	495·3 days.
Eccentricity e	0·25	0·300
Longitude of apse ω	300°	298°·98
Half amplitude K	7·8 km.	8·23 km.
Velocity of system γ	−0·57 km.	−0·60 km.
Periastron passage T	J. D. 2417730·0	J. D. 2417729·48
Projection semi-major axis $a \sin i$	....	53,474,000 km.
pvv	186·1	122·7

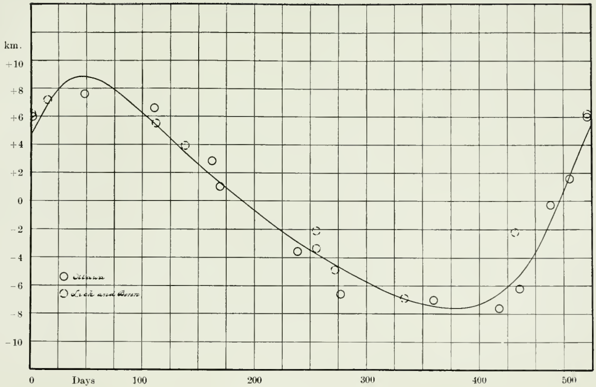


Fig. 22—Velocity Curve of η Boötis.

APPENDIX B.

THE SPECTROSCOPIC BINARY, α CORONÆ BOREALIS.

J. B. CANNON.

The star α Coronæ Borealis ($\alpha = 15^h\ 30^m$; $\delta = +\ 27°\ 3'$), was discovered to be a binary by Hartmann from measures of six plates taken at Potsdam in 1902 and 1903.* It was under observation at this Observatory during the years 1907 and 1908. In all 103 plates were secured, 46 in 1907 and the remaining 57 in 1908; the instrument used being the single-prism spectroscope.

This star belongs to the class I*a* 2 in the Vogel classification. The spectrum shows the dark lines, $H\beta$, $H\gamma$, $H\delta$, $H\epsilon$, the magnesium line λ 4481, the iron line λ 4549, the calcium line λ 3934 and a few other very faint lines. The hydrogen lines are all very broad and diffuse and very difficult of accurate measurement. $H\epsilon$ is so diffuse that it has not been measured at all. The line λ 4481 varies in character, in some plates well defined, in others diffuse. The line λ 4549 is very faint and has only been measured in a very few cases. The line λ 3934 is in general a fairly good line, being weighted about the same as $H\gamma$ and $H\delta$. In the measurement of nearly every plate it was found that the lines λ 4481 and λ 4549 gave entirely different velocities from the *H* lines and *K*. It was decided therefore to consider only $H\beta$, $H\gamma$, $H\delta$ and *K* in the first measurements and the elements determined in this treatment are from the consideration of these alone.

The lines measured, together with the velocities per revolution of the micrometer screw (0·5 pitch), are given in Table I.

TABLE I.

LINES (MEASURED) IN α CORONÆ BOREALIS.

Element.	Wave-Length.	Velocity per revolution.
Hydrogen....	4861·527	1451
"	4340·634	1044
"	4101·890	868
cium	3933·825	749

These lines vary in quality and were weighted accordingly. The whole plate was then weighted, regard being had, first, to the appearance of the spectrum, and second and more particularly, to the number of lines measured and the agreement in the measurements. The velocities found were plotted successively and gave a period of between seventeen and eighteen days. Trials of several periods ranging between these, gave 17·35 as the most satisfactory. There were available measurements of three plates of 1902 and ten of 1903 taken at Potsdam*, and it was found that on plotting these with the observations obtained here that if the period were increased to 17·355 days, they would, with one exception, lie very close to the curve. Table II. contains

* A. N., 163, 31, 1903.

the number of the plate, the Julian date, the phase—computed from the time of periastron finally accepted, and period 17·355 days,—the weight of the plate, the velocity and the residual between the observed velocity and that computed from the corrected elements.

In order to obtain observations in which the errors might be reduced and a curve drawn showing smaller residuals, the one hundred and three observations were combined into fourteen groups. Plates of both years were combined indiscriminately. those at nearly the same phase being grouped together. The weight of each plate (Table II.) was taken into account and the weighted mean of each group computed. with the mean phase.

(Table III. contains the mean phase from T mean velocity, weight and residual of these normal places.)

TABLE II.

MEASURES OF α CORONÆ BOREALIS.

Plate No.	Year.	Julian Day.	Phase.	Wt.	Velocity.	Residual.
784	1907.	2,417,720·74	13·041	4	−40	+12·5
790	"	725·63	0·576	4	+32	0·
794	"	725·75	0·696	3	+44	−10·
800	"	727·72	2·666	3	+17	+17·
808	"	735·69	10·636	3	−37	+15·
813	"	737·64	12·581	4	−30	+ 3·
830	"	738·74	13·681	2	−26	0·
837	"	739 73	14·671	4	−17	− 3·5
845	"	740·69	15·641	3	− 1	− 8·
850	"	741·69	16·641	4	+11	− 1·5
861	"	747·67	5·266	2	+17	− 4·5
869	"	748·64	6 236	4	+ 9	− 4·5
880	"	752·65	10 246	1	−41	+20·
888	"	753 62	11·216	2	−27	− 3·
892	"	754·64	12·236	4	−28	− 1·
912	"	761·64	1·876	2	+25	+13·5
917	"	762·64	2·876	3	+30	− 2·5
919	"	765·65	5·886	3	+ 8	0·
927	"	766·61	6·846	3	− 5	+ 4·5
936	"	767·58	7·816	4	+ 8	−15·
939	"	769·68	9·916	3	−29	−10·
941	"	770·64	10 876	1	−30	− 7·
944	"	773·62	13·851	2	−26	+ 0 5
951	"	775·62	15·851	3	−19	−15·
956	"	777·67	0 546	3	−32	0·
973	"	789·58	11·466	2	−16	− 9·
978	"	791·54	14·421	3	−24	+ 1·5
986	"	794·69	0·216	2	+12	+16·
1060 and 1061	"	839·77	10·386	2	−25	+ 4·
1006	"	800·69	6·216	2	−14	−18·
1014	"	803·63	9·156	2	− 7	− 8·5
1017	"	810 63	16·161	1	−14	+13·
1022	"	811·66	17·151	1	+ 5	−15·
1026	"	815·50	3·676	3	+30	− 4·
1032	"	825·57	13·741	2	−22	− 3·5
1037	"	831·67	2·486	2	+36	− 0·5
1047 and 1048	"	837·53	8·356	3	−15	+ 5·
1083 and 1084	"	850·56	4·016	4	+26	− 2·5
1393	1908.	2,418,010·92	8 186	3	− 5	+ 0·5
1402	"	017·87	15·136	3	−17	+ 1·
1493	"	047·80	10·356	3	− 6	−15·
1571 and 1572	"	096·69	7·181	3	−15	+12·5
1581	"	098·73	9·221	1	− 5	−10·
1601	"	105·71	16·201	3	+ 7	+ 5·5
1608	"	110·58	3.716	3	+ 9	+17·
1623 and 1624	"	115·69	8·831	4	−14	+ 1·
1628 and 1629	"	117·64	10·776	3	−11	−11·5
1638 and 1639	"	119·66	12 796	4	−21	− 6 5
1646 and 1647	"	120·68	13·816	3	−21	− 4·5
1652	"	124·64	0·421	3	+42	−11·
1656 and 1657	"	126 64	2·421	3	+27	+10·
1655	"	129·70	5·481	3	+12	− 1·

TABLE II.

MEASURES OF *α* CORONÆ BOREALIS—*Continued.*

Plate No.	Year.	Julian Day.	Phase.	Wt.	Velocity.	Residual.
1673 and 1674	1908.	2,418,131·62	7·401	4	− 3	− 1·5
1683 and 1684	"	133·57	9·351	3	18	+ 2·
1692	"	134·68	10·461	2	29	7·5
1697 and 1698	"	136·65	12·431	4	−24	− 3
1711	"	138·68	14·461	4	−17	+ 5·
1721 and 1722	"	147·54	5·966	6	0	+ 7·
1739	"	152·65	11·076	2	−44	−20·
1748 and 1749	"	154·57	12·996	6	−36	+ 8·5
1764	"	159·64	0·711	4	+37	3·
1773 and 1775	"	161·60	2·671	7	+43	− 8·5
1798	"	174·54	15·611	2	−16	− 6·
1809	"	175·62	16·681	3	− 3	+13·
1816 and 1817	"	178·55	2·266	6	+41	− 4·
1827	"	179·54	3·256	2	+27	+ 2·5
1836	"	181·61	5·326	4	+10	− 2·
1841 and 1842	"	182·54	6·256	7	+ 8	− 3·5
1852	"	185·56	9·276	2	15	− 0·5
1861	"	188·53	12·246	4	−30	+ 3·5
1865	"	189·56	13·276	1	−15	−12·
1882 and 1883	"	199·54	5·901	8	+11	− 3·5
1894, '95, '96 and '97	"	204·50	10·861	10	−21	− 2·
1949, 1950 and 1951	"	247·45	1·746	6	+46	− 7·5
1991	"	278·42	15·261	1	+ 8	−20·

TABLE III.

NORMAL PLACES OF *α* CORONÆ BOREALIS.

No.	Mean Phase.	Mean Velocity.	Wt.	Residual.
1	12·656	− 29·77	6	− 2·37
2	13·777	− 23·54	2	− 2·34
3	14·664	− 18·50	3	− 2·29
4	15·831	− 5·77	2·5	− 0·36
5	16·723	+ 5·00	1·5	− 6·22
6	0·556	+ 34·63	4	− 2·17
7	2·302	+ 37·14	6	− 0·71
8	3·559	+ 24·33	3	+ 2·66
9	5·657	+ 11·10	4	− 2·47
10	6·250	− 2·41	4	1·46
11	7·968	− 6·71	4	− 1·65
12	9·444	− 17·27	2	− 0·31
13	10·517	− 22·21	3	− 0·25
14	11·000	− 24·35	3	+ 0·75

From the radial velocity curve the elements of the orbit were determined by the graphic method of Dr. King.* These were:—

P = 17·355 days
T = J. D. 2,417,725·55
K = 33 km.
e = ·28
ω = 309°
γ = 0 km.

* Astro. Journal, Vol. XXVII.

To obtain elements which would give a curve more nearly suiting the normal places, a least-square solution was made. On the advice of Mr. Plaskett, the period 17·355 days was taken as fixed, and the fourteen observation equations (formed by the method of Lehmann-Filhés*) were determined without considering $\delta\mu$. From these the following normal equations result:—

$$\begin{array}{rrrrrl} -48x & 0{\cdot}4500y + & 3{\cdot}7267z + & 1{\cdot}1799u + & 2{\cdot}8166v & -14{\cdot}1350 - n = 0 \\ & +24{\cdot}0451y - & 7\,2422z + & {\cdot}4420u - & {\cdot}1050v & -\;4\,1083 - n = 0 \\ & & +23{\cdot}0108z - & {\cdot}2779u - & {\cdot}8737v & +\;3{\cdot}9440 - n = 0 \\ & & & +19{\cdot}5267u & +17{\cdot}5676v & +63\,4280 - n = 0 \\ & & & & +17{\cdot}8291v & +67\,9099 - n = 0 \end{array}$$

Where

$$x = \delta\gamma$$
$$y = \delta K$$
$$z = K\delta e$$
$$u = -K\delta\omega$$
$$v = \frac{K\mu\delta T}{(1-e^2)^{\frac{3}{2}}}.$$

The solution of the above equations gave the corrections to the element:—

$\delta\gamma = + \cdot635$ km.
$\delta K = - \cdot031$ km.
$\delta e = - \cdot015$
$\delta\omega = - 3°{\cdot}76$
$\delta T = - \cdot449$ days.

and hence the following new elements:—

$\gamma = + \cdot635$ km.
$K = 32{\cdot}969$ km.
$e = \cdot265$
$\omega = 305°{\cdot}24$
$T = 2{,}417{,}725{\cdot}101$ J. D.
$P = 17{\cdot}355$ days.

An ephemeris computed with these elements reduces the value of Σpvv from 498·94 to 217·35, but the differences found between these residuals and the observation equation residuals were in some cases rather large, and at a suggestion by Mr. Harper—whom I owe much for other valuable suggestions as well—a second solution was made. This time δK was omitted owing to the small correction obtained in the first solution, and the new observation equations contain only four unknowns, and hence only four normal equations follow:—

$$\begin{array}{rrrrl} 48x + & 2{\cdot}0615y + & 1{\cdot}1149z + & 2{\cdot}0989u & +6{\cdot}1200 - n = 0 \\ & +24\,8703y + & {\cdot}2750z + & {\cdot}3566u & -9{\cdot}4127 - n = 0 \\ & & +19{\cdot}7284z & +18{\cdot}6666u & -5\,8754 - n = 0 \\ & & & +19{\cdot}2174u & -4\,4691 - n = 0 \end{array}$$

in which

$$x = \delta\gamma$$
$$y = K\delta e$$
$$z = -K\delta\omega$$
$$u = \frac{K\mu\delta T}{(1-e^2)^{\frac{3}{2}}}.$$

The solution gives the corrections:—

$\delta\gamma = - \cdot137$
$\delta e = + \cdot012$
$\delta\omega = - 1°{\cdot}558$
$\delta T = - \cdot0475$

* A. N., 136, 17, 1894.

The probable error of a normal place of unit weight was computed and found to be ± 3·07, that of a plate as determined from the residual for each plate scaled from the curve to be ± 5·386. The probable error of each element was also computed and is attached to the final values below, the values obtained after applying the corrections found in the second least-squares solution:—

γ = + ·498 km. ± ·330 km.
K = 32·969 km.
e = ·277 ± ·0012
ω = 303°·68 ± 4°·25
T = 2,417,725·054 J. D. ± ·187
P = 17·355 days
$a \sin i$ = 7,560,000

These values give a second reduction of Σpvv from 217·35 to 207·7 and satisfactory differences between equation and ephemeris residuals, the average being ·08. The curve shown is drawn from the above elements and the circles show the position of the observed normal places.

Since the completion of the foregoing treatment of the binary, from the point of view of the hydrogen lines and the calcium line, λ 3934, all the plates have been reviewed, and the magnesium line λ 4481 carefully measured where measurement was possible, with the intent of determining in what respects the orbit deduced from this line might differ from that already determined from the other lines. The method of treatment was exactly similar to that formerly followed. The period was taken as before—17·355 days. The observations were grouped into normals, the same plates being taken together as in the former treatment and the relative weights assigned as before. The normals were plotted, and the best curve possible drawn through them, or rather the graphic method of Dr. King was employed to obtain the elements of the orbit, the velocity curve corresponding to which best suited these normal places.

The elements thus found were as follows:—

γ = + 6·69 km.
K = 33 km.
e = ·35
P = 17·355 days.
ω = 316°

Comparing these with the corresponding elements from the other lines, the main differences are seen to be in the values of γ and e.

In the work which has been done on the radial velocities of stars other than binary, some stars have been found, certain of whose lines gave consistently different velocities from other lines. Among them is *o* Ceti, the emission and absorption lines giving a considerable difference in the value of the radial velocity; so with nearly all Novæ. Nova Aurigæ has been discussed at some length by several astronomers and a similar phenomenon has been noted. Explanations have been suggested as to the cause of the different displacement of different lines. These consist chiefly of two,—first, a lagging envelope producing the lines of less displacement towards the red end of the spectrum, and second, an ever-expanding envelope coming from a continuously productive source. How far such conditions would go to explain a state of affairs such as we find in *a* Coronæ, it is difficult to say. We may also look upon the system as receding with a velocity of 6·69 km. per second—the velocity given by the magnesium line—and constantly expelling hydrogen and calcium vapors, the velocity of expulsion affected by the periodic recurrence of physical conditions, brought about by the changing relative positions of the stars in the orbit, which conditions fail to influence magnesium in any way so far as changes in the lines are concerned. This is quite plausible, for in the spectroscopic study of the Sun's surface, regions have been found, such as sun-spots, the spectra of which show certain lines considerably affected in character and position, while other lines denoting other elements remain unchanged.

After the first part of this work had been completed, Mr. Jordan issued from the Allegheny Observatory his publication on the Orbit of α Coronæ Borealis. Comparing his results with those obtained here from the lines H_{β}, H_{γ}, H_{δ} and K, it was seen that, although on the whole they agreed fairly well, there was considerable difference in the values of e. This is largely due no doubt to the fact that Mr. Jordan used the line (Mg) λ 4481, together with the above lines in the determination of his elements. However, the fact that the plates we obtained here were measured by several men and all agreed that the Mg line gave large discrepancies seems to justify the separate treatment.

The accompanying curves represent—Fig. 23, the hydrogen and calcium curve, and Fig. 24 the curve from the hydrogen and calcium lines, and that from the magnesium lines.

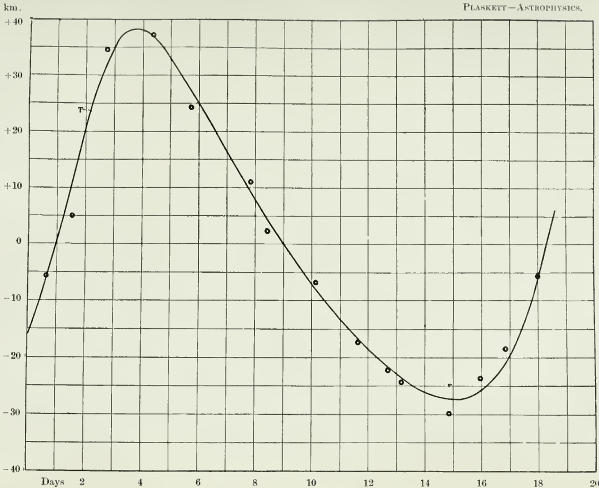


Fig. 23—α Coronæ Borealis, Curve from Hydrogen Lines and Calcium Line.

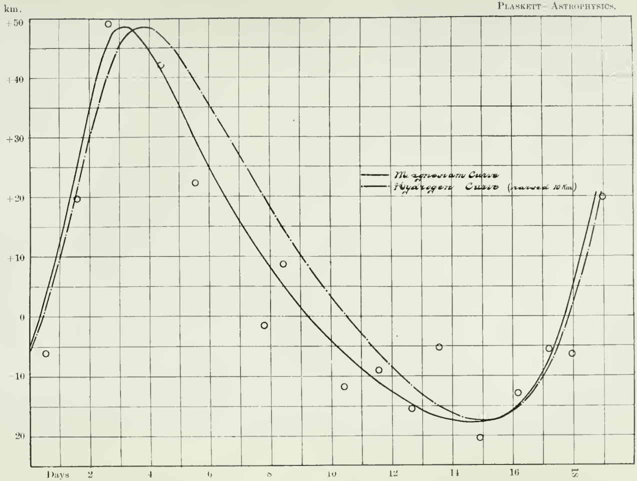


FIG. 24—Velocity Curve of α Coronæ Borealis.

APPENDIX C.

THE TWENTY-THREE FOOT SOLAR SPECTROGRAPH.

RALPH E. DELURY.

This instrument is adapted for analyzing with great dispersion the light of the sun and of laboratory sources, such as the electric spark, arc, flame, &c., and is primarily intended for investigating the conditions in the sun. It is situated in the basement of the Observatory in the Solar Research Room, which is connected on the north side by a cement tunnel to the louvred passage of the Coelostat House from which the image of the sun is directed to the spectrograph, and on the east side to the Chemical Laboratory, which is used also as a photographic dark-room in which are developed the photographs of the spectra taken in the spectrograph. The spectrograph may be described under the following heads:—(*a*) Optical Parts; (*b*) Mountings; (*c*) Slit-Attachment; (*d*) Camera and Plate-Holders; (*e*) Guide-plate for the Sun's Image.

(*a*) *Optical Parts.*

The optical parts are:—a slit with metal jaws 1·3 in. (3·4cm.) long, mounted so as to leave 1 in. (2·5 cm.) clear, and provided with a micrometer, for adjusting the width of the slit, reading to thousandths of an inch; a six-inch (15 cm.) collimating lens of 22 ft. 10 in. (695·5 cm.) focal length for yellow light; and one of the earlier Michelson plane gratings of speculum metal having a 4·25 in. by 4·75 in. (10·8 cm. by 12 cm.) surface ruled 12,700 lines to 1 in. (500 lines to 1 mm.). These parts are arranged after the plan described by O. Von Littrow in 1863 (see Kayser Handbuch der Spectroscopie 1, 513). In this arrangement the slit is placed at (or near) the focus of the lens and the dispersing system (in this case the grating) is placed on the other side of the lens in such a manner that the dispersed light returns through the lens which focuses it near the slit, as illustrated in Fig. 25, which represents a vertical section through the middle of the spectrograph and mountings. S is the slit, L the lens, placed at its focal distance from the slit and G is the reflecting grating placed just behind the lens L, and tilted so that its ruled lines are parallel to the slit. The beam of light to be examined passes through S spreading out to fill L, which renders it parallel before it reaches G, which disperses it and reflects or diffracts it back through L. By tilting the top of the grating slightly towards the slit the diffracted light is made to pass back through the lens which focuses it below the slit where it may be examined with an eye-piece or photographed in the plate-holder (C). By rotating G about a vertical axis on either side of the normal, the different parts of the different orders of spectra are diffracted back through the lens L, and by sliding the lens forward or backward the light of the different wave-lengths may be focussed sharply at C.

(*b*) *Mountings.*

The two tilting movements of the grating mentioned in (*a*) were provided in the cell of the grating by the John A. Brashear Co., from whom it was purchased. The forward tilt is given by screw J and suitable springs pressing against the back of the grating; and a screw placed on the side gives the means for adjusting the lines of the grating parallel to the slit. The grating in the cell rests on the stand G', the axis of which fits into a cylindrical socket in the bottom of the end, B, of the spectrograph, and by turning a handle K'' (Fig. 26), attached to a worm which works in the toothed sector, K, which is attached rigidly to the axis of G', the grating may be rotated about this axis which passes through the centre of the plane of the grating, thus reflecting any desired part of the spectrum of any order through the lens to C. By means of the vernier-pointer, V, readings to tenths of a degree may be made on the graduated arc E and a record of these readings with the corresponding wave-lengths of the spectra reflected to C is kept, so that by turning K'' until V points to the proper angle, any desired wave-length may be reflected to the centre of C and the grating may be clamped in this position by tightening the screw-clamp K'. The lens may be shifted and clamped at any focus by means of the handle H, and the position of the pointer F is read on a millimetre scale attached to the bottom of B, as shown in Fig. 26. Ordinarily the side represented in Fig. 26 is facing downwards and a mirror is placed below the scale and the arc so that the reading may be made conveniently. In addition to these movements of the grating and lens, the mountings permit of rotation of the spectrograph as a whole about its axis, *i.e.*, about the line joining the centre of the slit and the centre of the lens. This idea was suggested by Mr. Plaskett (Report Chief Astronomer for the year ending March 31, 1907, p. 58) and employed by Newall (Monthly Notices 68, 7, Nov., 1907), and used also in the spectrograph mounted vertically and used with the vertical telescope of the Mount Wilson Solar Observatory. It facilitates the study of the rotation of the sun, by enabling the observer to reflect the limbs of the sun at opposite ends of any diameter always tangentially to the slit, as described in detail under (*c*), in Fig. 25, A and B are the two ends resting on the supports A' and B' which rest on the cement piers P and P' built on the cement floor. The end A is of half-inch cast brass. It has a V-groove running around its circular rim into which the semi-circular cast-iron support A' is bevelled to fit. The back of A is a rectangular box 3 in. by 11 in. by 14 in., over which the wooden box O is tightly screwed and clamped. The axis of B, which is of cast-iron, rests in a cylindrical bearing in the brass support B'. The box on B projects 3 in. on top and 16 in. on the sides and bottom to give good support for the lens and grating and to provide a surface to which the box O is screwed tightly. The bottom of B is milled smooth to give easy bearings for the grating and lens mountings. The box O is painted black on the inside and is provided with diaphragms, M, to prevent as much as possible the diffused light reflected from the lens and grating from striking the photographic plate in the holder, C. There is a hinged door, D, just above the grating and lens so that these may be conveniently reached.

The spectrograph thus rests at its two ends on the supports A' and B' on which it may be rotated about its axis. The rim of A is toothed (T, Fig. 25) and into these teeth fits a gear attached to T' (Fig. 27), which is supported in A' and which may be turned by means of the handle T' (Figs. 27 and 28). The circular face of A is graduated in degrees and by means of the vernier attached to A' the angle may be read to tenths of degrees. This is necessary in determining the 'East and West' line by allowing the image of the sun to drift across the face of A tangentially to some arbitrary line on A. From this angle read on the vernier, the position of the diameter of the sun's disc which lies in the plane of the sun's equator, is easily found since the inclination of these two lines to each other at any time is known, and hence the arbitrary line on A may be made parallel to any required diameter of the sun's image.

The mountings were constructed by the Victoria Foundry Co. from designs made in accordance with the suggestions of Mr. Plaskett who supervised the construction of the spectrograph. The mechanisms for rotating the grating and the spectrograph were skillfully constructed by Messrs. Mackay and Lucas.

(*c*) *Slit-Attachment.*

The slit-attachment is shown in Fig. 27. It was designed by Mr. Plaskett and made by the John A. Brashear Co., *a*, *b*, *c*, *d* are 45° reflecting prisms mounted on

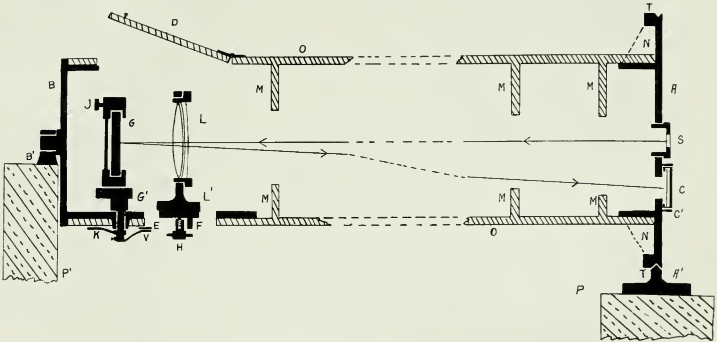


Fig. 25—Solar Spectrograph.

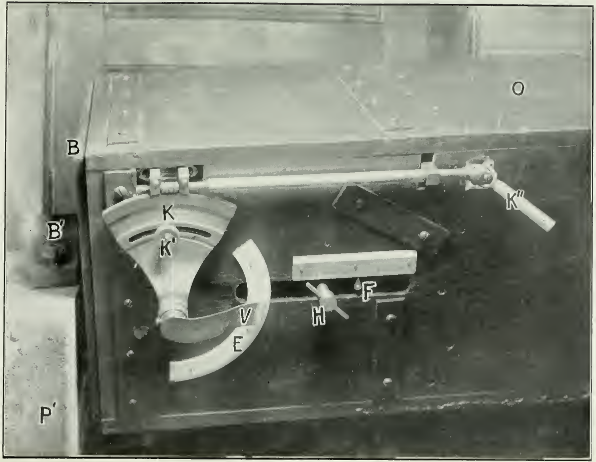


FIG. 26—Rear end of Solar Spectrograph.

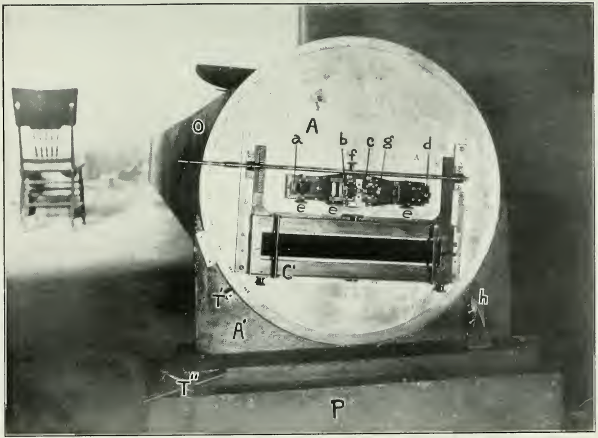


FIG. 27—Slit Mechanism of Solar Spectrograph.

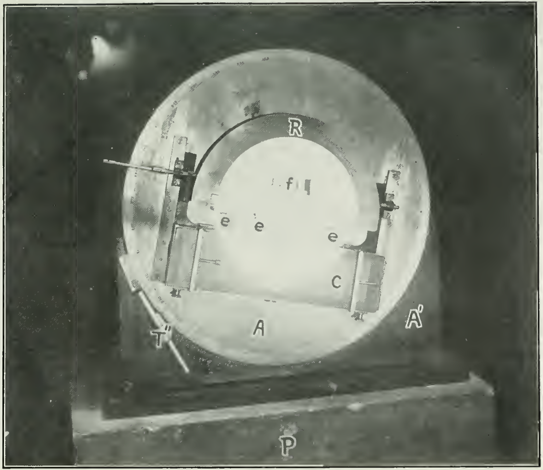


FIG. 28.—Front End of Solar Spectrograph.

brass plates which are supplied with racks and pinions e, e, e. When the sun's image is placed concentric with the circular front of the spectrograph, the prism d is moved to take the light from any desired point near the sun's east limb and reflects it to the prism c, which directs it down through the slit to the lens and grating. In a similar way the larger prism, a, reflects to the west limb through the prism b, whose tapering ends form a V-shaped space into which the tapering end of c fits closely, so that the spectrum from the east limb is placed closely between two strips of the spectrum from the west limb. The widths of these strips may be varied by moving the plate holding the prisms b and c back and forth, and by means of two little slides placed directly over the ends of the slit. When desired the shutter, f, may be used to keep the light passing through the slit from reaching the lens. In place of the plate bearing the prisms b and c, the attachment, h, may be used and by means of two adjustable screws which serve as stops between which it may be shifted so that two spectra of any desired widths may be taken in succession, the one being placed between two strips of the other, the V-shaped openings and the V-shaped slides providing the means for adjusting the widths of the strips. The prism arrangement is intended for obtaining plates for measuring the rotation of the sun or for any investigations where it is desirable to take the spectra simultaneously, while the attachment, h, is designed for taking spectra in succession, and of course the time of an exposure will be less in using it than in using the prisms which diminish the intensity of the light considerably.

(d) Camera and Plate-holders.

The plate-holders are made to take a 2·5 in. x 12 in. plate, a hinged back with three springs pressing the back of the plate at its edges holding the plate firmly in place without danger of bending it. The plate-holder, C, Fig. 28, is slid into the frame C', Fig. 27, and clamped, as shown in Fig. 28. The frame C' can be raised or lowered by rack and pinion as shown, so that several strips of spectra may be put side by side on the same plate, and spaced as desired by reference to the millimetre scale on the right hand side. The plate-holder fits over a 1·5 in. opening in A, Fig. 27. The frame C' may be tilted slightly so that the plane of the photographic plate may be made to follow more closely the focal surface of the lens.

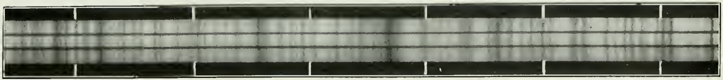
(e) Guide-plate for the Sun's Image.

In Fig. 28 is shown the guide-plate R, screwed tightly over the slit-attachment. R has a number of concentric circles and a diameter scratched on its surface and blackened so as to be easily visible. These circles are concentric with the circular front of the end-piece A. The figure shows the sun's image placed concentric with these circles. At each end of the diameter of these circles is a small rectangular opening, back of which is a little slotted silver-plated shutter which runs in bevelled slides. These shutters may be adjusted by means of the millimetre scales on the edges of the two rectangular openings, so that the slots are tangential to the same circle whose diameter is read off directly, the distance between the nearest ends of the rectangular openings being 200 mm. In the same manner the diameter of the solar image is measured. Back of these slots the prisms are adjusted to give the maximum brightness in the light reflected from the grating, and thus the spectrum from a point in the image near one limit may be placed between two strips of the spectrum from a part of the image at the other end of the diameter. To get any desired latitude on the sun's disc, the image is allowed to drift across the guide-plate tangentially to the diameter—the arbitrary line mentioned above—scratched on the plate and the vernier reading taken of the angle corresponding to this 'east and west line' which makes a known angle at any time with the sun's equator. The handle T'' is then turned to place the diameter in the desired position. One slit will thus be placed at a certain latitude north of the sun's equator and the other at the same latitude south of the equator, and the displacement of the spectral lines resulting therefrom will give a measure of the rotation of the sun in this latitude by turning T'' so that the slits are placed at the same latitude, but on the opposite sides of the equator to those of the former position the same displacement should result if: (1) the sun's equator has been accurately determined, (2) the image in both cases is concentric with the circles on the guide-plate, and (3) the rotation of the sun is the same for the same latitude in both hemispheres. Taking the mean of the two measures from plates taken in succession would eliminate most of the errors introduced.

SOME RESULTS.

The spectrograph was mounted in August, 1908. The cement piers, P, P' (Figs. 26, 27, 28), are made so as to make the axis of the spectrograph coincident with the axis of the coelostat mirror in the coelostat house, when the image from it is placed in the middle of the face, A, of the spectrograph, P being a few inches higher than P', giving the proper inclination (about $3\frac{1}{2}°$). The spectrograph was adjusted and numerous test photographs were taken in the various parts from λ 3800 to λ 6000. To keep the light reflected back from the surfaces of the lenses from striking the photographic plate the ordinary method of putting a strip across the lens, parallel to the plate, was tried; also, in some tests, the lens was tilted forward so as to throw the reflected light below the photographic plate. This latter method does not alter the character of the lines very much and possesses the advantage of doing away with the strip which masks the central part of the grating and lens. It was soon found that the character of the spectral lines in the different orders from either the left or right inclinations of the grating was not as good as desired. By directly reflected light the grating appears to have three areas of different reflecting powers and it was found that the spectra from these areas did not harmonize. The best spectra were obtained by masking the two smaller areas and using the remaining strip which constituted the right three-fifths of the grating. Even from this part of the grating the spectral lines are poor. In the first and second orders the spectra from the grating tilted to the right are much more intense than those obtained when the grating is tilted to the left, while the reverse is the case in the third order, and furthermore the lines are sharper when the grating is tilted to the left. Consequently the rotation plates obtained were made with the grating tilted to the left and the left two-fifths of the grating masked together with the central strip placed over the face of the lens to cut off the reflected light. The focal curves, for left and right inclinations of the grating were obtained in the first three and part of the fourth orders, for the whole grating with the central strip masked. These are plotted in Fig. 29, the dotted lines being the photographically determined curves and the continuous lines, those visually determined. It will be seen that the locus of the foci for any wave-length in the different orders, instead of being a straight line of constant focus, is a curve (nearly a straight line) of varying focus. This is very likely due to the character of the reflecting surfaces between the scratches on the grating, for it may be assumed that the diamond scratching-point distorted the strips between the scratches in such a way as to make one side of the surface slightly convex and the other slightly concave, as might easily happen since on one side of the diamond-point the speculum is scratched or furrowed, while on the other side it is not. At any rate the grating is not what it should be for the work planned for this spectrograph. This work must necessarily deal with the exact positions and character of the spectral lines and any large or small changes in these. It is chiefly the minute changes that are of interest at present in solar investigations, and the very best possible definition of the spectrum lines is required for a satisfactory measurement of these changes. It is hoped that a new grating of first quality may soon be secured, as such is necessary to yield satisfactory results. Everything else is now in readiness for the careful study of solar problems.

Fig. 29—Focal Curves of Solar Spectrograph.



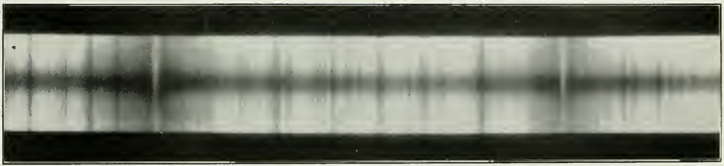


Fig. 30—Part of Rotation Plate L 413. Scale of the original, 1 A.U. = 1.115 mm.
Part of sun-spot Plate, L 405, showing emission in K and H. Scale of the original 1 A.U. = 1.11 mm.

In addition to rotation-plates, plates of the sun spot spectra were obtained whenever the conditions were suitable. Samples of both are shown in Fig. 30. In the following table the measurements of a sample rotation-plate (L 413) are given. In taking these plates long exposures (10 or 12 minutes in the third order near 4300) were necessary owing to the fact that a very small area of the grating was used. During this interval the sun's image would become blurred and distorted, thus allowing light from different points on the sun's surface to pass through the slits. The poor values in the following table are probably partially due to this cause and partially also to aberrations produced by some of the curious properties of the grating and to the very poorly defined lines produced. Many of the lines were so poor that measurements of them were not made and many of the finer lines were spread out and weakened so as to be almost invisible. It is hoped that the new grating will remedy these defects.

Measurements of plate L 413, 0°·0, slits 226mm. apart, diameter of the sun 232 mm.:—

λ	Mean of 5 mm. readings middle strip	Mean of 5 mm. readings lower strip.	Mean of 5 mm. readings upper strip.	Mean difference.	2δλ	Velocity km. per sec.
4136·678	2·9828	3·0314	3·0430	0·0544	0·0488	1·77
4137·156	3·5233	3·5650	3·5931	557	499	1·81
4140·089	6·7876	6·8342	6·8411	500	448	1·62
4147·836	15·4109	15·4623	15·4711	558	500	1·81
4149·533	17·2990	17·3517	17 3520	529	474	1·71
4150·411	18·2771	18·3256	18·3411	513	460	1·66
4154·071	22·5768	22·6215	22·6324	502	450	1·62
4154·667	23·0205	23·0724	23·0828	571	512	1 85
4154·976	23·3789	23·4309	23·4333	532	477	1·72
4157·948	26·6898	26·7408	26·7492	452	405	1·46
4157·948	26·6868	26·7431	26·7558	627	562	2·03
4158·959	27·8144	27 8550	27·8718	490	439	1·58
4163·818	33·2268	33·2824	33·2919	604	542	1·95
4169·110	39·1097	39·1550	39·1763	560	502	1·81
4171·068	41·2803	41·3317	41·3462	587	526	1·89
4174·095	44·6767	44 7188	44·7331	489	438	1·57
4175·806	46·6005	46·6480	46·6549	510	457	1·64
4176·739	47·6361	47·6780	47 6990	524	470	1·69
4179·025	50·1899	50 2346	50·2450	499	447	1·60
4179·025	50 1928	50·2358	50·2405	454	407	1·47
4181·919	53·4269	53·4799	53·4878	571	512	1 84
4182·548	54·1376	54·1827	54·1958	517	463	1 66
4187·204	59·3360	59·3872	59·3987	570	511	1·83
4187·943	60·1723	60·2212	60·2388	577	517	1·85
4187·943	60·1754	60·2208	60·2423	562	504	1·81
4196·372	69·5688	69·6076	69·6247	474	425	1·52
4199·267	72·7938	72 8540	72·8663	664	596	2·13
4199·267	72·8065	72·8626	72·8720	608	545	1·95
4201·089	74·8526	74·9020	74 9137	553	496	1·77
4202·919	76·8960	76·9398	76·9492	485	434	1·55
4203·730	77·8073	77·8667	77·8677	599	537	1·92
4204·622	78·7510	78·8003	78·8116	550	493	1·76
4207·291	81·7826	81·8279	81·8413	520	466	1·66
4208·766	83·4393	83·4904	83·4972	545	488	1·74
4213·812	89·0824	89·1385	89 1469	601	539	1·92
4216·351	91·9078	91·9656	91·9685	593	532	1·89
4220·509	96·5671	96·6150	96·6305	557	499	1·77
4233·328	110·4159	110 4651	110·4745	539	483	1·71
4236·112	113·1064	113·1574	113·1659	553	496	1·76
4236·279	113·2910	113·3460	113·3567	604	542	1·92
4236·279	113·2911	113·3482	113·3563	612	549	1·94
4238·970	116·3636	116·4092	116·4177	499	447	1·58
4246·966	126·2158	126·2723	126·2819	613	550	1·94
4258·774	139·0965	139·1464	139·1514	524	470	1·66
4265·418	147·6064	147·6630	147·6666	584	524	1·84
4268·915	150·7909	150·8440	150·8464	543	487	1·71
4271·325	153·4834	153·5426	153·5454	606	544	1 91
4271·934	154·6638	154·7190	154·7275	595	533	1·87

Measurements of Plate L 413 (Continued).

λ	Mean of 5 mm. readings middle strip	Mean of 5 mm. readings lower strip	Mean of 5 mm. readings upper strip.	Mean difference.	2δλ	Velocity km. per sec.
4274·958	157·5662	157·6159	157 6230	0·0533	0·0478	1·68
4279·643	162·8316	162·8856	162·8923	574	515	1·81
4282·565	166·1090	166·1575	166·1650	523	469	1·64
4283·169	166·7867	166·8456	166·8437	580	520	1·82
4287·566	171 7201	171·7671	171·7684	477	427	1·49
4288·310	172·5555	172·6182	172·6188	630	565	1·98
4289·525	173·9153	173·9697	173·9714	553	496	1·73
4289·885	174·3185	174·3698	174·3829	579	519	1·82
4290·080	174·8803	174·9256	174·9400	525	475	1·66
4390·377	175·0671	175·1189	175·1266	557	499	1·74
4291·114	176·2785	176·3263	176·3375	534	479	1·67
4295·383	181·0754	181·1309	181·1437	619	555	1·94
4300·211	185·9150	185·9642	185·9754	548	491	1·71
4300·211	184·7011	184·7533	184·7603	557	499	1·74
4302 692	187·4850	187·5400	187·5453	577	517	1·80
4312·462	200·4632	200·5002	200·5203	571	512	1·78
4316·962	205·6104	205·6557	205 6737	543	487	1·69
4320·907	207·9588	207·9978	207·0193	498	446	1·55
4321·119	208·1885	208·2350	208·2553	567	508	1·76
4331·811	220·2219	220·2719	220·2817	549	492	1·71
4337·216	226 3078	226 3617	226·3729	595	533	1·85
4338·084	227 2934	227·3348	227·3580	530	475	1·64
4338·430	227·6796	227·7315	227·7403	563	505	1·75
4339·617	229·0152	229·0619	229·0751	533	478	1·65
4339·882	229·3068	229·3559	229·3787	605	542	1·87
4343 861	233·7958	233·8477	233·8647	604	542	1·87
4344·451	234·4621	234·5066	234·5309	567	508	1·74
4344·670	234·7022	234·7509	234·7669	567	508	1 75
4344·670	234·7023	234·7510	234·7679	572	513	1·77
4351·216	242·0735	242·1259	242·1400	595	533	1·84
4351·216	242·0719	242·1223	242·1343	564	506	1·74
					Mean....	1·77

The scale, which is practically constant over the whole plate, is 1 A. U. = 1·115 mm., hence $2\delta\lambda = \frac{\text{mean difference}}{1{\cdot}115}$. The velocity is $\frac{\delta\lambda}{\lambda}$ (Velocity of light) = $299860 \frac{\delta\lambda}{\lambda}$ km. per second. Heliographic latitude of the centre of the sun's disc was 6° 26′ when plate L 413 was taken, consequently the velocity at the equator, as determined by this plate is $\frac{232}{226} \cdot 1{\cdot}77 \cdot \frac{1}{\cos 6° \ 26'} = 1{\cdot}83$ km. per second. This value is the linear velocity of the sun's limit at the equator, as measured, and will evidently give the synodic period of the rotation, the value for which is 1·86, as given by Adams. To reduce to the sidereal period requires the addition of 0·14km., making the velocity 1·97km. The generally accepted value is approximately 2·05km. per second, and the deficiency in the present case may be safely ascribed to errors introduced by the grating.

APPENDIX D.

DOUBLE STAR MEASURES. PHOTOGRAPHS OF COMET MOREHOUSE. OCCULTATIONS OF STARS BY THE MOON. FIELD INSTRUMENTS. ABERRATIONS OF THE STELLAR CAMERA OBJECTIVE.

R. M. MOTHERWELL.

DOUBLE STAR MEASURES.

Three half nights each week have been devoted to micrometer and photographic work, including the series of tests made on the camera objective. Micrometer work has consisted principally of the determination of the position angles and distances of visual double stars, the working list being prepared from Burnham's Catalogue of Double Stars. An endeavour is being made to measure only those which have not been measured for some time or whose motion is such as to require frequent measurements.

The filar micrometer used, is the Warner and Swasey type, and it has been found rather unsatisfactory in the determination of position angles owing to there being no quick-motion screw for moving the position circle. A self-registering attachment would be a great improvement as the present arrangement requires the frequent use of a hand-lamp which dazzles the eye. Considerable difficulty has also been experienced in keeping the eye-piece clear of frost in the winter, each setting of the micrometer-head or position-circle requiring several clearings of the glass.

Following are the measures made during the past year, each measure being the mean of eight settings for position angle and four double-distance measures:—

Star No.	Date.	Position Angle.	Distance.	Star No.	Date.	Position Angle.	Distance.
		°	″			°	″
151..........	1908·786	279 0	1·34	7117....	1908·464	298·2	Cloudy.
269..........	1908 765	113·9	5·78	7318..........	1908·317	184·3	3·81
1427..........	1908·921	313·9	3·28	....	1908·575	186·8	4·01
1750..........	1908·921	249·1	17·24	7429·5........	1909·429	252·9	9·39
2040..	1908·921	218·8	4·21	7450..........	1908·575	15·2	8·70
2043..........	1908·921	328·5	....	....	1908·617	14·3	9·21
2536...... ..	1908·996	305·3	2·73	....	1908·631	14·0	9·53
3398..........	1908·996	6·4	....	....	1909·412	14·9	8·91
4452........ ..	1909·341	43·3	2·60	....	1909·429	13 9	9·32
4530...... ..	1909·086	139·6	6·12	7451....	1908·317	255·4	16·64
4890...... ...	1908·247	196·9	5·14	....	1908·464	254·1	17 11
....	1909·086	196·7	4·88	....	1908·575	254·8	16·57
....	1909·303	197·0	5·11	....	1908·617	256·0	16 17
5011..........	1908·247	45·5	1·88	....	1908·631	254·6	16·65
5014...... ..	1909·202	235·9	3·50	7458	1908·575	288·9	3 21
....	1909·303	234·0	3·39	7604...	1908 464	211·9	17·12
....	1909 341	235·5	3·40	....	1908·497	211 9	16 89
5125...... .	1908·304	146·5	3·43	....	1908·575	214·0	16 59
5319...... ..	1908·304	176·9	2·50	7642.. .. .	1908·575	89 8	1·77
....	1908·426	177·3	2·78	7915.........	1908·439	18·2	5·03
5337.........	1908·977	295·2	30·78	....	1908·492	20·0	5 38
....	1909·183	294 4	31 50	....	1908·617	18·4	5·48
....	1909·202	294·8	31·89	5388...... .	1908 247	117·4	3 88
....	1909·399	294·3	31·09	....	1908 426	115 5	3 43
6780..	1909·183	353·4	Too frosty	....	1909·183	114·1	3 89
7065...	1909·183	111·1	"	....	1909·399	116·4	3 82

Star No.	Date.	Position Angle.	Distance.	Star No.	Date.	Position Angle.	Distance.
		°	″			°	″
5126	1908·247	68·6	3·05	.....	1908·641	338·7	27·47
.....	1909·303	68·1	3·50	.....	1908·765	339·3	26·90
.....	1909·399	66·5	3·27	9034	1908·541	51·9	7·84
5705	1909·303	32·2	3·37	.....	1908·581	50·5	8·50
5809	1908·977	27·6	24·86	9037	1908·541	7·41	5·90
.....	1909·078	28·0	25·17	.....	1908·581	7·33	5·88
.....	1909·086	30·7	24·90	.....	1908·641	7·24	5·68
.....	1909·202	27·6	24·89	.....	1908·765	7·12	5·91
.....	1909·303	28·3	25·33	9167	1908·541	154·8	0·84
6030	1908·426	308·5	2·80	.....	1908·613	154·5	0·89
6033	1908·426	108·8	6·28	9604	1908·541	9·7	2·81
.....	1909·078	107·8	5·72	.....	1908·613	10·5	2·75
.....	1909·202	106·8	6·06	9693	1908·492	138·6	4·07
.....	1909·303	106·7	6·57	.....	1908·522	138·0	3·74
6035	1909·078	178·9	16·32	.....	1908·575	138·3	.....
.....	1909·086	181·7	16·10	.....	1908·581	138·6	4·01
.....	1909·183	179·3	16·50	.....	1908·613	137·8	3·93
.....	1909·399	179·4	16·41	9905	1908·600	271·1	.....
6211	1908·426	359·2	2·60	9969	1908·600	155·7	Cloudy.
6386	1909·360	119·0	2·99	9977	1908·641	170·1	4·31
7927	1908·617	127·0	33·08	.....	1908·765	171·0	4·31
.....	1908·631	125·3	33·24	.....	1908·786	171·8	3·50
.....	1909·429	126·5	33·21	10061	1908·765	185·3	7·18
7930	1908·617	180·8	24·94	10072	1908·613	212·2	Hazy.
.....	1908·631	180·5	24·93	10305	1908·522	74·2	"
8003	1908·309	312·4	4·15	10385	1908·581	111·0	3·51
.....	1908·445	313·3	4·17	10685	1908·522	164·6	1·89
8082	1908·309	22·8	8·11	10709	1908·613	158·3	3·39
.....	1908·426	22·6	7·98	10742	1908·613	349·2	22·90
.....	1908·439	25·4	7·91	.....	1908·765	351·5	23·89
.....	1908·445	24·4	7·95	10773	1908·522	309·3	3·37
8303	1908·309	258·5	2·67	.....	1908·541	307·9	.....
.....	1908·445	258·7	.....	.....	1908·581	307·5	3·71
.....	1908·617	259·7	2·53	.....	1908·786	307·8	3·44
8364	1908·617	81·6	2·71	.....	1908·805	308·8	3·18
.....	1908·746	78·2	2·87	10901	1908·613	112·6	5·68
.....	1908·765	79·4	2·70	.....	1908·641	112·0	5·60
.....	1909·429	78·2	3·00	12043	1908·765	34·3	5·91
8384	1908·624	79·0	1·49	12753	1908·765	160·1	3·09
8404	1908·631	338·4	27·15				

COMET 1908c (MOREHOUSE).

This comet was visible for over three months, but dense smoke and unusually cloudy weather prevented any attempt at obtaining an extensive series of photographs. Single exposures were made on seven different nights, with the Brashear Doublet attached to the equatorial telescope. A filar micrometer was used in guiding and was very satisfactory in preventing drifting but, owing to the smallness of its field, did not permit of the head of the comet being shifted appreciably from the centre of the camera field. Had it been possible to so shift the head, more of the tail would have been included in the photograph.

The following table gives the date and duration of each exposure:—

Plate.	Eastern Standard Time.	Beginning of Exposure.		Duration.		Remarks.
	1908.	h	m	h	m	
31	October 16	6	45	1	0	Very smoky.
32	" 19	6	10	1	5	"
33	" 31	7	25	0	55	Clear.
34	November 1	7	15	0	55	Clear but unsteady.
35	" 13	6	15	1	0	Very clear.
36	" 26	5	30	1	25	Clear, high wind.

FIG. 31 & 32—Morehouse's Comet.

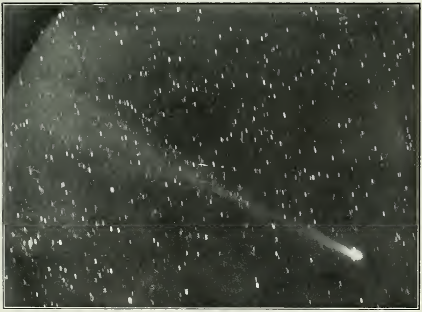


FIG. 33 & 34—Morehouse's Comet.

Fig. 35 & 36—Morehouse's Comet.

An exposure of one hour was made on October 20, but the smoke was too dense. In the course of the exposure the head of the comet passed over an eighth magnitude star without perceptibly dimming it.

Fig. 31. The dense smoke accounts for the faintness of this photograph, but still it is the most interesting one of the set, on account of the knots in the tail about one and a half degrees from the head. This portion seems to have separated from the head and drifted off while new matter has been given out. There has also probably been a motion southward on the part of this detached mass, greater than that of the comet as the new matter in the tail connects with the north side of the knots, while the southern part is altogether clear of the tail. The curved form of the central and southern portions of the detached mass is also worthy of notice. The new matter is connected to the head by a narrow neck and on either side rays extend back about 0·5 degrees.

Fig. 32. This photograph is even more faint than Fig. 31, but the head shows considerable detail. The new portion of the tail spoken of in Fig. 31 has apparently been forced back by the rays on either side, they being joined together now just back of the head. Although only three days have elapsed between these exposures we can readily see that, during this interval, the comet has been very active internally.

Figs. 33 and 34 indicate a continuation of this activity. Fig. 33 shows several distinct knots in the tail about one to one and a half degrees from the head. Beyond these the tail gradually widens out, being uniform on the north side but broken on the south side. Fig. 34, one day later, shows the same knots farther away from the head and more diffused. They seem to have been separated from the nucleus, the bright portion next to the head in Fig. 33 broadening out here into a fan-shaped tail. Beyond the knots the tail has widened slightly.

Fig. 35 shows a very bright tail extending out about two degrees with short rays on both sides of the head. As in Fig. 33 the north side of the tail is uniform, while the south side shows several offshoots. The comet was apparently in a very active state at this time, but thirteen days elapsed before I had an opportunity for another exposure, and Fig. 36 shows a much fainter and divided tail. Evidently the activity has become much less, the faintness of the tail being partly due to its division into two parts, but more particularly to a change in the conditions governing the state of the comet's head. Are these changes in appearance due to some internal state or are they due to changes in the surrounding medium?

While this set of photographs can lay no claim to completeness, it demonstrates clearly the necessity for frequent exposures at as close intervals as possible if we wish to know with any degree of accuracy the changes actually taking place. It also shows that these exposures should not be too long, otherwise one plate might be a combination of several phases.

No other comets were visible here in 1908, but several exposures were made toward the close of the year in search of Halley's comet. The end of July or the early part of August, 1909, should see the discovery of this famous celestial visitor. Photography will doubtless first reveal its presence and on account of this it is desirable that the stellar camera should be available for work every night. With the present mounting of the camera this means the suspending of all work with the equatorial at such times when the comet may be observed. This is much to be regretted as both the equatorial telescope and the camera are excellent instruments, and it is hoped that a separate mounting may be provided for the camera at an early date. Halley's comet will not return for at least seventy-five years, but every year brings with it new comets; so if our Dominion Observatory is to take a foremost place in the discovery and study of these strange visitors, the equipment necessary for camera work should be provided at once.

OCCULTATIONS OF STARS BY THE MOON.

The observations of occultations have been made mostly with the 15-inch equatorial telescope as its superior mounting and clock-work render it much more satisfactory than the 4½-inch Cooke telescope. Predictions have been made by the graphical method of Wm. F. Rigge, but less than 10 per cent of the predicted occultations were observed owing to cloudy weather. Following are the observations:—

OCCULTATIONS OF STARS BY THE MOON.

Date.	Phenomenon.	Star.	Limb.	G.M. Time of observation.		
1908.				h.	m.	s.
April 9	Disappearance	η Cancri	Dark	6	53	53·2
" 13	"	ν Virginis	"	7	2	55·6
	Reappearance	"	Bright	8	8	36 5
June 11	Disappearance	o¹ Libræ	Dark	13	44	23·3
" 12	"	ν² Scorpii	"	11	28	11·1
	Reappearance	"	Bright	12	0	16·8
October 13	Disappearance	n Tauri	"	16	52	41·0
November 1	"	γ Capricorni	Dark	5	30	1·8
1909.						
January 7	"	γ Cancri	Bright	12	19	15·8
March 12	"	β¹Scorpii	"	16	35	6·1
	Reappearance	"	Dark	17	25	37·8
	Disappearance	56B Scorpii	Bright	16	35	59·7
	Reappearance	"	Dark	17	24	50·0
March 14	Disappearance	63 Ophiuchi	Bright	16	12	3·1
	Reappearance	"	Dark	17	30	57·4

INSTRUMENTS USED ON THE BOUNDARY AND GEODETIC SURVEYS.

The instruments used on these surveys have all been carefully catalogued and stamped, an index system being used which shows the office number, description of instrument, price, date of receival, name of maker, location and disposal of each instrument. A separate account is also kept of the instruments as taken out by each party in the spring, so that each man can readily see what instruments he is held responsible for.

Following is a list of the principal instruments used during the season of 1908:—

Name of Instrument.	Number Used.	Name of Instrument.	Number Used.
Barometers	20	Heliotropes	8
Balances	5	Levels	11
Binoculars	18	Plane Tables	5
Cameras	18	Sextants	2
Chronometers	14	Tapes	25
Clinometers	4	Telescopes	9
Compasses	25	Transits	47

ABERRATION OF THE STELLAR CAMERA OBJECTIVE.

The stellar camera used in the Dominion Observatory, Ottawa, for photographing star clusters, nebulæ, comets, or any other celestial objects covering a wide field, is fitted with a Brashear photographic doublet of 203mm. aperture and 1060·3mm. focus. The camera tube (Fig. 37) is bolted to the telescope tube opposite to its place of attachment to the declination axis. This method of mounting is rather unsatisfactory, however, as the telescope tube intercepts a large portion of the light on the west side of the plate.

The effective field has a diameter of about 11° 20′, so the camera is well adapted in this respect to its work. The tube containing the objective is nickelled and moves freely in the main metal tube, the position of focus being adjusted by a rack and pinion with a clamp screw to hold it in the required position. This position is read on

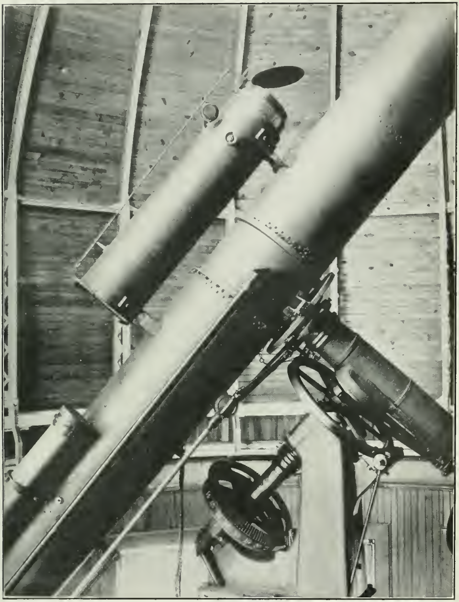


Fig. 37—Stellar Camera.

a millimetre scale. A metal shutter covers the objective and the plates are held in a metal frame fitted with springs. When accurate guiding is required the micrometer wires in the telescope are used, the great focal length of the refractor, as compared with the camera, rendering the guiding a simple matter.

The following description of the lens is given by Dr. Brashear:—

'The general construction is that which was first found by Petzval years ago, and has proven itself quite the best, where great angular aperture with sharp definition is required. The curves have been somewhat modified from our experience in the construction of other lenses—particularly those made for Dr. Max Wolf, of Heidelberg, Germany. It departs, however, from the ordinary practice of opticians in being corrected for short wave-lengths of light. This would be quite objectless in a camera which is to be used for portraits, but is not without moment in astronomical photography. The materials employed were specially chosen for their transparency, the flint being very light and the crown very white. The focal lengths of the front and rear combinations are in a ratio of about 7 to 12, while the focal length of the system is very nearly five times the aperture. The focal length we may find very slightly modified: indeed it is our custom to balance the inevitable zonal differences of magnification, which difficulty is found the most formidable to all constructors of astronomical photographic objectives.'

The camera gives a more uniformly defined field than most cameras of this type, but the definition is not sufficiently sharp to produce clear cut images. When a long exposure is made to reach faint stars there are three resulting forms of image. The fainter stars give a clear cut image, the next in brightness give an image with a dark centre surrounded by a halo, while the brighter stars give an image of uniform density but much enlarged. This variation in the images must be due to aberration, either spherical or chromatic, producing, instead of point images, discs of sensible size, possibly with a centre somewhat more intense than the surrounding portion. The difference in the appearance of the images of stars of different brightness on the negative is thus readily explained by the light of the fainter stars not being sufficient to form a halo, as in the next brighter stars, while in the very bright stars the light is strong enough to make the halo as dense as the central portion. The only question is whether this aberration is spherical or chromatic.

The most simple test for the presence of zonal errors in a lens is that of Hartmann, the theory involved being very simple, and the equipment for the experiment

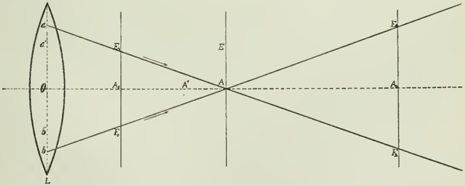


FIG. 38.

being within reach of any one. This method involves the determination of the point of intersection of rays of light passing through the lens at opposite ends of a diameter and equidistant from the centre.

Let L (Fig. 38) be the lens under test and consider two rays passing through a, b, so that $0a = 0b$. These rays converge to a point A which is called the focus of these rays. If these rays are intercepted at A we find them in a single point, but if intercepted at E_1 or E_2 we find them separated by a distance d_1 or d_2. These distances may be measured with a micrometer, or photographic plates may be placed at E_1, E_2, and the distances between the resulting images measured. This latter method has been employed in the present test.

Measuring the distances $0A_1$, $0A_2$ and d_1, d_2, we can easily obtain the correct position of focus.

Let $0A_1 = A_1 \quad E_1\ F_1 = d_1$

$0A_2 = A_2 \quad E_2\ F_2 = d_2$

$0A = A$

Then $A = A_1 + \dfrac{d_1}{d_1 + d_2}(A_2 - A_1)$. This is a simple geometrical property requiring no proof.

Again, consider two rays passing through at a', b'. If the lens is correctly ground these two rays will converge to the point A as did a and b, and so with rays from all parts of the lens. But unfortunately this is a difficult condition to obtain, the best of lenses being but a close approximation to it. In place of converging to A, a' and b' converge to some other point, say A', giving what is called zonal aberration, so that if we focus our camera for a and b, it is out of focus for a',b', and we get a disc about our image.

Take two rays at a distance $0a$ from the centre but on a diameter perpendicular to a, b, and consider their focus. If the lens is symmetrical for this zone, then the four rays will meet at the point A, their common focus, but if not symmetrical there will be two different foci for the two pairs of rays. This difference is called axial astigmatism and can be revealed in the Hartmann test for aberration.

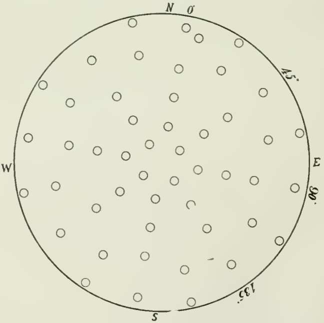


Fig. 39—Zonal Disc.

The lens is covered with a zone plate of the form shown in Fig. 39. The apertures are placed in ten zones of 15, 25, 35, 45, 55, 65, 75, 85, 94 and 98 mm. radius respectively. Each pair of openings is duplicated by a second pair at right angles in order to determine the axial astigmatism. In the case of the zones of 15, 25, 35, 45, 55, 65, 85 and 94 mm. radius, symmetrical pairs of apertures are placed 90° apart, but in the zones of 75 and 98 mm. radius the apertures are only 45° apart, so the outer part of the lens is more thoroughly tested than the centre. This is necessary owing to the greater amount of light admitted by the outer zones.

By making an exposure at E_1 and another at E_2, we can determine two positions of focus for each of the ten zones, these two positions being perpendicular to each other. An extra aperture in the zone plate enables one to identify the angle for the several zones and so avoid confusion in the determination of astigmatism.

The first zone plate used had apertures of 10 mm., but the diffraction at the edges was so great that in place of solid dark spots there were circular dark rings which did not permit of accurate measurement. The second zone plate used had a diameter of 203 mm. with apertures of 5·5 mm. These plates were made of medium weight bristol board. Exposures of 6 minutes were made on Capella. In order to avoid as much as possible chromatic aberration, Seed Process plates were used, their band of sensitiveness being narrow and confined chiefly to the blue and violet light beyond λ 4600. A plate with a wider range of sensitiveness would give images so elongated radially by chromatic aberration as to render accurate measurements very difficult or impossible.

All measures were made on the Zeiss comparator, the graduations reading to thousandths of a millimetre and readily estimated to ten thousandths. Test plates were first made with 4 x 5 Seed plates, to determine the correct time of exposure, a plate-adapter being used in the regular plate-holder. The positions corresponding to E_1 and E_2 were at 22 mm. and 67 mm., respectively, on the focussing scale on the camera tube. This gave the distance $A_2 - A_1$ equal to 45 mm. In the appended results the focus given is that which would be used in setting according to the above mentioned scale. The actual focus of the camera was determined as follows:—The telescope was set midway between Castor and Pollux and a photograph taken, with the camera at its usual focus (47·5 mm. on the scale) and the zone plate removed. The distance between the images on the photographic plate was measured and found to be $d = 79{\cdot}5260$ mm.

From the Ephemeris we have—

	R. A.	Dec.
Castor,	$7^h\ 28^m\ 43^s.9$	$+ 32°\ \ 5'\ 28''.13$
Pollux,	$7^h\ 39^m\ 41^s.284$	$+ 28°\ 14'\ 56''.34$

The difference in R. A. is $0^h\ 10^m\ 57^s{\cdot}384 = 2°\ 44'\ 20''{\cdot}76$

Zenith distance of Castor is $57°\ 54'\ 31''{\cdot}87$

Zenith distance of Pollux is $61°\ 45'\ \ 3''{\cdot}6$

From $\cos a = \cos b \cos c + \sin b \sin c \cos A$, we have $a = 4°\ 30'\ 48''$ = the distance between Castor and Pollux.

Hence, from the cotangent of a and the value of d we have the focus required

$$f = 1060{\cdot}3 \text{ millimetres.}$$

When the correct time of exposure had been obtained, the regular 8 x 10 plates were used and a series of exposures made at E_1 and E_2. Although the original object in view was to test for spherical aberration at the centre, this was extended to cover the whole field of the lens and images were made extending across the plate from south to north, in order to determine the curvature of field. Nine images were obtained within the focus and nine without, their respective positions being:—

Position A, 5°·3 from centre towards south end.
" B, 4° " " " "
" C, 2°·5 " " " "
" D, 1° " " " "
" E, at centre.
" F, 1° from centre towards north end.
" G, 2°·5 " " " "
" H, 4° " " " "
" I, 5°·5 " " " "

Owing to the uncertainty of the weather, exposures at positions A, B, C, D and E were made on one plate without the focus, and then exposures were made on another plate at the same positions within the focus. Exposures at F, G, H and I were then made on two other plates. This unfortunately caused a slight change in the adjustment of the camera and the result was an unaccountable dip in the curvature of the field. Further test plates were made at positions E, F and H, which showed clearly that the dip was not due to any fault of the lens, the resulting curve being quite uniform, as shown in Figs. 43 and 44.

The several plates were first measured for aberration and astigmatism. A summary of the results is given in the appended tables and curves. As stated before, the positions E_1 and E_2 correspond to 22 mm. and 67 mm. on the scale attached to the camera. The camera was set at 47·5 mm. to determine the focus $f = 1060.3$ mm. So we have $A = 1034{\cdot}8$ mm. and $A_2 - A_1 = 45$ mm. To obtain the actual focus for each zone in the following results we must add 1034.8 mm. to each given focus.

Position A shows a negative aberration of 3·61 mm.
" B " " " 3·82 mm.
" C " " " 3·75 mm.
" D " " " 3·63 mm.
" E " " " 3·60 mm.
" F " " " 3·63 mm.
" G " " " 3·64 mm.
" H " " " 3·82 mm.
" I " " " 3·63 mm.

Such a marked aberration, extending so uniformly across the field, shows beyond any doubt the cause of the diffuse appearance of the images already referred to. The curves in Figs. 40 and 41, each division representing 1 millimetre, show very clearly the magnitude of the aberration and its uniformity across the field from south to north. Another plate R, made on the east side of the field, shows a similar aberration, curve *P*, Fig. 42, representing it graphically.

Taking the mean focus for each zone we find the astigmatism so small as to be neglected at the centre of the field but increasing as we move outward. A closer examination reveals the fact that where $\varphi = 0°$, 90°, 67°·5 and 157°·5, the astigmatism is the greatest. This is due to the varying angle of incidence of the rays on the plate in the several positions A, B, C, etc. This variation in angle affects the distance between the images in the respective zones inversely as the angles they make with the north and south line. Thus (see Fig. 39) when $\varphi = 0°$, the change in distance is greatest; when $\varphi = 90°$, the change in distance is least; when $\varphi = 45°$, the change is almost the same as when $\varphi = 135°$. So we see that the apparent variation in astigmatism is due to the position of the plate and consequent distortion of some of the images rather than to any defect in the lens.

As already stated, the Seed Process plate used has its maximum sensitiveness about λ 4300 in the blue light. Thinking perhaps the lens had originally been tested with yellow light, owing to the difficulty of obtaining monochromatic light in the blue, it was consequently decided to test the lens by visual or yellow light. Cramer Iso-

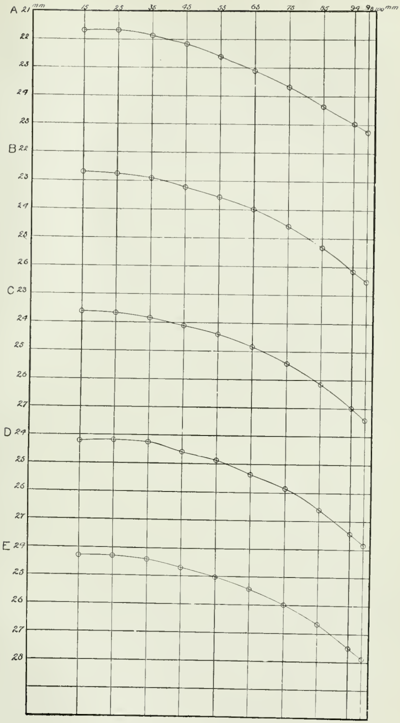


FIG. 40—Zonal Differences of Focus.

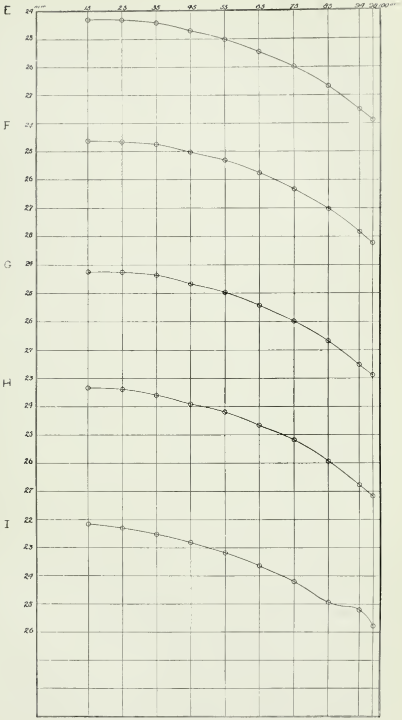


Fig. 41—Zonal Differences of Focus.

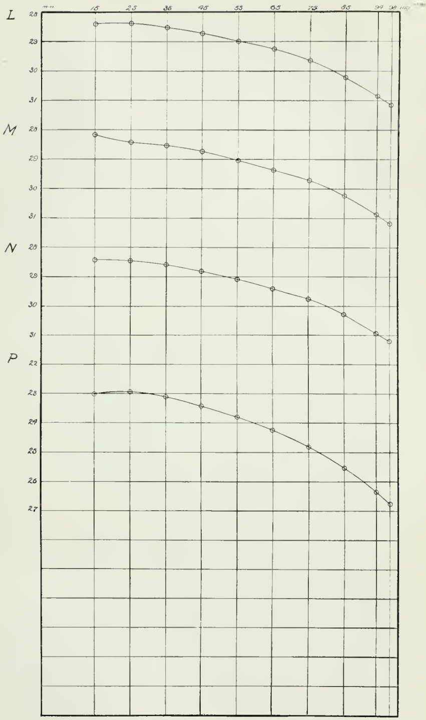


Fig. 42—Zonal Differences of Focus.

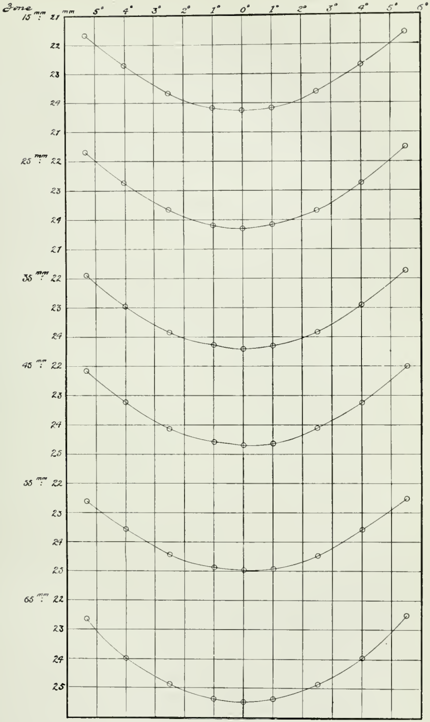


FIG. 43—Curvature of Field at different Zones.

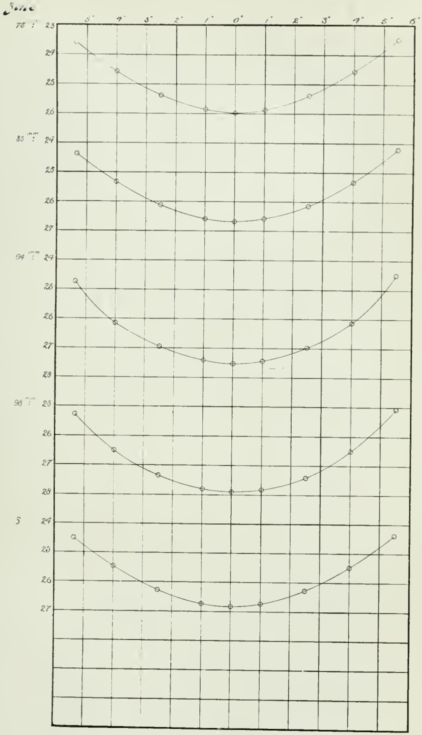


Fig. 44—Curvature of Field at different Zones.

chromatic plates were substituted for the Seed Process plates and a yellow screen was placed just above the plate-holder to cut out the blue and violet light. The Cramer plate was used as it has a band of sensitiveness in the yellow-green light about λ 5650, as well as the band of sensitiveness to blue and violet light possessed by all plates. Three exposures were made within the focus and three without, their positions being:

Position L, 50′ from centre to south.
" M, at centre.
" N, 50′ from centre to north.

The exposure in each case was 5 minutes.

Comparing these with positions A to I, we find the aberration less by about 0·6 mm.

Position L showing negative aberration of 2·77 mm.
" M " " " 3·03 mm.
" N " " " 2·78 mm.

But it is not small enough to indicate any special adjustment of the lens surface to yellow light. The uniformity of the aberration is shown in *L, M, N*, Fig. 42. The astigmatism is similar to that shown by the Seed Process plate.

A uniform increase of about 3·5 mm. in the focus, as compared with the blue light, is due partly to refraction of the light in passing through the yellow screen. The screen being about 6 mm. thick, the refraction would lengthen the focus by about 2 mm., the refractive index of glass being about 1·57. The remaining 1·5 mm. is due to the difference in focus of blue and yellow light.

Combining the results of positions A to I (see table XIV.), we have the focus of each zone of the lens at nine different points extending from 5°·3 on one side of the centre to 5°·5 on the other side. Figs. 43 and 44 show the curvature as given from these foci, the coordinates being the diameter of the field in degrees and the zonal foci in millimetres. As in the case of the aberration these curves are very uniform, indicating a difference of about 2·5 mm. between the focus at the edge of the field and that at the centre.

Since the zonal foci of the lens vary so much from the centre to the edge no one position of focus is suitable to all the lenses. To obtain a uniform field and at the same time get as sharp a definition as possible, we must study the effect produced by the various zones when out of focus.

If we set, for example, the camera at the focus of the zone with radius of 65 mm., then other zones will be out of focus and there will be discs or circles of confusion about each image. The density and size of these circles depend on the extent to which the several zones are out of focus and also on the area of these zones. The diameter of these circles of confusion may be determined as follows:—

$$d = 2r\frac{(F-F_0)}{F_0}$$

where d = diameter of circle of confusion,
r = radius of zone,
F = focus of zone,
F_0 = focus at which the camera is set.

This determines for us the circles of confusion but it does not give us any idea of the effect on the image. A circle of confusion of 20″ diameter and produced by a zone of 15 mm. radius would not be nearly so injurious to the image as one of the same diameter produced by a zone of 75 mm. radius. We see that simply determining the circles of confusion for the several zones will not give us the effect of the circles on the images, and so will not aid us in adjusting the camera to obtain the best images possible under existing conditions. We must determine at what position of focus the lens is most efficient. The following formula by Hartmann gives a test for the efficiency of a lens at various foci:—

$$T = \frac{200000}{F_0^2} \cdot \frac{\Sigma r^2 (F - F_0)}{\Sigma r}$$

where T = efficiency of lens,
F = focus of zone,
F_0 = focus at which the camera is set,
r = radius of zone.

(100000 is introduced simply to transfer the decimal point and so avoid exceedingly small numbers.) According to this test an objective is moderately good when T is greater than 1·5, good when T is between 0·5 and 1·5, and exceedingly good when T is less than 0·5. But as this criterion of efficiency refers to telescope objectives where the field of view and angular aperture are small, it is not an accurate test for photographic objectives of wide aperture.

Using the above formula, the best positions of focus at the several positions, A, B, C, etc., were obtained. Table XV. gives these foci, the diameters of the circles of confusion, and the efficiency of the lens. Curve *S*, Fig. 44, shows the combined results for the several positions A to I. From this curve it may be concluded that the best uniform field would be obtained by setting the camera at 25·75 mm. or 26·0 mm.

Testing for Chromatic Aberration.

Although the foregoing tests revealed a much greater spherical aberration than is consistent with the production of good negatives, objection was taken to the statement that this aberration was the cause of the observed defects in the images. Accordingly it was decided to test for chromatic aberration also.

The camera was detached from the telescope and mounted on a table, the source of light being an arc-lamp about 400 yards distant. The spectrograph was placed with the slit at the focus of the camera which was in line with the collimation tube. A cardboard disc was placed over the camera objective, the light entering through two oblong openings, 3 mm. by 8·5 mm., symmetrically placed on a common diameter.

Exposures were made with the slit first inside the camera focus and then outside, isochromatic plates being used to obtain the *D* lines. Images of the slits in the disc were thus obtained as produced by light of various wave-lengths. By measuring the distances between these images at twelve points and applying the Hartmann formula the focus of the camera was obtained for twelve different wave-lengths, as shown in the following table:—

Wave-length.	Focus.
λ 5893, *D*	41·93 mm.
5500	41·24 "
5180	40·33 "
4880H_β	39·30 "
4737	39·07 "
4520	38·62 "
4370	38·73 "
4230	38·79 "
4115	39·00 "
4020	39·71 "
3933, *K*	39·98 "
3780	40·88 "

Fig. 45 represents graphically the various foci and the chromatic aberration. The minimum focus is about $H\gamma$ and, while there is a range of 3·12 mm. in focus in the region between λ 5893 and λ 3780, there is less than 1 mm. range in the photographic region.

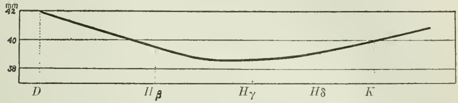


Fig. 45—Chromatic Aberration Curve.

Comparing this with the test for spherical aberration we have—

(*a*) Minimum spherical aberration of − 3·6 mm.

(*b*) Maximum chromatic aberration in photographic region of 1 mm.

Even if we allow for the chromatic aberration of 3 mm. at λ 5893, the light here is not rich enough in actinic properties to produce the observed halo. It seemed, therefore, unnecessary to continue the investigation *re* chromatic aberration.

Changing the Distance between the Components of the Outer Combination.

Prof. Hastings, of Yale University, who had been kept informed of the results of these tests, suggested that there might be sufficient internal reflection between the components of the objective to produce the observed halo and that this might be eliminated by increasing or decreasing the separation. Although we still felt that the defect was due to spherical aberration, this suggestion coming from the designer of the lens claimed our most careful attention and a series of tests were accordingly made. The original separation (one thickness of a postage stamp) was removed and new separations of various thicknesses used. Little blocks built up from bristol board were used until the best adjustment was obtained, after which hard rubber blocks were used.

The following table shows the tests and results:—

Date.	Separation of Components.	Focus.*	Spherical Aberration.	Description of Images.
1908.				
Jan	0 004 inches.	47·5 mm.	− 3·6 mm.	Described in first part of appendix.
1909.				
Jan. 12....	0·012 "	47·0 "	....	No change.
" 26....	Tissue paper.	47·5 "	....	"
Feb. 2.....	"	47·5 "	....	½″ and ¼″ discs were placed on lens to cut off outer portion, but there was very little improvement.
" 25.....	0 132 inches.	26·5 "	+ 2·4 mm.	Images about the same as originally.
Apr. 20.....	0·070 "	36·5 "	− 0·5 "	Images much improved. Halo greatly reduced.
May 25....	0·077 "	36·0 "	− 0·3 "	Images much the same as with .070 separation.

* Focus here refers to the scale on the camera tube.

Curve a, Fig. 46, shows the aberration with a separation of 0·004 inches, curve β shows the aberration with a separation of 0.132 inches, and curve γ shows the aberration with a separation of 0·070 inches. Figure 47 shows cuts of the Pleiades taken with the different separations.

Examining the above table it is seen that increasing the separation, shortened the focus and changed the aberration. Coincident with the change in aberration there was a decided change in the star images. Aberrations of – 3·6 mm. and + 2·4 mm. were accompanied by a very marked halo, while with an aberration of – 0·5 mm. the halo was negligible. Changing the separation to 0·070 inches has undoubtedly improved the objective as the field remained practically unchanged, and the halo was so small as to be neglected. But that this improvement has been effected by the removal of internal reflection does not seem at all probable. On the contrary, the above results seem to me to be but additional proof that the observed halo has been caused by spherical aberration, as was stated at the beginning of this appendix. It is not at all likely that the aberration and the halo would disappear simultaneously if the halo were caused by internal reflection.

Note.—Since the conclusion of the above work a communication has been received from the makers of the objective, stating that they also believe the defect to be due to spherical aberration and expressing their willingness to remove it without additional charge.

TABLE I.

ZONAL FOCI : POSITION A.

Radius of Zone	ϕ	d_1	d_2	Focus.	Mean.	Astigmatism.
	°	mm.	mm.			
15 mm..........	45	0·6450	0 6826	21·86	....	+0·20
	135	0·6333	0·6938	21·47	21·66	−0·19
25..........	0	1·0432	1·1627	21·28	....	−0·37
	90	1·0746	1·1201	22 03	21·65	+0·38
35..........	45	1·5131	1·5651	22·12	....	+0·23
	135	1·4948	1·6115	21·66	21·89	−0·23
45..........	0	1·9259	2·0621	21·73	....	−0·44
	90	1·9921	1·9715	22·62	22·17	+0·45
55..........	45	2·4355	2·3590	22·86	....	+0·26
	135	2·4166	2·4523	22·34	22·60	−0·26
65..........	0	2·8795	2·8646	22·56	....	−0·05
	90	2·9851	2·7288	22·66	22·61	+0·05
75..........	22·5	3·4195	3·1358	23·17	....	−0·15
	67·5	3·5344	3·0497	24·16	....	+0·54
	112 5	3·4794	3·1066	23·77	....	+0·15
	157·5	3·3935	3·2266	23·07	23·62	−0·55
85..........	45	4·0807	3·3663	24·66	....	+0·29
	135	4·0195	3·4899	24·09	24·37	−0·28
94..........	0	4·5566	3·7376	24 72	....	....
	90	....	....	....	24·72	....
98..........	22·5	4·8567	3·7280	25·46	....	+0·20
	67·5	....	....	....	....	....
	112·5	....	....	....	....	....
	157·5	4·8157	3 8320	25·06	25·26	−0·20

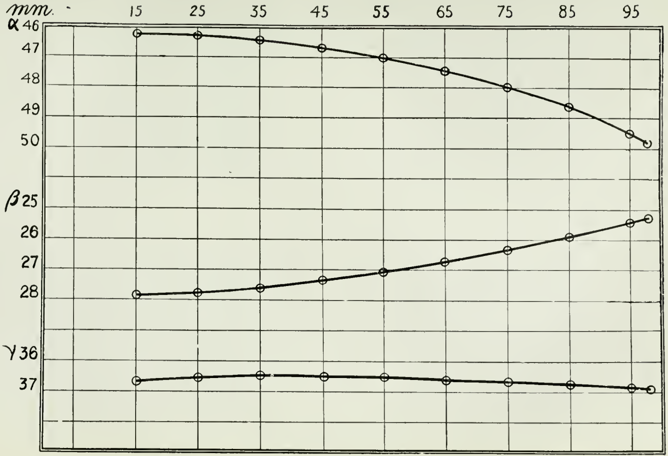
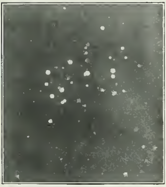


Fig. 46—Zonal Differences of Focus.



Focus 47·0
Separation—Tissue Paper.
No Disc.

Focus 47·0
Separation—Tissue Paper.
$\frac{1}{4}$-in. Disc.

Focus 26·5
Separation—0·132 inches.

Focus 36·5
Separation—0·070 inches.

FIG. 47—Star Photographs at Different Separations.

TABLE II.

ZONAL FOCI: POSITION B.

Radius of Zone.	ϕ	d_1	d_2	Focus.	Mean.	Astigmatism.
	°	mm.	mm			
15 mm	45	0·6694	0·6536	22·77	....	+0·08
	135	0·6625	0·6555	22·62	22·69	−0·07
25	0	1·1061	1·1020	22·54	....	−0·22
	90	1·1238	1·0793	22·99	22·76	+0·23
35	45	1·5766	1·5057	23·02	....	+0·10
	135	1·5740	1·5298	22·82	22·92	−0·10
45	0	2·0353	1·9518	22·97	....	−0·25
	90	2·0708	1·8979	23·48	23·22	+0·26
55	45	2·5308	2·2741	23·70	....	+0·14
	135	2·5368	2·3375	23·42	23·56	−0·14
65	0	3·0385	2·7147	23·77	....	−0·22
	90	3·0850	2·6503	24·21	23·99	+0·22
75	22·5	3·5797	2·9946	24·50	....	−0·07
	67·5	3·6489	2·9584	24·85	....	+0·28
	112 5	3·6175	2·9892	24·64	....	+0·07
	157·5	3·5760	3·0462	24·30	24·57	−0·27
85	45	4 2251	3·2505	25·43	....	+0·12
	135	4·2075	3·3061	25·20	25·31	−0·11
94	0	4·7707	3·5186	25·90	....	−0·28
	90	4·8840	3·4186	26·47	26·18	+0·29
98	22·5	5·0522	3·5470	26·44	....	−0·07
	67 5	5·0494	3·4591	26·71	....	+0·20
	112·5	5·0914	3·5125	26·63	....	+0·12
	157·5	5·0384	3·5950	26·26	26·51	−0·25

TABLE III.

ZONAL FOCI: POSITION C.

Radius of Zone.	ϕ	d_1	d_2	Focus.	Mean.	Astigmatism.
	°	mm.	mm.			
15 mm	45	0·7003	0·6365	23·57	....	−0·04
	135	0·7023	0·6334	23·66	23·61	+0·05
25	0	1·1571	1·0546	23 54	....	−0·10
	90	1·1701	1·0470	23·75	23·64	+0·11
35	45	1·6446	1·4542	23·88	....	+0·05
	135	1·6394	1·4625	23·78	23·83	−0·05
45	0	2·1303	1·8615	24·02	....	−0·10
	90	2·1444	1·8404	24·22	24·12	+0·10
55	45	2·6238	2·2009	24·47	....	+0·05
	135	2 6415	2·2368	24·37	24·42	−0·05
65	0	3·1652	2·5791	24·80	....	−0·05
	90	3·1857	2·5686	24·91	24·85	+0·06
75	22·5	3·7187	2·8718	25·39	....	−0·01
	67·5	3·7533	2·8700	25·50	....	+0·10
	112·5	3·7401	2·8848	25·40	....	0·00
	157·5	3·7206	2·8957	25 30	25·40	−0·10
85	45	4·3530	3 1223	26·20	....	+0·07
	135	4·3522	3 1638	26·06	26 13	−0·07
94	0	4·9560	3·3371	26·89	....	0·09
	90	5·0073	3·3159	27 07	26·98	+0·09
98	22·5	5·2 15	3 3850	27·32	....	−0·04
	67·5	5 2741	3·3635	27·48	....	+0·12
	112·5	5·2528	3·3800	27·38	....	+0·02
	157·5	5·2405	3·4089	27·26	27 36	−0·10

TABLE IV.

ZONAL FOCI: POSITION D.

Radius of Zone.	φ	d_1	d_2	Focus.	Mean.	Astigmatism.
	°	mm.	mm.			
15mm.	45	0·7204	0·6208	24·17		−0·03
	135	0·7128	0·6106	24·24	24·20	+0·04
25	0	1·1883	1·0255	24·15		−0·02
	90	1·1963	1·0292	24·19	24·17	+0·02
35	45	1·6786	1·4273	24·32		+0·04
	135	1·6764	1·4340	24·25	24·28	−0·03
45	0	2·1796	1·8131	24·57		−0·02
	90	2·1843	1·8102	24·61	24·59	+0·02
55	45	2·6726	2·1618	24·88		−0·01
	135	2·7039	2·1805	24·91	24·89	+0·02
65	0	3·2398	2·5165	25·33		−0·02
	90	3·2503	2·5140	25·37	25·35	+0·02
75	22·5	3·7991	2·8022	25·90		+0·03
	67·5	3·8159	2·8151	25·90		+0·03
	112·5	3·8110	2·8295	25·83		−0·04
	157·5	3·8084	2·8193	25·86	25·87	−0·01
85	45	4·4340	3·0715	26·58		+0·01
	135	4·4454	3·0862	26·56	26·57	−0·01
94	0	5·0594	3·2538	27·39		−0·03
	90	5·0882	3·2528	27·45	27·42	+0·03
98	22·5	5·3326	3·2971	27·81		+0·01
	67·5	5·3435	3·3117	27·78		−0·02
	112·5	5·3394	3·3005	27·81		+0·01
	157·5	5·3453	3·3101	27·79	27·80	−0·01

TABLE V.

ZONAL FOCI: POSITION E.

Radius of Zone.	φ	d_1	d_2	Focus.	Mean.	Astigmatism.
	°	mm.	mm.			
15mm	45	0·7243	0·6159	24·32		+0·03
	135	0·7189	0·6145	24·26	24·29	−0·03
25	0	1·1937	1·0189	24·28		−0·02
	90	1·2020	1·0215	24·33	24·30	+0·03
35	45	1·6884	1·4238	24·41		+0·01
	135	1·6907	1·4277	24·40	24·40	0·00
45	0	2·1965	1·8049	24·70		0·00
	90	2·1948	1·8038	24·70	24·70	0·00
55	45	2·6918	2·1478	25·03		+0·02
	135	2·7202	2·1765	25·00	25·01	−0·01
65	0	3·2594	2·5023	25·46		0·00
	90	3·2631	2·5050	25·46	25·46	0·00
75	22·5	3·8166	2·7969	25·97		−0·01
	67·5	3·8365	2·8062	25·99		+0·01
	112·5	3·8381	2·8112	25·97		−0·01
	157·5	3·8347	2·8057	25·99	25·98	+0·01
85	45	4·4596	3·0610	26·68		0·00
	135	4·4751	3·0733	26·68	26·68	0·00
94	0	5·0876	3·2357	27·51		0·00
	90	5·1113	3·2509	27·51	27·51	0·00
98	22·5	5·3623	3·2966	27·87		−0·02
	67·5	5·3789	3·2991	27·89		0·00
	112·5	5·3738	3·3000	27·88		−0·01
	157·5	5·3729	3·2913	27·91	27·89	+0·02

TABLE VI.

ZONAL FOCI: POSITION F.

Radius of Zone.	ϕ	d_1	d_2	Focus.	Mean.	Astigmatism.
	°	mm.	mm.			
15 mm.	45	0·7396	0·6078	24·70	....	+0·11
	135	0·7315	0·6130	24·48	24·59	−0·11
25	0	1·2242	1·0149	24·60	....	−0·04
	90	1·2304	1·0127	24·68	24·64	+0·04
35	45	1·7274	1·4155	24·73	....	+0·01
	135	1·7267	1·4160	24·72	24·72	0·00
45	0	2·2431	1·7927	25·01	....	−0·03
	90	2·2483	1·7875	25·07	25·04	+0·03
55	45	2·7507	2·1330	25·35	....	+0·01
	135	2·7761	2·1567	25·33	25·34	−0·01
65	0	3·3281	2·4797	25·79	....	−0·01
	90	3·3424	2·4826	25·82	25·80	+0·02
75	22·5	3·9033	2·7731	26·31	....	−0·02
	67·5	3·9215	2·7751	26·35	....	+0·02
	112·5	3·9230	2·7794	26·34	....	+0·01
	157·5	3·9134	2·7826	26·30	26·33	−0·03
85	45	4·5513	3·0286	27·02	....	0·00
	135	4·5709	3·0376	27·03	27·02	+0·01
94	0	5·1894	3·2095	27·80	....	−0·04
	90	5·2240	3·2063	27·88	27·84	+0·04
98	22·5	5·4615	3·2621	28·17	....	−0·05
	67·5	5·4831	3·2539	28·24	....	+0·02
	112·5	5·4846	3·2448	28·27	....	+0·05
	157·5	5·4797	3·2630	28·21	28·22	−0·01

TABLE VII.

ZONAL FOCI: POSITION G.

Radius of Zone.	ϕ	d_1	d_2	Focus.	Mean.	Astigmatism.
	°	mm.	mm.			
15 mm.	45	0·7307	0·6203	24·29	....	+0·04
	135	0·7256	0·6228	24·22	24·25	−0·03
25	0	1·1958	1·0336	24·14	....	−0·10
	90	1·2129	1·0297	24·34	24·24	+0·10
35	45	1·7039	1·4425	24·37	....	+0·01
	135	1·6995	1·4409	24·35	24·36	−0·01
45	0	2·2025	1·8339	24·55	....	−0·10
	90	2·2164	1·8137	24·75	24·65	+0·10
55	45	2·7191	2·1758	25·00	....	+0·03
	135	2·7339	2·1962	24·95	24·97	−0·02
65	0	3·2652	2·5402	25·31	....	−0·12
	90	3·2975	2·5100	25·55	25·43	+0·12
75	22·5	3·8418	2·8348	25·89	....	−0·07
	67·5	3·8710	2·8123	26·06	....	+0·10
	112·5	3·8743	2·8281	26·01	....	+0·05
	157·5	3·8565	2·8481	25·88	25·96	−0·08
85	45	4·5039	3·0808	26·72	....	+0·04
	135	4·5072	3·1024	26·65	26·68	−0·03
94	0	5·1090	3·2893	27·38	....	−0·13
	90	5·1685	3·2472	27·64	27·51	+0·13
98	22·5	5·3913	3·3340	27·80	....	−0·08
	67·5	5·4340	3·3009	28·00	....	+0·12
	112·5	5·4298	3·3093	27·96	....	+0·08
	157·5	5·3990	3·3450	27·78	27·88	−0·10

TABLE VIII.

ZONAL FOCI: POSITION H.

Radius of Zone.	ϕ	d_1	d_2	Focus.	Mean.	Astigmatism.
	°	mm.	mm.			
15 mm	45	0·7033	0·6505	23·38	....	+0·04
	135	0·7010	0·6528	23·30	23·34	−0·04
25........	0	1·1515	1·0961	23·05	....	−0·31
	90	1·1775	1·0610	23·67	23·36	+0·31
35........	45	1·6507	1·4920	23·64	....	+0·07
	135	1·6408	1·5005	23·50	23·57	−0·07
45........	0	2·1198	1·9152	23·64	....	−0·27
	90	2·1580	1·8560	24·19	23·91	+0·28
55........	45	2·6321	2·2501	24·26	....	+0·06
	135	2·6458	2·2870	24·14	24·20	−0·06
65........	0	3·1527	2·6581	24·41	....	−0·26
	90	3·2126	2·5830	24·94	24·67	+0·27
75........	22·5	3·7121	2·9610	25·03	....	−0·16
	67·5	3·7705	2·9036	25·42	....	+0·23
	112·5	3·7646	2·9178	25·35	....	+0·16
	157·5	3·7126	2·9823	24·95	25·19	−0·24
85........	45	4·3805	3·1994	26·01	....	+0·06
	135	4·3703	3·2255	25·89	25·95	−0·06
94........	0	4·9372	3·4590	26·46	....	−0·33
	90	5·0597	3·3340	27·13	26·79	+0·34
98........	22·5	5·2258	3·4928	26·97	....	−0·19
	67·5	5·3153	3·4031	27·43	....	+0·27
	112·5	5·3021	3·4164	27·37	....	+0·21
	157·5	5·2219	3·5158	26·89	27·16	−0·27

TABLE IX.

ZONAL FOCI: POSITION I.

Radius of Zone.	ϕ	d_1	d_2	Focus.	Mean.	Astigmatism.
	°	mm.	mm.			
15 mm	45	0·6675	0·6798	22·29	....	+0·14
	135	0·6580	0·6869	22·02	22·15	−0·13
25........	0	1·0786	1·1508	21·77	....	−0·53
	90	1·1344	1·1005	22·84	22·30	+0·54
35........	45	1·5761	1·5551	22·65	....	+0·17
	135	1·5518	1·5765	22·32	22·48	−0·16
45........	0	1·9937	2·0341	22·27	....	−0·55
	90	2·0805	1·9245	23·38	22·82	+0·56
55........	45	2·5249	2·3421	23·34	....	+0·16
	135	2·5131	2·3998	23·02	23·18	−0·16
65........	0	2·9778	2·8323	23·06	....	−0·59
	90	3·1123	2·6623	24·25	23·65	+0·60
75........	22·5	3·5401	3·1225	23·91	....	−0·30
	67·5	3·6580	2·9877	24·77	....	+0·56
	112·5	3·6314	3·0360	24·51	....	+0·30
	157·5	3·5107	3·1646	23·67	24·21	−0·54
85........	45	4·2245	3·3275	25·17	....	+0·20
	135	4·1720	3·4060	24·77	24·97	−0·20
94........	0	4·7029	3·6958	25·20	....	....
	90	....	....	....	25·20	....
98........	22·5	5·0145	3·6885	25·93	....	+0·15
	67·5	....	....	....	....	....
	112·5	....	....	....	....	....
	157·5	4·9712	3·7578	25·63	25·78	−0·15

TABLE X.

ZONAL FOCI: POSITION L.

Radius of Zone.	ϕ	d_1	d_2	Focus.	Mean.	Astigmatism.
	°	mm.	mm.			
15 mm................	45	0·8580	0·5011	28·41	.. ..	+0·03
	135	0·8478	0·4980	28·35	28·38	−0·03
25....	0	1·4122	0·8305	28·34	....	−0·02
	90	1·4257	0·8345	28·38	28·36	+0·02
35...................	45	2·0004	1·1616	28·47	....	−0·04
	135	2·0018	1·1533	28·55	28·51	+0·04
45.....................	0	2·5920	1·4647	28·75	... .	+0·03
	90	2·5883	1·4712	28·69	28·72	−0·03
55......	45	3·1567	1·7504	28·95	....	−0·05
	135	3·1968	1·7537	29·06	29·00	+0·06
65....	0	3·8030	2·0479	29·25	....	−0·01
	90	3·8094	2·0455	29·28	29·26	+0·02
75	22·5	4·4142	2·2996	29·59	....	−0·08
	67·5	4·4469	2·2925	29·69	....	+0·02
	112·5	4·4305	2·2881	25·68	....	+0·01
	157·5	4·4525	2·2920	29·71	29·67	+0·04
85............. . . .	45	5·1293	2·5171	30·19	....	−0·05
	135	5·1351	2·4940	30·29	30·24	+0·05
94..............	0	5·7941	2·6695	30·81	... .	−0·04
	90	5·8120	2·6555	30·89	30·85	+0·04
98...........	22·5	6·0783	2·7200	31·09	....	−0·06
	67·5	6·0767	2·6950	31·17	....	+0·02
	112·5	6·0729	2·6946	31·17	....	+0·02
	157·5	6·0908	2·7050	31·16	31·15	+0·01

TABLE XI.

ZONAL FOCI: POSITION M.

Radius of Zone.	ϕ	d_1	d_2	Focus.	Mean.	Astigmatism.
	°	mm.	mm.			
15 mm................	45	0·8617	0·5145	28·18	....	+0·02
	135	0·8519	0·5111	28·13	28·16	−0·03
25.	0	1·4154	0·8238	28·44	....	−0·02
	90	1·4309	0·8295	28·49	28·46	+0·03
35....	45	2·0053	1·1647	28·47	.. ..	−0·06
	135	2·0039	1·1490	28·60	28·53	+0·07
45	0	2·5951	1·4685	28·74	.. ..	−0·01
	90	2·5865	1·4601	28·76	28·75	+0·01
55.........	45	3·1740	1·7598	28·95	....	−0·08
	135	3·2043	1·7498	29·11	29·03	+0·08
65......	0	3·8230	2·0360	29·36	....	0·00
	90	3·8263	2·0381	29·36	29·36	0·00
75	22·5	4·4467	2·2842	29·73	....	+0·03
	67·5	4·4591	2·2817	29·59	....	−0·11
	112·5	4·4541	2·2803	29·76	....	+0·06
	157·5	4·4353	2·2760	29·74	29·70	+0·04
85	45	5·1375	2·4931	30·30	... .	+0·05
	135	5·1476	2·5197	30·21	30·25	−0·04
94	0	5·8073	2·6596	30·86	... .	−0·01
	90	5·8189	2·6630	30·87	30·87	0·00
98	22·5	6·0981	2·6932	31·21	....	+0·02
	67·5	6·1118	2·7059	31·19	....	0·00
	112·5	6·0862	2·7090	31·14	....	−0·05
	157·5	6·0983	2·6950	31·21	31·19	+0·02

TABLE XII.

ZONAL FOCI: POSITION N.

Radius of Zone.	φ	d_1	d_2	Focus.	Mean.	Astigmatism.
	°	mm.	mm.			
15mm	45	0·8573	0·4968	28·49	....	+0·07
	135	0·8578	0·5042	28·34	28·42	−0·08
25...........	0	1·4272	0·8332	28·41	....	−0·05
	90	1·4232	0·8235	28·51	28·46	+0·05
35........	45	2·0043	1·1518	28·58	.. ..	−0·02
	135	2·0138	1 1536	28·61	28·60	+0·01
45.	0	2·6017	1·4565	28·85	... .	+0·04
	90	2·5934	1·4642	28·76	28·81	−0·05
55......	45	3·1837	1·7478	29·05	... .	0 00
	135	3·2112	1·7647	29·04	29·05	−0·01
65..	0	3·8245	2·0250	29·42	... .	+0·01
	90	3·8307	2·0334	29·40	29·41	−0·01
75......	22·5	4·4507	2·2902	29·71	....	−0·04
	67·5	4·4655	2·2819	29·78	. . ..	+0·03
	112·5	4·4729	2 2797	29·81	.. .. ..	+0 06
	157·5	4·4521	2·2895	29·72	29·75	−0·03
85.........	45	5·1540	2·5082	30·27	....	−0·02
	135	5·1560	2·4981	30·31	30·29	+0·02
94....	0	5·8248	2·6439	30·95	....	+0 03
	90	5·8086	2·6549	30·88	30·92	−0·04
98................ .	22·5	6·0993	2·6965	31·20	....	0·00
	67·5	6·1101	2·7062	31·19	....	−0·01
	112·5	6·1006	2·6947	31·21	....	+0·01
	157·5	6·0933	2·6951	31·20	31·20	0·00

TABLE XIII.

ZONAL FOCI: POSITION R.

Radius of Zone.	φ	d_1	d_2	Focus.	Mean.	Astigmatism.
	°	mm.	mm.			
15mm	45	0 6950	0 6533	23·20	....	+0·18
	135	0·6707	0·6506	22·84	23·02	−0·18
25....	0	1·1187	1·1000	22·69	....	−0·23
	90	1·1413	1·0780	23·14	22·92	+0·23
35	45	1·6051	1·5079	23·20	....	+0·08
	135	1·5904	1·5168	23·03	23·12	−0·09
45..	0	2·0648	1·9508	23·14	....	−0·30
	90	2·0968	1·8769	23·74	23·44	+0·30
55	45	2 5811	2·2793	23·90	....	+0·12
	135	2·5683	2·3143	23·67	23·78	−0·11
65...	0	3·0716	2·7009	23·94	....	−0·28
	90	3·1285	2·6173	24·50	24·22	+0·28
75	22·5	3·6463	2·9964	24·70	.. ..	−0·09
	67·5	3·6927	2·9238	25·11	....	+0·32
	112·5	3·6642	2·9616	24 89	. ...	+0·10
	157.5	3·6180	3·0345	24·47	24·79	−0·32
85...	45	4·2992	3·2352	25·68	.. ..	+0·15
	135	4·2542	3·2864	25·39	25·53	−0·14
94	0	4 8501	3·5156	26·09	. . . .	−0·30
	90	4·9240	3·3800	26·68	26·39	+0·29
98...	22·5	5·1406	3·5317	26·67	....	−0·12
	67·5	5·2145	3·4394	27·12	....	+0·33
	112·5	5·1649	3·4780	26·89	....	+0·10
	157·5	5·1125	3·5791	26·47	26·79	−0·32

TABLE XIV.

ZONAL FOCI.

Radius of Zone.	Position.					
	A	B	C	D	E	F
15 mm	21·66	22·69	23·61	24·20	24·29	24·59
25	21·65	22·76	23·64	24·17	24·30	24·64
35	21.89	22 92	23·83	24·28	24·40	24·72
45	22·17	23·22	24·12	24·59	24·70	25·04
55	22·60	23 56	24·42	24·89	25·01	25·34
65	22·61	23·99	24·85	25·35	25·46	25·80
75	23·62	24·57	25·40	25·87	25·98	26·33
85	24·47	25·31	26·13	26·57	26·68	27·02
94	24·72	26·18	26·98	27·42	27·51	27·84
98	25·26	26·51	27·36	27·80	27·89	28·22
	G	H	I	L	M	N
15 mm	24·25	23·34	22·15	28 38	28·16	28·42
25	24·24	23·36	22·30	28·36	28·46	28·46
35	24·36	23·57	22·48	28·51	28·53	28·60
45	24·65	23·91	22·82	28·72	28·75	28·81
55	24 97	24·20	23·18	29·00	29·03	29·05
65	25·43	24·67	23·65	29·26	29·36	29·41
75	25 96	25·19	24·21	29·67	29·70	29·75
85	26·68	25·95	24·97	30·24	30·25	30·29
94	27·51	26·79	25·20	30·85	30·87	30·92
98	27 88	27·16	25·78	31·15	31·19	31·20

TABLE XV.

Plate.	Best Focus.	Confusion Circle.	Efficiency.
		"	
A	24·5	44·2	11·46
B	25·5	38·5	13·43
C	26·25	39·2	13·11
D	26·75	37·9	13·01
E	26·8	38·5	12·77
F	27·00	43·1	12·56
G	26 7	41·7	12·71
H	26·00	41·00	13·08
I	25·00	36·00	10·52
L	30·20	33·3	9·64
M	30·25	33·0	9·47
N	30·30	31·7	9·38

TABLE XVI.

ZONAL TEST.

Settings 6·5 & 51·5; Separation 0·132 inches.

Radius of Zone.	φ	d_1	d_2	Focus.	Mean.
	°	mm.	mm.		
15 mm	45	0·6422	0·7178	21·25	
	135	0·6389	0·7130	21·27	21·26
25	0	1·0595	1·1848	21·24	
	90	1·0605	1·1895	21·21	21·22
35	45	1·4779	1·6885	21·00	
	135	1·4683	1·6827	20·97	20·98
45	0	1·8743	2·1880	20·76	
	90	1·8729	2·1754	20·82	20·79
55	45	2·2487	2·6728	20·56	
	135	2·2606	2·6841	20·57	20·56
65	0	2·6086	3·2090	20·18	
	90	2·6180	3·2997	19·91	20·04
75	22·5	2·9475	3·7395	19·83	
	67·5	2·9587	3·7468	19·86	
	112·5	2·9633	3·7468	19·87	
	157·5	2·9505	3·7495	19·82	19·84
85	45	3·2795	4·3160	19·43	
	135	3·2858	4·3213	19·44	19·43
94	0	3·5285	4·8575	18·93	
	90	3·5398	4·8555	18·97	18·95
98	22·5	3·6505	5·0963	18·78	
	67·5	3·6643	5·0935	18·83	
	112·5	3·6723	5·0755	18·89	
	157·5	3·6566	5·0691	18·86	18·84

TABLE XVII.

ZONAL TEST.

Settings 16·5 & 61·5; Separation 0·070 inches.

Radius of Zone.	φ	d_1	d_2	Focus.	Mean.
	°	mm.	mm.		
15 mm	45	0·6014	0·7332	20·23	
	135	0·5953	0·7372	20·10	20·16
25	0	0·9944	1·2348	20·07	
	90	0·9931	1·2375	20·03	20·05
35	45	1·3921	1·7460	19·96	
	135	1·3905	1·7501	19·93	19·95
45	0	1·7970	2·2300	20·08	
	90	1·7882	2·2236	20·06	20·07
55	45	2·1784	2·7251	19·99	
	135	2·1720	2·7159	19·99	19·99
65	0	2·5940	3·2068	20·12	
	90	2·5899	3·2110	20·09	20·11
75	22·5	2·9884	3·6893	20·14	
	67·5	2·9855	3·6896	20·13	
	112·5	2·9914	3·6926	20·14	
	157·5	2·9805	3·6919	20·10	20·13
85	45	3·4127	4·1765	20·24	
	135	3·4084	4·1754	20·22	20·23
94	0	3·7945	4·5940	20·36	
	90	3·7910	4·6020	20·33	20·35
98	22·5	3·9770	4·7611	20·48	
	67·5	3·9740	4·7611	20·47	
	112·5	3·9755	4·7650	20·47	
	157·5	3·9755	4·7735	20·45	20·47

TABLE XVIII.

SETTINGS 16·5 AND 61·5; 0·077 SEPARATION

Radius of Zone.	ϕ	d_1	d_2	Focus.	Mean.
	°	mm.	mm.		
15..................	45	0·5717	0·7561	19·38	
	135	0·5830	0·7540	....	19·38
25..................	0	0 9550	1·2645	19·36	
	90	0·9549	1·2662	19·35	19·36
35..................	45	1·3335	1·7745	19·31	
	135	1·3365	1·7831	19·28	19·30
45..................	0	1·7208	2·2832	19·34	
	90	1·7228	2·2750	19·39	19·37
55..................	45	2·0918	2·7819	19·31	
	135	2·0909	2·7681	19·36	19·34
65..................	0	2·4909	3·2762	19·44	
	90	2 4915	3·2844	19·41	19·43
75..................	22·5	2·8593	3·7774	19·39	
	67·5	2·8637	3 7804	19·39	
	112·5	2·8707	3·7829	19·42	
	157·5	2·8585	3·7694	19·41	19·40
85..................	45	3·2567	4·2874	19·43	
	135	3 2742	4·2702	19·53	19·48
94..................	0	3·6387	4·7187	19·59	
	90	3·6456	4·7240	19·60	19·60
98..................	22·5	3·7929	4·9030	19·63	
	67·5	3·7942	4·9054	19·63	
	112·5	3·8191	4·8918	....	
	157·5	3·7988	4·8958	19 66	19·64

APPENDIX E.

OBSERVING RECORDS AND DETAILED MEASURES OF β ORIONIS, θ AQUILÆ, ϵ HERCULIS, η BOÖTIS, α CORONÆ BOREALIS AND δ AQUILÆ.

P.—Plaskett.
H.—Harper.
C.—Cannon.
Pl.—Parker.

β ORIONIS.

RECORD OF SPECTROGRAMS.

Star.	No. of Negative.	Camera.	Plate.	Date.	Middle of Exposure. G. M. T.	Duration.	Hour Angle at end.	Temperature Centigrade. Room. Beginning.	Room. End.	Prism Box. Beginning.	Prism Box. End.	Slit Width.	Seeing.	Observer.	Remarks.
				1908.	h. m.	m.	h. m.								
β Orionis ...	1241a	II.	Seed 27..	Jan. 20..	15 03	2½	52 W.	– 7·0	....	– 6·9	6·9	001	Poor...	P	
" ...	1241b	"	" ..	" 20.	15 05	"	55 "	....	....	"	"	"	"	P	
" ..	1241c	"	" ..	" 20..	15 07½	"	57½ "	....	....	"	"	"	"	P	
" ..	1242a	"	" ..	" 20..	15 12½	"	1 02½ "	....	....	"	"	"	"	P	
" ..	1242b	"	" ..	" 20..	15 15	"	1 05 "	....	....	"	"	"	" ..	P	
" ..	1242c	"	" ..	" 20..	15 17½	"	1 07½ "	....	....	"	"	"	"	P	
" ..	1243a	"	" ..	" 20..	15 25	1½	1 16 "	....	....	"	"	·0015	"	P	
" ...	1243b	"	" ..	" 20..	15 27	"	1 18 "	....	....	"	"	"	" ...	P	
" ...	1243c	"	" ..	" 20..	15 29	"	1 20 "	....	....	"	"	"	" ...	P	
" ...	1244a	"	" ..	" 20..	15 45	1¼	1 36 "	....	....	"	"	"	" ...	P	
" ..	1244b	"	" ..	" 20..	15 47	"	1 38 "	....	....	"	"	"	"	P	
" ..	1244c	"	" ..	" 20..	15 49	"	1 40 "	....	....	"	"	"	" ...	P	
" ..	1245a	"	" .	" 20..	15 52	50s	1 43 "	....	....	"	"	002	" ..	P	
" .	1245b	"	" ..	" 20..	15 53	"	1 44 "	....	....	"	"	"	" ..	P	
" ..	1245c	"	" ..	" 20..	15 54	"	1 45 "	....	....	"	"	"	" ...	P	
" .	1247a	"	"	" 20..	16 16	40s	2 05 "	....	....	"	"	.003	" ...	P	
" .	1247b	"	" ..	" 20..	16 17	"	2 06 "	....	....	"	"	"	" ..	P	
" ..	1247c	"	" ..	" 20..	16 18	"	2 07 "	....	....	"	"	"	"	P	
" ...	1248a	"	" ..	" 20..	16 26	"	2 15 "	....	....	"	"	"	"	P	
" ...	1248b	"	" ..	" 20..	16 27	"	2 16 "	....	....	"	"	"	"	P	
" ...	1248c	"	" ..	" 20..	16 28	"	2 17 "	....	....	"	"	"	"	P	
" ...	1249a	"	" ..	" 20..	16 35	1	2 23 "	....	....	"	"	·002	" ..	P	
" ...	1249b	"	" ..	" 20..	16 37	"	2 25 "	....	....	"	"	"	"	P	
" ..	1249c	"	" .	" 20..	16 39	"	2 27 "	....	– 6·5	"	"	"	" ...	P	
" ...	1285a	IIIS	" ..	" 27..	15 46	5	2 00 "	– 13·0	– 13·0	– 16·0	– 16·0	·001	Good...	P	
" ..	1285b	"	" ..	" 27..	15 51	"	2 05 "	"	"	"	"	"	"	P	

"	1285c	"	"	" 27	15	56	"	2	10	"	"	"	"	"	"	"	P	
"	1286a	"	"	" 27	16	04	"	2	18	"	"	"	"	"	·0015	"	P	
"	1286b	"	"	" 27	16	09	"	2	23	"	"	"	"	"	"	"	P	
"	1286c	"	"	" 27	16	14	"	2	28	"	"	"	"	"	"	"	P	
"	1289a	"	"	" 27	17	14	2½	3	30	"	"	"	"	"	·002	"	P	
"	1289b	"	"	" 27	17	17	"	3	33	"	"	"	"	"	"	"	P	
"	1289c	"	"	" 27	17	20	"	3	36	"	"	"	"	"	"	"	P	
"	1290a	"	"	" 27	17	25	"	3	41	"	"	"	"	"	"	"	P	
"	1290b	"	"	" 27	17	28	"	3	44	"	"	"	"	"	"	"	P	
"	1290c	"	"	" 27	17	31	"	3	47	"	"	"	"	"	"	"	P	
"	1405	IIIL	"	Mar. 20	11	51	13	1	37	"	− 3·4	− 3·4	1·2	1·2	·001	Fair	P	
"	1406	"	"	" 20	12	07	14	1	50	"	"	4·0	"	"	"		P	
"	1407	"	"	" 20	12	21	13	2	04	"	− 4·0	− 4·3	"	1·1	"		P	
"	1408	"	"	" 20	12	32	11	2	15	"	− 4·3	− 5·2	1·1	"	"	to	P	
"	1409	"	"	" 20	12	46	14	2	30	"	− 5·2	− 5·2	"	1·0	"		P	
"	1410	"	"	" 20	13	00	11	2	45	"	"	− 6·0	1·0	"	"		P	
"	1411	"	"	" 20	13	12	9	2	52	"	− 6·0	− 6·5	1·0	0·9	·0015		P	
"	1412	"	"	" 20	13	25	15	3	10	"	− 6·5	− 6·8	0·9	0·8	"	good	P	Off part of time.
"	1413	"	"	" 20	13	47	8	3	30	"	− 6·8	− 7·0	0.8	0·8	"		P	
"	1414	"	"	" 20	13	57	11	3	40	"	− 7·0	− 6·5	"	"	"		P	
"	1426a	"	"	" 24	12	03	10	2	02	"	1·0	1·0	5·1	5·1	·002	Fair	P	
"	1427	"	"	" 24	12	14	8	2	12	"	......	......	......	......	"	"	P	
"	1428	"	"	" 24	12	23	8	2	20	"	......	......	......	......	"	"	P	
"	1429	"	"	" 24	12	32	9	2	30	"	− 2·0	......	5·0	......	"	"	P	
"	1430	"	"	" 24	12	42	9	2	40	"	......	......	......	......	"	"	P	
"	1431	"	"	" 24	12	52	8	2	50	"	− 3·4	......	4·9	......	"	"	P	
"	1433	"	"	" 24	13	16	7	3	15	"	......	......	......	......	·003	"	P	
"	1434	"	"	" 24	13	32	6	3	30	"	4·5	......	4·7	......	"	"	P	
"	1435	"	"	" 24	13	39	6	3	36	"	......	......	......	......	"	"	P	
"	1436	"	"	" 24	13	46	6	3	44	"	......	......	......	......	"		P	
"	1437	"	"	" 24	13	56	9	3	56	"	......	......	......	......	"	"	P	
"	1438	"	"	" 24	14	07	10	4	05	"	− 5·0	− 5·0	4·6	4·6	"	"	P	
"	1439	"	"	" 30	12	19	8	2	40	"	3·5	3·5	5·7	5·7	·0022	"	P	Slit intended for ·0018.
"	1440	"	"	" 30	12	29	8	2	50	"	"	"	"	"	"	"	P	
"	1441	"	"	" 30	12	38	9	3	00	"	3·5	3·3	5·7	5·7	·0022	"	P	
"	1442	"	"	" 30	12	49	10	3	13	"	3·3	3·0	"	"	"	"	P	
"	1448	"	"	April 3	12	16	9	2	57	"	− 2·8	− 3·2	1·7	1·7	·002	"	P	
"	1449	"	"	" 3	12	28	10	3	10	"	− 3·2	− 3·8	"	"	"	"	P	
"	1450	"	"	" 3	12	40	10	3	22	"	− 3·8	− 3·4	"	"	"	"	P	
"	1451	"	"	" 3	12	53	10	3	35	"	− 3·4	− 3·1	"	"	"	"	P	
"	1457	"	"	" 4	12	19	8	3	00	"	− 1·6	......	2·0	2·0	·0018	"	P	
"	1458	"	"	" 4	12	28	8	3	10	"	"	......	"	"	"	"	P	
"	1459	"	"	" 4	12	37	8	3	20	"	2·0	......	"	"	"	"	P	
"	1469	"	"	" 13	12	10	10	3	30	"	5·8	......	9·7	......	·002	Good.	P	
"	1470	"	"	" 13	12	22	10	3	42	"	......	......	......	......	"	"	P	
"	1471	"	"	" 13	12	34	11	3	53	"	......	......	......	......	"	"	P	
"	1873	"	"	Sept. 7	21	52	16	......			12·0	11·8	21·0	21·0	·0015	"	C	
"	1874	"	"	" 7	22	10	19	......			11·8	11·6	"	"	"	"	C	
"	1935	"	"	Oct. 13	21	19	20	0	45	W.	7·3	7·6	11·7	11·6	·0016	Fair.	P	
"	1936	"	"	" 13	21	48	28	1	20	"	7·6	"	11·6	"	"	"	P	

β ORIONIS.

RECORD OF SPECTROGRAMS—*Continued.*

P.—Plaskett.
H.—Harper.
C.—Cannon.
P[1]—Parker.

Star.	No. of Negative.	Camera.	Plate.	Date.	Middle of Exposure G. M. T.	Duration.	Hour Angle at end.	Temperature Centigrade. Room. Beginning.	Room. End.	Prism Box. Beginning.	Prism Box. End.	Slit Width.	Seeing.	Observer.	Remarks.
				1908.	h. m.	m.	h. m.								
β Orionis...	1937	IIIL	Seed 27...	Oct. 13..	22 19	30	1 50 W.	7·6	7·6	11·6	11·6	·0016	Fair......	P	
" ...	1938	"	" ..	" 13..	22 47	25	2 15 "	"	7·5	"	"	"	"	P	
" ...	1978	"	" ..	Nov. 21..	18 24	18	0 25 "	2·7	2·6	4·9	4·9	·0015	"	P	
" ...	1979	"	" ..	" 21..	18 43	17	0 45 "	2·6	1·5	"	"	"	....	P	
" ...	1980	"	" ..	" 21..	19 05	22	1 10 "	1·4	−0·3	"	4·8	"	....	P	
" ...	1981	"	" ..	" 21..	19 33	30	1 40 "	−0·3	−1·5	4·8	"	"	....	P	Fog.
" ...	1984	"	" ..	" 28..	16 05	20	1 30 E.	5·2	5·0	6·7	6·7	·0016	....	P	
" ...	1985	"	" ..	" 28..	16 34	22	1 00 "	5·0	5·5	"	"	"	....	P	
" ...	1986	"	" ..	" 28..	17 08	15	0 10 "	5·5	"	"	"	"	....	P	
" ...	1987	"	" ..	Dec. 1..	17 53	27	0 35 W.	−3·8	−4·0	−1·8	−1·8	"	Good.....	P	
" ...	1988	"	" ..	" 1..	18 18	16	1 00 "	−4·0	−4·1	"	"	"	"	P	
" ...	1989	"	" ..	" 1..	18 36	16	1 18 "	−4·1	−4·2	"	"	"	"	P	
" ...	1990	"	" ..	" 1..	18 52	15	1 34 "	−4·2	−4·5	"	"	"	"	P	
" ...	2003	"	" ..	" 5..	16 10	10	1 00 E.	−16·0	−16·5	7·9	7·9	"	Fair....	P	
" ...	2004	"	" ..	" 5..	16 22	10	0 48 "	....	....	....	....	·0016	"	P	
" ...	2005	"	" ..	" 5..	16 38	13	0 32 "	....	....	....	....	"	Poor....	P	
" ...	2006	"	" ..	" 5..	16 53	13	0 15 "	....	−17·8	....	−7·9	"	"	P	
" ...	2054	IL	" ..	" 21..	15 24	3	0 24 "	−11·2	−11·2	−1·6	−1·6	·0015	Good.....	P[1]	
" ...	2055	"	" ..	" 21..	15 29	2	0 20 "	"	"	"	"	"	"	P[1]	
" ...	2057	"	" ..	" 21..	16 54	2	0 45 W.	−12·4	−12·4	−1·9	−1·9	"	"	P[1]	
" ...	2058	"	" ..	" 21..	17 00	2	0 51 "	"	"	"	"	"	"	P[1]	
" ...	2065	IIIL	" ..	" 22..	17 38	10	1 20 "	−18·5	....	−13·0	....	·0016	"	P	
" ...	2066	"	" ..	" 22..	17 52	9	1 32 "	....	....	....	....	"	"	P	
" ...	2067	"	" ..	" 22..	18 02	8	1 43 "	....	....	....	....	"	"	P	
" ...	2068	"	" ..	" 22..	18 14	8	2 10 "	....	19·0	....	13·0	"	"	P	
" ...	2070	"	" ..	" 23..	14 01	14	1 55 E.	−14·5	−14·5	−7·5	−7·5	"	....	H	Drifting.
" ...	2071	"	" ..	" 23..	14 41	44	1 00 "	−16·0	−15·0	−7·8	7·9	"	Poor.....	H. P.	
" ...	2072	"	" ..	" 23..	15 08	8	0 50 "	"	"	−7·9	"	"	"	P	
" ...	2073	"	" ..	" 23..	15 19	8	0 40 "	"	"	"	"	"	"	P	
" ...	2075	"	" ..	" 26..	15 49	8	0 00	−9·8	....	−4·1	....	"	Steady...	P	

" ...	2076	"	"	" 26..	15 59	8	0 10 W.			− 4·2		"		P	
" ...	2077	"	"	" 26..	16 09	8	0 20 "	"	"	"		"		P	
" ...	2078	"	"	" 26..	16 19	8	0 30 "					"		P	
" ...	2079	"	"	" 27..	14 07	20	1 30 E.	0·0		0·0		"	Hazy	P	
" ...	2080	"	"	" 27..	15 12	15	0 20 "	0·5		0·1		"	Poor	P	Only 5m. seeing.
" ...	2082	IL	"	" 31..	15 19	2	0 06 "	−10·0	−13·5	− 3·3	− 3·3	·0015		H	
" ...	2083	"	"	" 31..	15 23	2½	0 02 "	"	"	"	"	"		H	
" ...	2084	"	"	" 31..	15 29	3	0 02 W.	"	"	"	"	"		H	
" ...	2085	"	"	" 31..	15 57	5	0 31 "	"	"	"	"	"		H	
				1909.											
" ...	2092	"	"	Jan. 6..	16 49	2	1 36 W.	−16·5		− 2·8		·0015	Good.	H	
" ...	2093	"	"	" 6..	16 53	2	1 40 "					"	"	H	
" ...	2094	"	"	" 6..	17 13	2	2 00 "					"	"	H	
" ..	2095	"	"	" 6..	17 16	2	2 04 "		−17·5		− 3·1	"	"	H	
" ...	2105	"	"	" 7..	12 49	2	2 15 E.	−16·3	−16·3	− 9·2	− 9·2	"	Poor	P	
" ...	2106	"	"	" 7..	13 01	2	2 03 "	"	"	"	"	"	"	P	
" ...	2107	"	"	" 7..	13 04	2	2 00 "					"	"	P	
" ...	2108	"	"	" 7..	13 07	2	1 57 "	−16·4	−16·4	− 9·2	− 9·3	"		P	
" ...	2111	IIIL	"	" 7..	16 28	8	1 20 W.	−18·0		−13·3		·0016	Fair	P	
" ...	2112	"	"	" 7..	16 36	7	1 30 "					"	"	P	
" ...	2114	"	"	" 7..	16 56	8	1 55 "		−18·0		−13·3	"		P	
" ...	2117	IL	"	" 8..	15 48	2	1 00 "	−11·6	−11·6	− 8·9	− 8·9	·0015	Good	P[1]	
" ...	2118	"	"	" 8.	15 52	2	1 04 "	−11·6	−11·6	"	"	·0015	"	P[1]	
" ...	2122	"	"	" 12..	11 55	2	2 50 E.	− 9·0	−11·5	− 6·8	− 6·9	·0013	Poor	P	
" ...	2123	"	"	" 12..	11 59	2	2 46 "					"		P	
" ...	2124	"	"	" 12..	12 09	2	2 36 "					"		P	
" ...	2125	"	"	" 12..	12 12	2	2 33 "					"		P	
" ...	2126	"	"	" 12..	12 15	2	2 30 "		−11·5		− 6·9	"		P	
" ..	2127	"	"	" 12..	12 18	2	2 27 "		"		"	"		P	
" ...	2128	"	"	" 13..	15 36	2	0 55 W.	−15·0	−15·0	−12·0	−12·0	·0013		C	Focus as Jan. 12.
" ...	2129	"	"	" 13..	15 41	2	1 00 "	"	"	"	"	"	Good.	H	
" ...	2130	"	"	" 13..	15 46	2	1 06 "	"	"	"	"	"	"	H	
" ...	2141	"	"	" 15..	14 54	2	0 19 "	−14·8		− 4·7			"	C	
" ...	2142	"	"	" 15..	15 11	2	0 36 "						"	C	
" ...	2143	"	"	" 15..	15 15	2	0 40 "						"	C	
" ...	2144	"	"	" 15..	15 19	2	0 47 "		−15·6		− 5·2			C	
" ...	2151	"	"	" 16..	12 25	10	2 00 E.	−21·5	−21·5	−12·0	−12·0	·0010	Very hazy	P	
" ...	2152	"	"	" 16..	12 36	7	1 49 "					"	Better.	P	
" ...	2153	"	"	" 16..	12 44	4	1 41 "					"		P	
" ...	2154	"	"	" 16..	12 52	5	1 33 "					"		P	
" ...	2155	"	"	" 16..	12 59	6	1 26 "					"		P	
"	2156	"	"	" 16..	13 12	16	1 10 "		−22·0		−12·0	"		P	
" ...	2157	"	"	" 17..	13 48	5	0 40 "	−13·5		−11·8		·0015	Good.	P[1]	Focus unchanged.
" ...	2158	"	"	" 17..	13 56	7	0 30 "		−13·5		−11·8	"	"	P[1]	
" ...	2161	"	"	" 18..	12 41	3	1 40 "	−17·5		−13·8		"		P	
" ...	2162	"	"	" 18..	12 46	3	1 35 "					"		P	
" ...	2163	"	"	" 18..	12 51	3	1 30 "					"		P	
" ...	2164	"	"	" 18..	13 04	2	1 17 "					"		P	

β ORIONIS.

RECORD OF SPECTROGRAMS.—*Continued.*

P.—Plaskett.
H.—Harper.
C.—Cannon.
P¹—Parker.

Star.	No. of Negative.	Camera.	Plate.	Date.	Middle of Exposure. G. M. T.	Duration.	Hour Angle at End.	Temperature Centigrade. Room. Beginning.	Room. End.	Prism Box. Beginning.	Prism Box. End.	Slit Width.	Seeing.	Observer.	Remarks.
				1909.	h. m.	m.	h. m.								
β Orionis	2165	IL	Seed 27	Jan. 18	13 10	2	1 11 E.					·0015	....	P	
"	2166	"	"	" 18	13 14	2	1 08 "		−19·5		−13·8	"		P	
"	2177	"	"	" 26	10 36	3	3 10 "	− 1·0		+ 1·8		·0013	Good	P	
"	2178	"	"	" 26	10 51	2	2 55 "					"	"	P	
"	2179	"	"	" 26	10 56	2	2 50 "					"	"	P	
"	2180	"	"	" 26	11 01	3	2 45 "					"	"	P	
"	2181	"	"	" 26	11 11	2	2 35 "					"	"	P	
"	2182	"	"	" 26	11 16	3	2 30 "					"	"	P	
"	2183	"	"	" 26	11 21	2	2 25 "		− 1·6		+ 1·8	"	"	P	
"	2184	"	"	" 28	11 21	2	2 20 "	− 8·3		− 6·9		"	"	P	
"	2185	"	"	" 28	11 25	2	2 16 "					"	"	P	
"	2186	"	"	" 28	11 29	2	2 12 "					"	"	P	
"	2187	"	"	" 28	11 41	2	2 00 "					"	"	P	
"	2188	"	"	" 28	11 44	2	1 57 "					"	"	P	
"	2189	"	"	" 28	11 47	2	1 55 "		− 9·0		− 6·9	"	"	P	
"	2195	"	"	" 29	12 53	2	0 40 "	6·4		0·0		"		C	
"	2196	"	"	" 29	12 57	3	0 38 "					"		C	
"	2197	"	"	" 29	13 01	2	0 34 "					"		C	
"	2198	"	"	" 29	13 05	3	0 30 "		− 6·4		0·0	"		C	
"	2201	"	"	" 30	12 29	2	1 00 "					"	Fair	P	
"	2202	"	"	" 30	12 41	2	0 48 "					"	"	P	
"	2203	"	"	" 30	12 45	2	0 45 "					"	"	P	
"	2204	"	"	" 30	12 48	2	0 42 "		− 3·8		2·6	"	"	P	
"	2205	IIIL	"	" 30	15 47	14	2 20 W.	− 6·0		− 2·7		·0016	Unsteady.	P	
"	2206	"	"	" 30	16 04	16	2 37 "					"		P	
"	2207	"	"	" 30	16 24	19	3 00 "		− 6·6		− 2·8	"		P	
"	2211	IL	"	" 31	17 16	3	3 32 "	−19·0		− 6·0		·0013	Fair	H	
"	2212	"	"	" 31	17 20	3	3 36 "	−19·0		− 6·0		"	"	H	
"	2213	"	"	" 31	17 24	5	3 40 "					"	"	H	
"	2214	"	"	" 31	17 29	5	3 45 "		−19·0		− 6·0	"	"	H	

"	...	2215	"	"	Feb.	2..	11	14	2	2	05	E.	6·6	....	− 2·7	....	·0012	....	P	
"	...	2216	"	"	"	2..	11	23	2	1	56	"	....	....	....	....	"	....	P	
"	...	2217	"	"	"	2..	11	26	2	1	53	"	....	....	....	....	"	....	P	
"	...	2218	"	"	"	2..	11	29	2	1	50	"	....	....	....	....	"	....	P	
"	...	2219	"	"	"	2..	11	41	2	1	38	"	....	....	....	....	"	....	P	
"	...	2220	"	"	"	2..	11	45	2	1	35	"	....	− 7·1	....	− 2·8	"	....	P	
"	...	2236	"	"	"	6..	12	29	2		37	"	− 4·0	....	− 1·9	....	"	....	P	
"	...	2239	"	"	"	6..	12	50	1		16	"	....	....	....	....	"	....	P	
"	...	2240	"	"	"	6..	12	52	1		15	"	....	− 4·4	....	− 1·9	"	....	P	
"	...	2241	IIIL	"	"	6..	16	12	25	3	20	W.	− 3·8	− 3·5	− 3·0	− 3·0	·0016	....	P	Cloudy ⅔ time.
"	...	2242	"	"	"	6..	16	43	34	3	55	"	− 3·5	"	"	"	"	Poor	P	
"	...	2243	"	"	"	7..	15	11	13	2	15	"	− 2·5	− 3·5	− 1·2	− 1·2	"	Fair......	P	
"	...	2244	"	"	"	7..	15	25	11	2	28	"	....	....	....	....	"	"	P	
"	...	2245	"	"	"	7..	15	37	10	2	39	"	....	....	....	....	"	"	P	
"	...	2249	IL	"	"	8..	13	32	2		38	"	−13·5	....	− 5·2	....	·0012	Good....	P[1]	
"	...	2250	"	"	"	8..	13	36	2		42	"	....	....	....	....	"	"	P[1]	
"	...	2251	"	"	"	8..	13	41	2		47	"	....	....	....	....	"	"	P[1]	
"	...	2252	"	"	"	8..	14	01	2	1	07	"	....	....	....	....	"	"	P[1]	
"	...	2253	"	"	"	8..	14	05	2	1	11	"	....	....	....	....	"	"	P[1]	
"	...	2254	"	"	"	8..	14	09	2	1	15	"	....	−13·7	....	5·3	"	"	P[1]	
"	...	2265	"	"	"	10..	12	07	4		45	E.	4·0	....	− 1·8	....	·0011	Poor	H	Very windy.
"	...	2266	"	"	"	10..	12	12	3½		40	"	....	....	....	....	"	....	H	
"	...	2267	"	"	"	10..	12	16	2½		36	"	....	....	....	....	"	....	H	
"	...	2268	"	"	"	10..	12	21	2½		31	"	....	....	....	....	"	....	H	
"	...	2269	"	"	"	10..	12	33	2½		19	"	....	....	....	....	"	....	H	
"	...	2270	"	"	"	10..	12	37	2		10	"	....	4·0	....	− 1·8	"	....	H	
"	...	2272	"	"	"	11..	11	26	2	......	......	......	7·5	....	− 2·2	....	·0012	Good.....	P	
"	...	2273	"	"	"	11..	11	32	2	1	17	E.	....	....	....	....	"	"	P	
"	...	2274	"	"	"	11..	11	35	2	1	14	"	....	....	....	....	"	"	P	
"	...	2275	"	"	"	11..	11	38	2	1	11	"	....	....	....	....	"	"	P	
"	...	2276	"	"	"	11..	11	46	2	1	03	"	....	....	....	....	"	"	P	
"	...	2277	"	"	"	11..	11	49	2	1	00	"	....	....	....	....	"	"	P	
"	...	2278	IIIL	"	"	13..	12	27	10		05	"	− 4·5	....	+ 0·1	....	·0016	Fair......	P	
"	...	2279	"	"	"	13..	12	40	10		08	W.	....	....	....	....	"	"	P	
"	...	2280	"	"	"	13..	12	53	10		21	"	....	− 5·0	....	0·0	"	"	P	
"	...	2284	"	"	"	20..	12	29	18		25	"	1·3	....	+ 3·8	....	·0015	....	P	
"	...	2285	"	"	"	20..	13	05	50	1	20	"	....	− 2·3	....	+ 3·6	"	Poor	P	Very cloudy.
"	...	2286	"	"	"	20.	15	12	15	3	10	"	....	− 3·4	....	+ 3·3	"	Fair......	P	
"	...	2288	"	"	"	21..	12	57	9		55	"	− 1·6	....	+ 4·3	....	"	Good.....	P	
"	...	2289	"	"	"	21..	13	07	9	1	05	"	....	....	....	....	"	"	P	
"	...	2290	"	"	"	21..	13	17	9	1	15	"	....	....	....	....	"	"	P	
"	...	2291	"	"	"	21..	13	28	9	1	25	"	....	− 2·4	....	+ 4·2	"	"	P	
"	...	2292	"	"	"	22..	12	02	10		10	"	− 0·8	− 1·0	3·0	3·0	"	"	P[1]	
"	...	2293	"	"	"	22..	12	15	10		20	"	1·0	"	"	2 9	"	"	P[1]	
"	...	2294	"	"	"	22..	12	30	10		35	"	"	"	"	"	"	"	P[1]	
"	...	2295	"	"	"	22..	12	42	9		47	"	"	"	"	"	"	"	P[1]	
"	...	2309	"	"	"	27..	11	32	25		03	"	1·5	1·2	5·0	5·0	"	Hazy....	P	
"	...	2311	"	"	"	28..	11	56	8		20	"	− 6·8	....	− 1·2	....	"	Good.....	P	
"	...	2312	"	"	"	28..	12	07	10		30	"	....	....	....	....	"	"	P	
"	...	2313	"	"	"	28..	12	18	7		41	"	....	....	....	....	"	"	P	

P.—Plaskett.
H.—Harper.
C.—Cannon.
Pl—Parker.

β ORIONIS.

RECORD OF SPECTROGRAMS.—*Continued.*

Star.	No. of Negative.	Camera.	Plate.	Date.	Middle of Exposure. G. M. T.	Duration.	Hour Angle at End.	Temperature Centigrade. Room. Beginning.	Room. End.	Prism Box. Beginning.	Prism Box. End.	Slit Width.	Seeing.	Observer.	Remarks.
				1909.	h. m.	m.	h. m.								
β Orionis...	2314	IIIL	Seed 27..	Feb. 28..	12 27	7	50 W.	....	....	....	....	·0015	Good.....	P	
" ...	2315	"	" ..	" 28..	12 39	12	1 02 "	....	....	....	....	"	"	P	
" ...	2316	"	" ..	" 28..	12 50	8	1 15 "	....	8·4	....	1·3	"	"	P	
" ...	2317	"	" ..	Mar. 2..	11 05	10	22 E.	0·3	....	3·6	....	·0016	"	P	
" ...	2318	"	" ..	" 2..	11 19	8	8 "	....	....	....	....	"	"	P	
" ...	2319	"	" ..	" 2..	11 29	8	2 W.	....	....	....	....	"	"	P	
" ...	2320	"	" ..	" 2..	11 39	8	10 "	1·0	....	3·6	....	"	"	P	
" ...	2364	"	" ..	" 13..	12 12	8	1 28 "	2·8	....	7·2	....	·0015	"	P	
" ...	2365	"	" ..	" 13..	12 24	8	1 40 "	....	....	....	....	"	"	P	
" ...	2366	"	" ..	" 13..	12 36	8	1 52 "	....	....	....	....	"	"	P	
" ...	2367	"	" ..	" 13..	12 46	7	2 02 "	....	....	....	....	"	"	P	
" ...	2368	"	" ..	" 13..	12 57	6	2 10 "	....	2·1	....	7·0	"	"	P	
" ...	2372	"	" ..	" 15..	11 45	10	1 10 "	−0·4	....	2·0	....	"	"	P	
" ...	2373	"	" ..	" 15..	11 56	7	1 21 "	....	....	....	....	"	"	P	
" ...	2374	"	" ..	" 15..	12 05	6	1 30 "	....	....	....	....	"	"	P	
" ...	2375	"	" ..	" 15..	12 13	6	1 35 "	....	....	....	....	"	"	P	
" ...	2376	"	" ..	" 15..	12 21	6	1 40 "	....	−1·2	....	+1·9	"	"	P	
" ...	2386	"	" ..	" 18..	11 42	9	1 20 "	−0·4	....	3·8	....	"	....	P	
" ...	2387	"	" ..	" 18..	11 52	7	1 30 "	....	....	....	....	"	....	P	
" ...	2388	"	" ..	" 18..	12 02	8	1 40 "	....	....	....	....	"	....	P	
" ...	2389	"	" ..	" 18..	12 12	7	1 50 "	....	0·5	....	3·7	"	....	P	
" ...	2390	"	" ..	" 20..	12 16	7	1 00 "	11·0	....	7·2	....	"	Fair.....	P	
" ...	2391	"	" ..	" 20..	12 26	7	1 10 "	....	....	....	....	"	"	P	
" ...	2392	"	" ..	" 20..	12 38	10	1 22 "	....	....	....	....	"	"	P	
" ...	2393	"	" ..	" 20..	12 48	7	1 30 "	....	....	....	....	"	"	P	
" ...	2394	"	" ..	" 20..	12 58	7	1 40 "	....	0·5	....	7·0	"	"	P	
" ...	2397	"	" ..	" 21..	13 38	8	3 25 "	−1·8	....	4·0	....	"	"	P	
" ...	2398	"	" ..	" 21..	13 48	9	3 35 "	....	....	....	....	"	"	P	
" ...	2399	"	" ..	" 21..	14 00	11	3 47 "	....	....	....	....	"	"	P	
" ...	2400	"	" ..	" 21..	14 14	12	4 02 "	....	−3·8	....	3·9	"	"	P	

"	2402	"	"	" 22	11 51	10	1 31	"	3·1		4·8		"	Good	P
"	2403	"	"	" 22	12 02	10	1 42	"					"	"	P
"	2404	"	"	" 22	12 13	11	1 51	"					"	"	P
"	2405	"	"	" 22	12 35	9	2 15	"		2·6		4·8	"	"	P
"	2420	"	"	" 23	11 46	6	1 40	"	5·4		8·1		"	"	P
"	2421	"	"	" 23	11 57	6	1 51	"					"	"	P
"	2422	"	"	" 23	12 05	6	1 59	"					"	"	P
"	2423	"	"	" 23	12 13	7	2 07	"					"	"	P
"	2424	"	"	" 23	12 27	8	2 20	"					"	"	C
"	2425	"	"	" 23	12 38	8	2 33	"		3·5		6·8	"	"	C

β ORIONIS 1241 *a*.

1908. Jan. 20.
G. M. T. 15h 00m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·0256	....	....	....	1½	53·1058	....	....	....
3	53·0008	·0048	·0350	+40·28	3	45·2624	·2724	·0337	+55·17
2	53·4440	·4490	·0467	53·40	2	45·2628	....	....	....

Weighted mean........................ +41·64
V_a................ −17·93
V_d................ − ·09
Curvature............ − ·28

Radial velocity...................... + 23·3

β ORIONIS 1241 *b*.

1908. Jan. 20.
G. M. T. 15h 00m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7354	....	....	....	2	53·1094	....	....	....
2	54·0270	....	....	....	3	45·2712	·2755	·0368	+38·41
3	54·0008	·0048	·0350	+40·28	2	45·2684	....	....	....
1	53·4328	·4360	·0337	+38·54					

Weighted mean........................ +39·23
V_a................ −17·93
V_d................ − ·09
Curvature............ − ·28

Radial velocity...................... + 20·9

β ORIONIS 1241 *c*.

1908. Jan. 20.
G. M. T. 15h 00m

Measured by } J. S. Plaskett.
Observed by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
	54·7640	....	....	....		53·1358	....	....	....
	54·0552	....	....	....		45·2960	....	....	....
2	54 0360	·0130	·0448	+51·56	3	45·2952	·2727	·0340	+35·49
1	53·4715	·4485	·0462	+52·83					

Weighted mean........................ +43·74
V_a................ −17·93
V_d................ − ·09
Curvature............ − ·28

Radial velocity...................... + 25·4

β ORIONIS 1242 a.

1908. Jan. 20.
G. M. T. 15^h 15^m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	54·7385	......	......	......	2	53·1054	......	......	......
2	54·0270	......	......	......	2	45·2652	·2737	·0350	+36·58
3	54·0012	·0052	·0354	+40·74	2	45·2653	......	......	......
3	53·4384	·4434	·0411	+47·00					

Weighted mean		+42·03
V_a	−17·93	
V_d	− ·09	
Curvature	− ·28	
Radial velocity		+ 23·7

β ORIONIS 1242 b.

1908. Jan. 20.
G. M. T. 15^h 15^m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	54·7430	......	......	......	2	53·1110	......	......	......
1	54·0320	......	......	......	3	45·2740	·2783	·0396	+41·34
2½	54·0078	·0078	·0380	+43·76	2	45·2692	......	......	......
1½	53·4467	·4467	·0444	50·75					

Weighted mean		+44·22
V_a	−17·93	
V_d	− ·09	
Curvature	− ·28	
Radial velocity		+25·9

β ORIONIS 1242 c.

1908. Jan. 20.
G. M. T. 15^h 15^m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	54·7111	......	......	......	2	53·0790	......	......	......
1	54·0022	......	......	......	2	45·2307	·2655	·0268	+27·97
3	53·9678	·9990	0292	+33·61	2	45·2378	......	......	......
2	53·4174	·4500	·0477	+54·55					

Weighted mean		+37·98
V_a		−17·93
V_d		− ·09
Curvature	− ·28	
Radial velocity		+19·7

β ORIONIS 1243 a.

1908. Jan. 20.
G. M. T. 15h 27m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	54 7409	....	....	.... .	2	53·1154	....	....	....
2	54 0332	....	.. ..	... .	3	45·2837	2760	0373	−38·93
3	54·0104	0064	·0366	−42·12	...	45 2814	....	... .	... .
2	53·4376	4346	·0323	36·94					

Weighted mean...		−39·63
V_a.....	17·93	
V_d.....	·09	
Curvature	− ·28	
Radial velocity...		21 3

β ORIONIS 1243 b.

1908. Jan. 20.
G. M. T. 15h 27m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	54 7300	....	.. .. . .	....	2	53·1011	....	....	....
2	54·0188	... ...	... .	.... ..	3	45·2702	·2730	·0343	+35·80
2	53·9988	0098	0400	−46·04	......	45·2712	. . ..	.. ....	....
2	53·4319	·4429	·0406	46·43					

Weighted mean....		−41·76
V_a....	−17·93	
V_d....... ..	·09	
Curvature...... ...	− 28	
Radial velocity.		+23·5

β ORIONIS 1243 c.

1908. Jan. 20.
G. M. T. 15h 27m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	54 7244	....	... .	.. ..	2	53·0980	.. . . ..	.. ..	....
2	54·0125	....	....	... .	3	45·2705	2820	0433	+45·19
2	53·9841	·0000	0302	−34·76	.. ..	45·2622	... .	... .	....
2	53·4295	4445	·0422	48·26					

Weighted mean..		−43·09
V_a...	−17 93	
V_d............. ..	− 09	
Curvature.... . ..	− ·28	
Radial velocity		−24·8

β ORIONIS 1244 a.

1908. Jan. 20.
G. M. T. 15ʰ 47ᵐ

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7275	.....	.....	.....	2	53·0998	.....	.....	.....
2	54·0201	.....	.....	.....	3	45·2686	2811	0424	+44·25
3	53·9956	·0056	·0358	+41·20	2	45·2611	.....	.....	.....
2	53·4305	·4410	·0387	43·14					

Weighted mean . . . . +42·82
V_a . . . . . . −17·93
V_d . . . . . . ·09
Curvature . . . . . . ·28

Radial velocity . . . . . . +24·5

β ORIONIS 1244 b.

1908. Jan. 20.
G. M. T. 15ʰ 47ᵐ

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7310	.....	.....	.....	2	53·1050	.....	.....	.....
2	54·0209	.....	.....	.....	3	45·2620	·2723	·0336	+35·07
3	53·9910	9990	·0292	+33·61	2	45·2632	.....	.....	.....
2	53·4264	·4340	0317	36·25					

Weighted mean . . . . +34·82
V_a . . . . . . −17·93
V_d . . . . . . − ·09
Curvature . . . . . − ·28

Radial velocity . . . . . . +16·5

β ORIONIS 1244 c.

1908. Jan. 20.
G. M. T. 15ʰ 47ᵐ

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7336	.....	.....	.....	2	53·1058	.....	.....	.....
2	54·0231	.....	.....	.....	3	45·2684	·2780	·0393	+41·02
3	54·0019	0090	·0392	+45·11	2	45·2638	.....	.....	.....
2	53·4595	·4460	·0437	49·97					

Weighted mean . . . . +44·75
V_a . . . . . . −17·93
V_d . . . . . . − ·09
Curvature . . . . . − ·28

Radial velocity . . . . . . +26·4

β ORIONIS 1245 *a*.

1908. Jan. 20.
G. M. T. 15^h 53^m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	54·7272				2	53·1018			
1	54·0156				3	45·2650	·2763	·0376	+39·24
3	53·9966	·0090	·0392	+45·12	2	45·2622			
2	53·4315	·4430	·0407	46·54					

Weighted mean		+43·27
V_a	−17·93	
V_d	− ·09	
Curvature	− ·28	
Radial velocity		+ 25.0

β ORIONIS 1245 *b*.

1908. Jan. 20.
G. M. T. 15^h 53^m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	54·7467				2	53·1202			
2	54·0342				3	45·2774	·2750	·0363	+37·89
3	54·0134	·0074	·0376	+43·27	2	45·2760			
2	53·4430	·4340	·0337	38·53					

Weighted mean		+40·07
V_a	−17·93	
V_d	− ·09	
Curvature	− ·28	
Radial velocity		+ 21.8

β ORIONIS 1245 *c*.

1908. Jan. 20.
G. M. T. 15^h 53^m

Observed by } J. S PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	54·7458				2	53·1193			
2	54·0321				3	45·2750	·2740	·0353	+36·84
3	54·0084	·0034	·0336	+38·67	2	45·2742			
2	53·4436	·4390	·0367	41·97					

Weighted mean		+38·81
V_a	17·93	
V_d	− ·09	
Curvature	− ·28	
Radial velocity		+ 20·5

β ORIONIS 1249 *a*.

1908. Jan. 20.
G. M. T. 16ʰ 37ᵐ

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings	Dispᵗ in revⁿˢ	Velocity.
2	54·7444	......	......	......	2	53·1200	......	......	......
2	54·0334	......	......	......	3	45·2714	2668	·0291	+30·37
3	54·0037	·9987	·0289	+33·26	2	45·2782	......	......	......
2	53·4376	4320	·0297	33·96					

Weighted mean		+32·35
V_a	17·93	
V_d	− ·09	
Curvature	− ·28	
Radial velocity		+14·0

β ORIONIS 1247 *a*.

1908. Jan. 20.
G. M. T. 16ʰ 17ᵐ

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7364	......	......	......	2	53·1070	......	......	......
1	54·0227	......	......	......	2	45·2606	2715	·0327	+34·13
3	54·0078	0138	·0440	+50·64	2	45·2624	......	......	......
2	53·4296	·4350	·0327	37·40					

Weighted mean		+42·14
V_a	−17·93	
V_d	− ·09	
Curvature	− ·28	
Radial velocity		+23·8

β ORIONIS 1247 *b*.

1908. Jan. 20.
G. M. T. 16ʰ 17ᵐ

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity
2	54·7274	......	......	......	2	53·0931	......	......	......
1	54·0096	......	......	......	3	45·2634	·2794	0397	+41·43
3	53·9963	0135	·0437	+50·29	2	45·2577	......	......	......
2	53·4377	·4557	0534	61·06					

Weighted mean		+49·66
V_a	−17·93	
V_d	− ·09	
Curvature	− ·28	
Radial velocity		+31·3

β ORIONIS 1247c.

1908. Jan. 20.
G. M. T. 16h 17m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7281	......	......	......	2	53·0985	......	......	......
1	54·0124	......	......	......	3	45·2528	·2692	·0305	+31·83
3	53·9902	0048	·0350	+40·28	2	45·2570	....	....	.
2	53·4238	4386	·0363	41·51					

Weighted mean . . . . +37·42
V_a . . . . . . −17·93
V_d . . . . . . − ·09
Curvature . . . − ·28

Radial velocity . . . . +19·0

β ORIONIS 1248 a.

1908. Jan. 20
G. M. T. 16h 27m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity
2	54·7473	......	......	......	2	55·1167	......	......	......
1	54·0314	......	......	......	2	45·2794	......	......	......
2	53·9942	9900	0211	+24·28	3	45·2792	·2735	·0348	+36·32
1	53·4267	4220	0197	22·53					

Weighted mean . . . . +30·01
V_a . . . . −17·93
V_d . . . . − ·09
Curvature . . . . − ·28

Radial velocity . . . . +11·6

β ORIONIS 1248 b.

1908. Jan. 20.
G. M. T. 16h 27m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7402	....	....	....	2	53·1140	......	......	....
1	54·0234	....	....	....	3	45·2624	·2660	·0273	+28·49
1	53·9742	·9760	0071	+8·17	2	45·2770	......	......	....
1	53·4253	·4260	0237	27·10					

Weighted mean . . . . +24·15
V_a . . . . . . −17·93
V_d . . . . . . ·09
Curvature . . . . − ·28

Radial velocity . . . . + 5·8

β ORIONIS 1248 c.

1908. Jan. 20.
G. M. T. 16^h 27^m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	54·7472	...	...	...	2	53·1250	...	...	...
1	54·0420	...	...	...	3	45·2991	2891	·0504	+52·60
2	54·0294	·0174	0505	+58·12	2	45·2836	...	...	...
2	53·4593	·4493	·0470	53·75					

Weighted mean		+54·51
V_a	17·93	
V_d	– ·09	
Curvature	– ·28	
Radial velocity		+36·1

β ORIONIS 1249 b.

1908. Jan. 20.
G. M. T. 16^h 37^m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	54·7478	...	...	...	2	53·1232	...	...	...
2	54·0356	...	...	...	3	45·2788	·2680	·0293	+30·58
2	54·0084	·0004	·0306	+35·22	—	45·2844	...	...	...
2	53·4450	4365	·0342	39·11					

Weighted mean		+34·34
V_a	–17·93	
V_d	– ·09	
Curvature	– ·28	
Radial velocity		+16·0

β ORIONIS 1249 c.

1908. Jan. 20.
G. M. T. 16^h 37^m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	54·7362	...	...	...	2	53·1092	...	...	...
2	54·0240	...	...	...	3	45·2725	·2760	·0373	+38·93
2	53·9998	·0040	·0342	+39·36	—	45·2704	...	...	...
2	53·4435	·4473	·0451	51·57					

Weighted mean		+42·66
V_a	–17·93	
V_d	– ·09	
Curvature	– 28	
Radial velocity		+24·2

β ORIONIS 1285 *a*.

1908. Jan. 27.
G. M. T. 15h 30m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns.	Velocity.
2	56·2642	....	......	....	2	54·8480	....	....	....
2	56·2207	·2768	·0470	+35·17	1½	42·3191	·3130	·0520	+32·61
1½	55·3517	·4083	·0539	39·88	2	42·3130	....	....	....

Weighted mean		+35·81
V_a	−20·08	
V_d	− ·16	
Curvature	− ·30	
Radial velocity		+15·3

β ORIONIS 1285 *b*.

1908. Jan. 27.
G. M. T. 15h 30m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	57·3371	....	......	....	2	54·8307	....	....	....
2	56·2462	....	....	....	2	42·3000	·3283	·0673	+42·20
2	56·1983	·2724	·0426	+31·88	1½	42·3092	....	....	....
1	55·3500	·4241	·0697	51·53					

Weighted mean		+39·72
V_a	20·08	
V_d	·16	
Curvature	− ·30	
Radial velocity		+19·2

β ORIONIS 1285 *c*.

1908. Jan. 27.
G. M. T. 15h 30m.

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	57·3127	....	....	....	2	54·8130	....	....	....
2	56·2255	....	....	....	2	42·2834	....	....	....
2	56·1773	·2718	·0420	+31·43	1½	42·2936	·3293	·0683	+42·83
2	55·3222	·4147	·0603	44·62					

Weighted mean		+39·38
V_a	−20·08	
V_d	− ·16	
Curvature	− ·30	
Radial velocity		+17·9

β ORIONIS 1286 *a*.

1908. Jan. 27.
G. M. T. 16ʰ 09ᵐ.

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	57·2727	....	.....	......	2	54·7770	...	.....	.....
2	56·1937	....	.....	.....	2	42·2466		....	.....
2	56·1589	·2869	·0571	+42·73	1½	42·2512	·3227	·0617	+38·6
2	55·2850	·4130	·0586	43·36					

Weighted mean .... +42·20
V_a .... −20·08
V_d .... − ·19
Curvature .... ·30

Radial velocity .... +21·3

β ORIONIS 1286 *b*.

1908. Jan. 27.
G. M. T. 16ʰ 09ᵐ

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	57·3533	....	.....	......	2	54·8539	......	.....	.....
2	56·2652	....	.....	.....	2	42·3240	....	.....	.....
2	56·2297	·2848	·0550	+41·16	1½	42·3241	·3192	·0582	+36·50
1½	55·3552	·4074	·0530	39·21					

Weighted mean .... +39·17
V_a .... −20·08
V_d 20
Curvature .... − ·28

Radial velocity .... +18·7

β ORIONIS 1286 *c*.

1908. Jan. 27.
G. M. T. 16ʰ 09ᵐ

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	57·3761	......	....	......	2	54·8777	......	....	......
2	56·2915	....	....	....	2	42·3443	......	....	......
2	56·2610	·2898	·0600	+44·90	2	42·3548	·3296	·0686	+43·02
2	55·3896	·4175	·0631	46·68					

Weighted mean .... +44·87
V_a .... −20·08
V_d .... ·19
Curvature .... − ·30

Radial velocity .... +24·3

β ORIONIS 1289 *a*.

1908. Jan. 27.
G. M. T. 17h 17m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	57·3477				2	54·8500			
2	56·2633				3	42·3258	·3168	·0558	+34·99
2	56·2241	·1671	·0627	+46·92	2	42·3286			
1½	55·3630	·3070	·0474	35·07					

Weighted mean ... +38·62
V_a ... −20·08
V_d ... ·19
Curvature ... − ·30

Radial velocity ... +18·1

β ORIONIS 1289 *b*.

1908. Jan. 27.
G. M. T. 17h 17m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	57·3801				2	54·8794			
1	56·2921				3	42·3664	·3275	·0665	+41·70
3	56·2507	·2780	·0482	+36·07	2	42·3584			
2	55·3890	·4155	·0611	45·21					

Weighted mean ... +40·46
V_a ... −20·08
V_d ... ·19
Curvature ... ·30

Radial velocity ... +19·9

β ORIONIS 1289 *c*.

1908. Jan. 27.
G. M. T. 17h 17m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	57·3608				2	54·8612			
2	56·2675				3	42·3602	·3425	·0815	+51·11
3	56·2378	·2900	·0602	+45·05	2	42·3378			
2	55·3721	·4200	·0656	48·54					

Weighted mean ... + 48·19
V_a ... − 20·08
V_d ... − ·19
Curvature ... − ·30

Radial velocity ... + 27·8

β ORIONIS 1290 *a*.

1908. Jan. 27.
G. M. T. 17h 28m

Observed by / Measured by } J. S. Plaskett

Wt.	Mean of Settings.	Corrected Star Settings	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	57·3519				2	54·8582			
2	56·2658				2	42·3268	·3156	·0546	+34·24
3	56·2260	·2800	·0502	+37·56	2	42·3308			

Weighted mean .... + 36·23
V_a ... − 20·08
V_d ... − ·19
Curvature ... − ·30

Radial velocity ... + 15·6

β ORIONIS 1290 *b*.

1908. Jan. 27.
G. M. T. 17h 28m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	57·3527				2	54·8536			
2	56·2622				2	42·3223	·3190	·0580	+36·37
3	56·2360	·2940	·0642	+48·04	2	42·3224			
2	55·3534	·4074	·0530	39·21					

Weighted mean ... + 42·18
V_a ... − 20·08
V_d ... − ·19
Curvature. − ·30

Radial velocity ... + 21·6

β ORIONIS 1290 *c*.

1908. Jan. 27.
G. M. T. 17h 28m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	57·3590				2	54·8680			
2	56·2706				3	42·3490	·3313	·0503	+31·54
3	56·2320	·2810	·0512	+38·31	2	42·3368			
1½	55·3704	·4134	·0590	43·65					

Weighted mean ... + 36·70
V_a ... − 20·08
V_d ... − ·19
Curvature ... − ·30

Radial velocity ... + 16·1

β ORIONIS 1405.

1908. Mar. 20.
G. M. T. 11h 51m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3300				2	58·7869			
2	61·3502				2	36·2090	·2170	·1265	+44·48
2	61·3121	3064	·1259	−52·05	2	36·1858			
1½	59·7292	·7236	1271	52·00					

Weighted mean .... −48 37
V_a ...... 24·86
V_d ...... − ·14
Curvature ...... − ·28

Radial velocity ...... +23 1

β ORIONIS 1406.

1908. Mar. 20.
G. M. T. 12h 07m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3238				2	58·7846			
2	61·3466				1½	36·2180	·2235	·1330	+46·76
2	61·3115	3095	1290	53·33	2	36 1886			
1½	59 7150	7122	·1157	47·33					

Weighted mean ...... +49·56
V_a ...... −24 86
V_d ...... − 14
Curvature ...... − ·28

Radial velocity ...... + 24·3

β ORIONIS 1407.

1908. Mar. 20.
G. M. T. 12h 21m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3248				2	58·7785			
2	61·3441				2	36·1872	·2090	·1185	+41·66
3	61·2936	·2941	·1136	+46·96	2	36·1721			
1½	59·7240	7260	·1295	52·98					

Weighted mean ...... +46·72
V_a ...... −24·86
V_d ...... − ·14
Curvature ...... − ·28

Radial velocity ...... +21·4

β ORIONIS 1408.

1908. Mar. 20.
G. M. T. 12h 32m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3338	....	....	....	2	58·7904	....	....	....
2	61·3533	....	....	....	2	36·2218	·2315	·1410	+49·58
2	61·3036	·2946	·1141	+47·17	1½	36·1832	....	....	....
1½	59·7392	·7302	·1337	54·70					

Weighted mean .... +50·15
V_a .... 24·86
V_d .... − ·14
Curvature .... − ·28

Radial velocity .... + 24·9

β ORIONIS 1409.

1908. Mar. 20.
G. M. T. 12h 46m

Observed by / Measured by } J. S. Plaskett.

Wt	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3224	....	....	....	1	58·7782	....	....	....
2	61·3452	....	....	....	2	36·2226	·2365	·1460	+51·33
2	61·3028	·3048	·1243	+51·39	2	36·1801	....	....	....
1½	59·7364	·7390	·1425	58·30					

Weighted mean .... +53·25
V_a .... −24·86
V_d .... − ·14
Curvature .... − ·28

Radial velocity .... +28·0

β ORIONIS 1410.

1908. Mar. 20.
G. M. T. 13h 00m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3280	....	....	....	2	58·7856	....	....	....
2	61·3492	....	....	....	2	36·2229	·2265	·1360	+47·82
2	61·3050	·3010	·1205	+49·81	2	36·1906	....	....	....
1½	59·7178	·7136	·1171	47·91					

Weighted mean .... +48·57
V_a .... −24·86
V_d .... − ·14
Curvature .... − ·28

Radial velocity .... +23·3

β ORIONIS 1411.

1908. March 20.
G. M. T. 13^h 12^m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	63·1088	....	....	......	2	58·5647	....	....	....
3	61·0842	61·2989	÷ ·1184	+48·95	2	35·9590	....	....	....
1½	59·5095	59·7259	·1294	52·94	2	0·9551	36·2203	·1298	−45·64

Weighted mean........................ +48·85
V_a .... −24·86
V_d .... − 17
Curvature .... − ·28

Radial velocity....................... −23·5

β ORIONIS 1412.

1908. March 20.
G. M. T. 13^h 27^m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	63·1178	....	....	......	2	58·5736	....	....	....
3	61·0974	61·3005	·1200	+49·60	2	35·9727	....	....	....
2	59·5242	59·7314	·1349	55·18	2	36·0000	36·2215	·1310	−46·06

Weighted mean .... +50·18
V_a .... −24·86
V_d .... − ·17
Curvature.............. ·28

Radial velocity .... +24·9

β ORIONIS 1413.

1908. March 20.
G. M. T. 13^h 47^m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in Rev^{ns}	Velocity.
2	63·3873	......	....	......	2	58·8412	....	....	....
3	61·3699	61·3083	·1278	+52·83	2	36·3010	36·2455	·1550	+54·50
1½	59·7810	59·7205	·1240	50·73	2	36·2495	......	....	....

Weighted mean........................ +52·86
V_a.................. −24·86
V_d .... − ·17
Curvature.............. ·28

Radial velocity.................. +27·5

β ORIONIS 1414.

1908. March 20.
G. M. T. 13h 57m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3927	......	......	......	2	58·8485	......	......	......
3	61·3695	61·3015	·1210	+50·02	2	36·2981	36·2350	·1445	+54·40
2	59·7945	59·7270	1350	53·38	2	36·2572	......	......	......

Weighted mean.......... +52·23
V_a.......... 24·86
V_d.......... ·17
Curvature.......... ·28

Radial velocity.......... +26·9

β ORIONIS 1426.

1908. March 24.
G. M. T. 12h 03m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3455	......	......	......	2	58·7935	......	......	......
2	61·2946	61·2780	0975	+40·35	1½	36·1955	36·2300	1395	+49·05
1½	59·7192	59·7040	·1075	43·98	2	36·1592	......	......	......

Weighted mean.......... +44·05
V_a.......... −24·36
V_d.......... − ·16
Curvature.......... − ·28

Radial velocity.......... +19·2

β ORIONIS 1427.

1908. March 24.
G. M. T. 12h 15m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3382	......	......	......	2	58·7912	......	......	......
2	61·2918	61·2798	·0993	+41·09	2	36·2085	36·2340	·1435	+50·45
1	59·7208	59·7098	1133	46·35	2	36·1682	......	......	......

Weighted mean.......... +45·89
V_a.......... −24·36
V_d.......... − ·16
Curvature.......... − ·28

Radial velocity.......... +21·1

β ORIONIS 1428.

1908. March 24.
G. M. T. 12ʰ 23ᵐ

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3148	....	....	....	2	58·7726	......	....	....
2	61·2682	61·2772	·0967	40·01	2	36·1838	36·2255	·1350	+47·47
1½	59·6971	59·7060	·1095	44·80	2	36·1522	....	....	......

Weighted mean		+44·03
V_a	−24·36	
V_d	− ·16	
Curvature	− ·28	
Radial velocity		+19·2

β ORIONIS 1429.

1908. March 24.
G. M. T. 12ʰ 36ᵐ

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3133	....	....	....	2	58·7619	......	....	....
2	61·2675	61·2825	·1020	−42·21	2	36·1559	36·2215	·1310	+46·06
1½	59·6988	59·7160	·1195	48·89	2	36·1282	....	....	....

Weighted mean		+45·43
V_a	−24·36	
V_d	− ·16	
Curvature	− ·28	
Radial velocity		+21·6

β ORIONIS 1430.

1908. March 24.
G. M. T. 12ʰ 42ᵐ

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3288	....	....	....	2	58·7792	....	....	....
2	61·2808	61·2795	·0995	+41·17	1½	36·1830	36·2190	·1285	+45·18
1½	59·7068	59·7075	·1110	45·41	2	36·1581	....	....	....

Weighted mean		+43·65
V_a	−24·36	
V_d	− ·16	
Curvature	− ·28	
Radial velocity		+18·8

β ORIONIS 1431.

1908. March 24.
G. M. T. 12h 52m

Observed by } J. S. Plaskett
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3248	....	....	....	2	58·7802	....	....	....
2	61·2775	61·2775	·0970	+40·14	2	36·1932	36·2350	·1445	+50·81
1½	59·6884	59·6890	·0925	+37·84	2	36·1520	....	....	....

Weighted mean........ .... +43·39
V_a .... −24·36
V_d .. .. −·16
Curvature.... . −·28

Radial velocity . . .. +18·6

β ORIONIS 1433.

1908. March 24.
G. M. T. 13h 16m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3394	.....	....	....	2	58·7740	....	....	....
2	61·2791	61 2816	·1011	+41·84	2	36·1666	36·2106	·1201	+42·23
1½	59·6956	59 7020	·1055	43·16	2	36·1490	....	....	....

Weighted mean.. .. .. + 42 34
V_a .... − 24 36
V_d .... − ·16
Curvature. .. ... − ·28

Radial velocity. ... . + 17·5

β ORIONIS 1434.

1908. March 24.
G. M. T. 13h 32m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3430	......	......	......	2	58·7969	....	....	....
2	61·2968	61·2790	·0985	+40·76	1	36·2018	36·2210	·1305	+45·88
1	59·7385	59 7215	1254	51·30	2	36 1742	....	....	....

Weighted mean.... .. .. + 44·08
V_a .. .. − 24·36
V_d . ... − ·16
Curvature.... . . ·28

Radial velocity..... .. . . . + 19·3

β ORIONIS 1435.

1908. March 24.
G. M. T. 13h 39m

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings	Disp^t in rev^ns	Velocity.
2	63·3082	......	......	......	2	58·7515	......	......	......
2	61·2508	61·2727	·0922	−38·15	1½	36·1366	36·2126	·1221	−42·93
1	59·6764	59·7034	·1069	43·32	2	36·1180	......	......	......

Weighted mean		−40·89
V_a	−24·36	
V_d	·16	
Curvature	·28	
Radial velocity		−16·1

β ORIONIS 1436.

1908. March 24.
G. M. T. 13h 48m

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings	Disp^t in rev^ns	Velocity.
2	63·3496	......	......	......	2	58·8030	......	......	......
2	61·2902	61·2762	·0957	39·60	1½	36·2066	36·2310	·1405	+49·40
1½	59·7106	59·6876	·0921	37·68	2	36·1692	......	......	......

Weighted mean		−41·96
V_a	−24·36	
V_d	−·16	
Curvature	−28	
Radial velocity		17·2

β ORIONIS 1437.

1908. March 24
G. M. T. 13h 5·6m

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3020	......	......	......	2	58·7548	......	......	......
1½	61·2558	61·2800	·0995	−41·17	2	36·1466	36·2180	·1275	+44·83
1	59·6798	59·7050	·1085	44·39	2	36·1222	......	......	......

Weighted mean		+43·51
V_a	−24·36	
V_d	−·16	
Curvature	−28	
Radial velocity		+18·7

β ORIONIS 1438.

1908. March 24.
G. M. T. 14h 07m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3504	......	......	..	2	58·8022	......	......	......
1½	61·3018	61·2780	·0975	+40·54	1½	36·2016	36·2170	·1265	+44·48
1	59·7345	59·7125	·1160	47·46	2	36·1784	......	......	......

Weighted mean		+43·75
V_a	−24·36	
V_d	·16	
Curvature......	·28	
Radial velocity		+18·0

β ORIONIS 1439.

1908. March 30.
G. M. T. 12h 19m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3002	......	......	......	2	58·7534	......	......	......
3	61·2444	·2993	·0870	+35·86	2	36·1192	·1568	1087	+38·11
1½	59·6804	·7304	·1066	43·48	2	36·1146	......	......	......

Weighted mean......		+38·31
V_a	−23·39	
V_d	·21	
Curvature......	−·28	
Radial velocity		+14·4

β ORIONIS 1440.

1908. March 30.
G. M. T. 12h 29m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3356	......	......	......	2	58·7895	......	......	......
2	61·2894	3087	·0964	+39·74	2	36·1602	·1480	0999	+35·02
1½	59·6994	·7132	·0894	40·54	2	36·1612	......	......	......

Weighted mean......		+38·24
V_a	−23·39	
V_d	−·21	
Curvature......	−·28	
Radial velocity		+14·4

β ORIONIS 1441.

1908. Mar. 30.
G. M. T. 12ʰ 38ᵐ

Observed by, Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·4150	....	....	....	2	58·8640	....	....	....
2	61·3622	·3042	·0919	+37·88	1½	36·2522	·1620	·1139	−39·93
1	59·7768	·7148	·0910	37·12	2	36·2426	....	....	....

Weighted mean ... +38·39
V_a ... −23·39
V_d ... − ·21
Curvature ... − ·28

Radial velocity ... −14·5

β ORIONIS 1442.

1908. Mar. 30.
G. M. T. 12ʰ 49ᵐ

Observed by, Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3596	....	....	....	2	58·8129	....	....	....
2	61·3220	3175	·1052	−43·36	1½	36·1715	·1572	·1091	+38·25
1½	59·7322	·7220	·0982	40·06	2	36·1666	....	....	....

Weighted mean ... +40·84
V_a ... −23·39
V_d ... − ·21
Curvature ... − ·28

Radial velocity ... +17·0

β ORIONIS 1448.

1908. April 3.
G. M. T. 12ʰ 16ᵐ

Observed by, Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3573	....	....	....	2	58·8206	....	....	....
2½	61·3387	61·3037	·1232	+50·93	1½	36·2340	36·2126	·1184	+41·63
1½	59·7541	59·7160	·1195	48·89	2	36·2156	....	....	....

Weighted mean ... +48·02
V_a ... −22·69
V_d ... − ·16
Curvature ... − ·28

Radial velocity ... +24·9

β ORIONIS 1449.

1908. April 3.
G. M. T. 12h 28m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3266	....	....	....	2	58 7829	....	....	....
2	61·3045	61 3024	1219	+50·39	2	36·2068	36·2285	·1380	+48·52
1½	59 7338	59·7320	1355	55·43	2	36·1722	....	....	....

Weighted mean .... +51 08
V_a........ 22·69
V_d........ ·16
Curvature........ ·28

Radial velocity........ +27·9

β ORIONIS 1450.

908. April 3.
G. M. T. 12h 40m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3216	....	....	....	2	58·7768	....	....	....
2	61 3092	61·3124	·1319	+54 53	1	36·2098	36·2325	·1420	+49.93
1½	59·7388	59·7428	·1463	59·85	2	36·1714	....	....	....

Weighted mean........ +55·28
V_a........ −22·69
V_d........ − ·16
Curvature........ − ·28

Radial velocity........ +32·2

β ORIONIS 1451.

1908. April 3.
G. M. T. 12h 53m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3301	....	....	....	2	58·7860	....	....	....
2	61·3062	61·3007	·1202	+49·69	1½	36·2164	36·2275	·1370	+48·47
1½	59·7310	59·7260	·1295	52·98	2	36·1830	....	....	....

Weighted mean........ +50·22
V_a........ −22·69
V_d........ − ·16
Curvature........ − ·28

Radial velocity........ +27·1

β ORIONIS 1457.

1908. April 4.
G. M. T. 12h 19m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3698	....	......	....	2	58·8305	......	......	....
3	61·3515	61·3069	·1264	+52·25	2	36·2996	36·2580	·1638	+57·59
2	59·7708	59·7224	·1259	51·51	2	36·2358	....	......	....

Weighted mean ...... +53·56
V_a ...... −22·41
V_d ...... − ·22
Curvature ...... ·28

Radial velocity ...... +29·9

β ORIONIS 1458.

1908. April 4.
G. M. T. 12h 28m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3566	......	....	....	2	58·8112	......	......	....
2	61·3314	61·3004	·1199	+49·57	1½	36·2475	36·2460	·1551	+54·67
1½	59·7500	59·7196	·1231	50·36	2	36·1956	......	.....	......

Weighted mean ...... +51·34
V_a ...... 22·40
V_d ...... − ·23
Curvature ...... − ·28

Radial velocity ...... +27·4

β ORIONIS 1459.

1908. April 4.
G. M. T. 12h 38m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3648	....	....	....	2	58·8227	...	......	......
3	61·3354	61·2944	·1139	+47·09	1½	36·2782	36·2500	·1625	+57·13
1½	59·7562	59·7150	·1185	48·47	2	36·2194	.....	......	......

Weighted mean ...... +49·93
V_a ...... −22·40
V_d ...... − ·23
Curvature ...... − ·28

Radial velocity ...... +27·0

β ORIONIS 1469.

1908. April 13.
G. M. T. 12h 10m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
.....	63·3830	.....	.....	.....	....	58·8337	.....	.....	.....
.....	61·4037	.....	.....	.....	....	36·1867	.....	.....	.....
2½	61·3453	·3210	·1087	+44·81	1	36·2037	·1690	·1209	+42·38
1½	59·7340	·7090	·1852	34·75					

Weighted mean ... +42 03
V_a ... −20·23
V_d ... − ·28
Curvature ... − ·28

Radial velocity ... +21·3

β ORIONIS 1470.

1908. April 13.
G. M. T. 12h 22m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
.....	63·3425	.....	.....	.....	....	58·7861	.....	.....	.....
.....	61·3570	.....	.....	.....	....	36·1305	.....	.....	.....
.....	61·3030	·3230	·1107	+45·63	....	36·1485	·1700	·1219	−42·73
.....	59·7213	·7449	·1202	49·03					

Weighted mean ... +45·75
V_a ... −20·23
V_d ... − ·25
Curvature ... ·28

Radial velocity ... +25·0

β ORIONIS 1471.

1908. April 13.
G. M. T. 12h 34m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity
.....	63·3504	.....	.....	.....	....	58·7960	.....	.....	.....
.....	61·3650	.....	.....	.....	....	36·1787	.....	.....	.....
2½	61·3036	·3156	1033	+42·58	1½	36·1611	·1876	·1395	+48·89
1½	59·7275	·7400	1162	47·40					

Weighted mean ... +45·61
V_a ... −20·23
V_d ... ·26
Curvature ... − ·28

Radial velocity ... +24·8

β ORIONIS 1873.

1908. Sept. 7.
G. M. T. 21^h 52^m

Observed by J. B. Cannon.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3948	......	......	......	2	58·8286	......	......	......
2	61·4080	......	......	......	2	36·1061	......	......	......
2	61·2458	·2498	·0068	+2·18	1	35·9859	·9890	0168	−5·87
2	59·6682	·6722	·0208	+8·46					

Weighted mean .... +3·08
V_a .... +25·29
V_d .... + ·09
Curvature .... ·28

Radial velocity .... +28·2

β ORIONIS 1874.

1908. Sept. 7.
G. M. T. 22^h 10^m

Observed by J. B. Cannon.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3952	......	......	......	2	58·8342	......	......	......
2	61·4064	......	......	......	2	36·1037	......	......	......
2	61·2468	2495	·0050	+2·06	1	35·9972	0025	·0033	−1·15
2	59·6584	·6600	·0086	+3·50					

Weighted mean .... +1·99
V_a .... 25·29
V_d .... ·09
Curvature .... − 28

Radial velocity .... +27·1

β ORIONIS 1935.

1908. Oct. 13.
G. M. T. 21^h 19^m

Observed by }
Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3985	......	......	......	2	58·8313	......	......	......
2	61·4043	......	......	......	2	36·1175	......	......	......
2	61·2224	·2270	0175	7·19	1	36·0062	·9982	·0076	−2·66
1	59·6723	·6760	·0210	+8·54					

Weighted mean .... 2·00
V_a .... +20·66
V_d .... − ·05
Curvature .... − ·28

Radial velocity .... +18·3

β ORIONIS 1936.

1908. Oct. 13.
G. M. T. 21h 48m

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revn	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63 3626	.....	.....	.....	2	58·7965	....	....	...
2	61·3762	.....	.....	.....	2	36·0878	.....	.....	.....
3	61·1940	·2285	0160	−6 58	1	35·9778	·0000	0058	2·03
1½	59·6216	·6576	·0062	+2 52					

Weighted mean.... ... .. . − 3·27
V_a... .... −20 66
V_d... .... − ·10
Curvature. ... ·28

Radial velocity. . . . . +17 0

β ORIONIS 1937.

1908. Oct. 13.
G. M. T. 22h 19m

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3670	......	...	....	2	58 8030	... .	....	..
2	61 3727	....	....	... ...	2	36·0830	... .	......	.....
2	61·2064	·2414	·0031	1·27	½	36·9604	·9875	0183	6 50
1	59 6093	6423	0091	3·70					

Weighted mean... − 2 71
V_a. .... −20 65
V_d. .... . . ·11
Curvature.. . . − ·28

Radial velocity... .... +17·5

β ORIONIS 1938.

1908. Oct. 13.
G. M. T. 22h 47m

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63 3806	....	....	....	2	58·8156	....	.. ..	... .
2	61 3922	....	....	....	2	36·1048	... ..	... ...	.....
3	61·2124	·2304	·0141	− 5 80	1	35·9790	9840	·0218	− 7 62
2	59·6301	·6386	·0128	5·20					

Weighted mean.. . − 5·90
V_a. . .. . +26·65
V_d.. . .. . − ·18
Curvature.. .... − ·28

Radial velocity .... +14·3

β ORIONIS 1978.

1908. Nov. 21. G. M. T. 18ʰ 24ᵐ

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3468	......	......	......	2	58·7938	......	......	......
2	61·3628	......	......	......	2	36·1436	......	......	......
1	61·2132	·2282	·0159	+ 6·55	½	36·0681	·0766	0285	+ 9·99
½	59·6547	·6700	·0462	18·75					

Weighted mean.		+10·46
V_a		+ 6·82
V_d	·02	
Curvature.	− ·28	
Radial velocity....		+17·0

β ORIONIS 1979.

1908. Nov. 21. G. M. T. 18ʰ 43ᵐ

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3061	......	......	......	2	58·7652	......	......	......
2	61·3300	......	......	......	2	36·1120	......	......	......
1½	61·1662	2174	......	......	½	36·0187	·0587	·0106	+ 3·72
1	59·6141	·6591	·0353	+14·39					

Weighted mean................		+10·83
V_a		+ 6·82
V_d	·05	
Curvature.......	− ·28	
Radial velocity		+17·3

β ORIONIS 1980.

1908. Nov. 21. G. M. T. 19ʰ 05ᵐ

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings,	Dispᵗ in revⁿˢ	Velocity.
2	63·3533	......	......	......	2	58·7995	......	......	......
2	61·3671	......	......	......	2	36·1350	......	......	......
3	61·2382	·2480	·0357	+14·72	1½	36·0917	·1090	·0609	+21·34
2	59·6646	·6745	·0507	20·58					

Weighted mean..............		+18·08
V_a		+ 6·82
V_d	− ·09	
Curvature.......	·28	
Radial velocity..........		+24·5

β ORIONIS 1981.

1908. Nov. 21.
G. M. T. 19h 33m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3651				2	58 8100			
2	61·3788				2	36·1536			
3	61·2564	·2540	·0417	+17 19	1	36·1135	1120	·0639	+22 40
1½	59·6711	·6700	·0462	18·75					

Weighted mean	+ 18·56
V_a	+ 6·82
V_d	− ·13
Curvature	·28
Radial velocity	+ 25·0

β ORIONIS 1984.

1908. Nov. 28.
G. M. T. 16h 05m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3672				2	58·8125			
2	61·3818				2	36·1472			
3	61·2562	·2518	·0395	+16·28	2	36·1186	·1236	·0755	+26·47
1½	59·6454	6418	·0180	7·34					

Weighted mean	+17·35
V_a	+ 3·79
V_d	+ ·15
Curvature	− ·28
Radial velocity	+21·0

β ORIONIS 1985.

1908. Nov. 28.
G. M. T. 16h 34m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·4001				2	58·8418			
2	61·4112				2	36·1728			
3	61 2867	·2527	0405	+16·65	1½	36·1352	·1155	·0674	+23·63
2	59·7043	·6713	0475	19·37					

Weighted mean	+ 19·10
V_a	+ 3·79
V_d	+ ·10
Curvature	− ·28
Radial velocity	+ 22·7

β ORIONIS 1986.

1908. Nov. 28.
G. M. T. 17h 08m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3743	....	....	......	2	58·8170	......	......	......
2	61·3865	.....	......	......	2	36·1450	......	......	......
3	61·2439	·2340	·0217	+ 8·94	2	36·1220	·1290	·0869	+28·36
1½	59·6728	·6645	·0407	16·60					

Weighted mean.........		+16·91
V_a.....		+ 3·79
V_d.....		+ ·05
Curvature..	·28	
Radial velocity ...		+20·5

β ORIONIS 1987.

1908. Dec. 1.
G. M. T. 17h 53m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3748	.....	....	......	2	58·8267	......	......	......
2	61·3934	......	......	....	2	36·2127	......	......	......
2	61·2490	·2005	·0200	+ 8·33	1	36·1757	·1573	·0668	+23·44
1	59·6824	·6385	·0420	17·13					

Weighted mean....		+14·31
V_a....		+ 2·42
V_d.....	− ·04	
Curvature ..	− ·28	
Radial velocity...		+16·4

β ORIONIS 1988.

1908. Dec. 1.
G. M. T. 18h 18m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3353	....	....	....	2	58·7876	......	......	......
2	61·3527	......	....	....	2	36·1671	......	......	......
2	61·2276	·2515	·0392	+16·16	1	36·1272	·1123	·0643	+22·54
1	59·6515	·6735	·0497	20·27					

Weighted mean		+18·78
V_a.........		+ 2·42
V_d......	− ·09	
Curvature...	− ·28	
Radial velocity.		+20·9

β ORIONIS 1989.

1908. Dec. 1.
G. M. T. 18h 36m

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3437	....	....	....	2	58·7973	....	....	....
2	61·3587	....	....	....	2	36·1794	....	....	....
2	61·2166	·2335	·0212	+ 8·74	1½	36·1287	·1015	·0535	+18·75
½	59·6620	·6760	·0522	21·29					

Weighted mean		+14·06
V_a		+ 2·42
V_d	·12	
Curvature	− ·28	
Radial velocity		+16·1

β ORIONIS 1990.

1908. Dec. 1.
G. M. T. 18h 52m

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
	63·3478	....	....	....	....	58·8000	....	....	....
..	61·3679	....	....	....	....	36·1850	....	....	....
3	61·2397	·2520	·0397	+16·36	1	36·1648	·1320	·0839	+29·41
2	59·6724	·6830	·0592	24·15					

Weighted mean		+21·13
V_a		+ 2·41
V_d	− ·16	
Curvature	− ·28	
Radial velocity		+23·1

β ORIONIS 2003.

1908. Dec. 5.
G. M. T. 16h 10m

Observed by J. B. CANNON.
Measured by J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
.	63·3465	....	....	....	....	58·8090	....	....	....
......	61·3690	....	....	....	...	36·2298	....	....	....
3	61·2456	·2215	·0410	+16·95	1	36·2074	·1715	·0810	+28·48
1½	59·6764	·6518	.0553	22·62					

Weighted mean		+22·16
V_a		+ ·63
V_d		+ ·10
Curvature	− ·28	
Radial velocity		+22·6

β ORIONIS 2004.

1908. Dec. 5.
G. M. T. 16h 22m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings	Disp^t in rev^ns	Velocity.
2	63 3170	...	......	......	2	58 7790	......	......	......
2	61·3390	......	......	......	2	36·1924	......	......	......
2	61.2216	·2275	0470	19·43	1	36·1868	·1886	0981	+34·49
½	59·6557	·6610	0635	25·98					

Weighted mean		+24·67
V_a		−·63
V_d		+·08
Curvature	·28	
Radial velocity		+25 1

β ORIONIS 2005.

1908. Dec. 5.
G. M. T. 16h 38m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings	Disp^t in rev^ns	Velocity.
2	63·3054	......	......	......	2	58·7707	......	......	......
2	61·3304	......	......	......	2	36·1884	......	......	......
2½	61·2269	·2415	·0610	25·22	1½	36·1715	1775	·0870	+30·59
1½	59·6314	·6450	·0485	19·84					

Weighted mean		+25·22
V_a		−·63
V_d		+05
Curvature	·28	
Radial velocity		+25·6

β ORIONIS 2006.

1908. Dec. 5.
G. M. T. 16h 53m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3019	......	......	......	2	58·7614	......	......	......
2	61·3242	......	......	......	2	36 1852	......	......	......
3	61·2261	·2480	0675	+27·90	1	36·1782	1872	·0967	+34·00
1½	59·6262	·6480	0515	21 07					

Weighted mean		+27·14
V_a		−·63
V_d		−·03
Curvature	·28	
Radial velocity		+27·5

β ORIONIS 2054.

1908. Dec. 21. G. M. T. 15h 24m

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Setting.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns.	Velocity.
...	54 7148	...	...	....	.	53·0909	. .	....	....
...	54·0045	....	..	....	...	45 2924	. . .	....	.....
.....	53·9654	·9630	0198	22·90	....	45·2894	2907	·0318	33 39
	53·4020	·4000	·0218	25·05					

Weighted mean		28·28
V_a	6·51	
V_d		·04
Curvature	·28	
Radial velocity		+21·5

β ORIONIS 2055.

1908. Dec. 21. G. M. T. 15h 29m

Observed by T. H. PARKER. Measured by J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7334	......	....	.....	2	53·1065	....	...	....
2	53·9890	9690	0258	+29·84	1	45·2957	2907	0318	+33·39
1½	53·4172	3990	·0208	23·90	2	45·2891	......	....	....

Weighted mean		+28·65
V_a	6·51	
V_d	+	·03
Curvature	− ·28	
Radial velocity		+21·9

β ORIONIS 2057.

1908. Dec. 21. G. M. T. 16h 54m

Observed by T. H. PARKER. Measured by J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	56·6288	....	...	...	2	53·0900	....	....	....
2	54·7099	....	.....	....	1½	45·2802	2926	0327	+34·34
2	53·9683	·9695	·0263	+30·42	2	45·2730	......	....	....
1	53·4072	4080	0298	34·24					

Weighted mean		+32·57
V_a	− 6·53	
V_d	− ·07	
Curvature	− ·28	
Radial velocity		+25·7

β ORIONIS 2058.

1908. Dec. 21.
G. M. T. 17h [illegible]

Observed by T. H. Parker.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	56·6155	....	....	....	2	53·0753	....	....	....
2	54·6935	....	....	....	1½	45·2686	·2855	·0267	+28·04
1½	53·9424	·9585	·0143	+16·54	2	45·2681	....	....	....
1½	53·3996	·4140	·0358	41·14					

Weighted mean		−28·91
V_a	− 6·53	
V_d	− ·07	
Curvature	− ·28	
Radial velocity		+22·0

β ORIONIS 2065.

1908. Dec. 22.
G. M. T. 17h 38m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3046	....	....	....	2	58·7699	....	....	....
2	61·3280	....	....	....	1	36·2329	....	....	....
1½	61·2436	·2278	·0792	+32·84	2	36·2528	·2560	1230	+43·38
2	59·6639	·6520	·0828	33·55					

Weighted mean		−35·50
V_a	− 6·98	
V_d	·11	
Curvature	·28	
Radial velocity		+28·1

β ORIONIS 2066.

1908. Dec. 22.
G. M. T. 17h 52m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·2896	....	....	....	2	58·7610	....	....	....
2	61·3178	....	....	....	2	36·2286	....	....	....
3	61·2262	·2220	·0734	−30·43	1	36·2245	·2320	·0990	+34·92
1½	59·6270	·6245	·0553	22·68					

Weighted mean		+29·13
V_a	− 6·98	
V_d	− ·12	
Curvature	− ·28	
Radial velocity		+21·7

β ORIONIS 2067.

1908. Dec. 22.
G. M. T. 18h 02m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·2842	......	......	......	2	58·7512	......	......	......
2	61·3040	......	......	......	2	36·2038	......	......	......
2	61·2047	·2110	·0624	+25·87	1	36·2081	·2405	·1075	+37·92
1	59·6403	·6480	·0788	32·32					

Weighted mean	+30·49
V_a	− 6·98
V_d	·14
Curvature	− ·28
Radial velocity	+23·1

β ORIONIS 2068.

1908. Dec. 22.
G. M T. 18h 14m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·2842	......	......	......	2	58·7570	......	......	......
2	61·3115	......	......	......	2	36·2160	......	......	......
2	61·2151	·2160	·0674	+27·94	1	36·2098	·2300	·0970	+34·21
1	59·6468	·6483	·0791	32·45					

Weighted mean	+30·63
V_a	− 6·98
V_d	− ·14
Curvature	·28
Radial velocity	+23·2

β ORIONIS 2070.

1908. Dec. 23.
G. M. T. 14h 00m

Observed by W. E. HARPER.
Measured by J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
3	63·2758	......	......	......	2	58·7363	......	......	......
2	61·2947	......	......	......	2	36·1449	......	......	......
3	61·1996	·2490	·0685	+28·32	½	36·1500	·1990	·1085	+38·15
1½	59·6100	·6580	·0615	25·16					

Weighted mean	+28·36
V_a	− 7·36
V_d	+ ·18
Curvature	·28
Radial velocity	+20·9

β ORIONIS 2071.

1908. Dec. 23.
G. M. T. 14ʰ 40ᵐ

Observed by W. E. Harper.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3263	.....	....	......	2	58·7844	....	....	.....
2	61·3499	......	......	......	2	36·2102	......	......	......
3	61·2612	·2580	·0775	+32·04	1	36·2124	·1964	·1059	+37·23
1	59·6928	·6920	·0935	38·25					

Weighted mean.... .... +34·32
V_a..... . − 7·36
V_d.... .. .. − ·12
Curvature ..... − ·28

Radial velocity .... +26·8

β ORIONIS 2072.

1908. Dec. 23.
G. M. T. 15ʰ 08ᵐ

Observed by J. B. Cannon.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3214	...	....	......	2	58·7812	....	....	....
2	61·3398	.....	.....	....	2	36·2100	....	.. .	....
2½	61·2460	·2500	·0695	+28·73	1	36·2152	·1995	·1090	+38·32
1½	59·6670	·6703	·0738	30·19					

Weighted mean... . ... +31·09
V_a... .... − 7·36
V_d.... .... + ·09
Curvature... .... − ·28

Radial velocity. . ... +23·5

β ORIONIS 2073.

1908. Dec. 23.
G. M. T. 15ʰ 20ᵐ

Observed by / Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·2965	....	......	...	2	58·7615	....	....	... .
2	61·3207	....	....	.. ...	2	36·1916	....	....	....
3	61·2222	·2470	·0665	+27·49	1	36·1928	·1954	·1049	36·88
1½	59·6362	·6595	·0630	25·77					

Weighted mean........ .... +28·73
V_a.............. − 7·36
V_d... .... + ·07
Curvature...... . − ·28

Radial velocity... .... +21·2

β ORIONIS 2075.

1908. Dec. 26.
G. M. T. 15h 50m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3319	...	...	...	2	58·7877	...	...	...
2	61·3525	...	...	...	2	36·1851	...	...	...
3	61·2697	2622	·0817	+33·77	1½	36·1791	·1882	0977	+34·45
1½	59·6900	6850	·0885	36·21					

Weighted mean ... 34·52
V_a ... − 8·68
V_d ... ·01
Curvature ... ·28

Radial velocity ... 25·6

β ORIONIS 2076.

1908. Dec. 26.
G. M. T. 16h 00m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3051	...	...	...	2	58·7573	...	...	...
2	61·3204	...	...	...	2	36·1624	...	...	...
3	61·2357	2590	·0785	+32·45	1½	36·1630	·1950	1045	+36·74
1½	59·6614	·6874	0919	37·60					

Weighted mean ... +34·81
V_a ... − 8·68
V_d ... ·01
Curvature ... ·28

Radial velocity ... 25·9

β ORIONIS 2077.

1908. Dec. 26.
G. M. T. 16h 09m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings	Dispt in revns	Velocity.
2	63·3424	...	...	...	2	58·7943	...	...	...
2	61·3608	...	...	...	2	36·1993	...	...	...
3	61·2612	2450	·0645	+26·66	1½	36·2132	2082	·1177	+41·38
1½	59·6842	·6736	0765	31·30					

Weighted mean ... +31·48
V_a ... 8·68
V_d ... ·02
Curvature ... − ·28

Radial velocity ... +22·5

β ORIONIS 2078.

1908. Dec. 26.
G. M. T. 16ʰ 18ᵐ

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3147	......	......	......	2	58·7684	......	......	......
2	61·3334	......	......	......	2	36·1610	......	......	......
2	61·2290	·2410	·0605	+25·01	1	36·1567	·1900	·0995	+34·98
½	59·6970	·7120	·1135	46·45					

Weighted mean .... +30·92
V_a .... 8·68
V_d .... ·04
Curvature ..... − ·28

Radial velocity .... +22·0

β ORIONIS 2079.

1908. Dec. 27.
G. M. T. 14ʰ 07ᵐ

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3248	......	......	......	2	58·7809	......	......	......
2	61·3453	......	......	......	2	36·1593	......	......	......
3	61·2754	·2750	·0945	+39·07	1	36·1787	·2140	.1235	+43·42
2	59·7087	·7115	·1150	47·05					

Weighted mean .... +42·45
V_a ... − 9·08
V_d .... ·15
Curvature .... − ·28

Radial velocity ..... +33·2

β ORIONIS 2080.

1908. Dec. 27.
G. M. T. 15ʰ 10ᵐ

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3504	......	......	......	2	58·8064	......	......	......
2	61·3730	......	......	......	2	36·1823	......	......	......
3	61·3054	·2780	·0975	+40·31	½	36·1975	·2095	·1190	+41·84
1	59·7017	·6790	·0825	33·75					

Weighted mean ... . +39·02
V_a .... − 9·08
V_d .... − ·05
Curvature ... ... − ·28

Radial velocity..... .... + 29·7

β ORIONIS 2082.

1908. Dec. 31.
G. M. T. 15h 19m

Observed by W. E. Harper.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7142				2	53·0938			
2	54·0115				2	45·2860	2855	·0368	+38·53
2	53·9684	·9790	·0224	+25·84	2	45·2716			
2	53·4146	·4225	·0323	37·03					

Weighted mean .... + 33·80
V_a .... 10·77
V_d .... ·00
Curvature .... ·28

Radial velocity .... + 22·7

β ORIONIS 2083.

1908. Dec. 31.
G. M. T. 15h 23m

Observed by W. E. Harper.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7063				2	53·0866			
2	54·0015				1½	45·2868	2850	·0363	+38·00
2	53·9690	·9860	·0294	+33·92	2	45·2719			
1	53·4065	·4215	0313	35·88					

Weighted mean .... + 35·72
V_a .... − 10·77
V_d .... ·00
Curvature .... ·28

Radial velocity .... + 24·7

β ORIONIS 2084.

1908. Dec. 31.
G. M. T. 15h 29m

Observed by W. E. Harper.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·6938				2	53·0745			
2	53·9878				2	45·2702	2812	·0325	+34·02
2	53·9587	·9880	·0314	+36·23	2	45·2600			
1	53·3888	·4160	0258	29·57					

Weighted mean .... + 34·01
V_a .... − 10·77
V_d .... ·00
Curvature .... − ·28

Radial velocity .... + 23·0

β ORIONIS 2085.

1908. Dec. 31.
G. M. T. 15ʰ 57ᵐ

Observed by W. E. Harper.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·6997	....	....	....	2	53·0777	....	....	....
2	53·9927	....	....	....	2	45 2854	·2895	0408	− 42·71
3	53·9592	·9835	·0269	−31·03	2	45·2717	....	....	....
1½	53·4022	·4255	·0353	40·46					

Weighted mean		+ 37·57
V_a	− 10 77	
V_d	·00	
Curvature	28	
Radial velocity		+ 26·5

β ORIONIS 2092.

1909. Jan. 6.
G. M. T. 16ʰ 49ᵐ

Observed by W. E. Harper.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7150	....	....	....	2	53·0905	....	....	....
2	54·0102	....	....	....	1½	45·2713	·2730	·0243	+25·44
3	53·9756	9860	·0294	+33·92	2	45·2734	....	....	....
1½	53·4128	·4230	·0328	37·60					

Weighted mean		+32·72
V_a	−13·21	
V_d	− ·16	
Curvature	·28	
Radial velocity		+19 1

β ORIONIS 2093.

1909. Jan. 6.
G. M. T. 16ʰ 53ᵐ

Observed by W. E. Harper.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7120	....	....	....	2	53·0884	....	....	....
2	54·0046	....	....	....	2	45 2787	·2750	·0263	+27·43
3	53·9727	·9860	·0294	+33·92	2	45·2773	....	....	....
1½	53·4136	·4250	0348	39·89					

Weighted mean		+33·30
V_a	−13·21	
V_d	− ·16	
Curvature	− ·28	
Radial velocity		+19·6

β ORIONIS 2094.

1909. Jan. 6. G. M. T. $17^h\ 13^m$ — Observed by W. E. Harper. Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	54 7235	....	.	.. ..	2	53 1074	......	..	....
2	54·0160	... .	....	.. ..	2	45 2957	2830	·0343	+35·81
3	53·9867	·9850	·0284	+32·77	2	45 2876	....	......	....
2	53·4193	4143	0241	27·63					

Weighted mean.........		32·17
V_a	13·21	
V_d	·16	
Curvature ...	·28	
Radial velocity..		18·5

β ORIONIS 2095.

1909. Jan. 6. G. M. T. $17^h\ 16^m$ — Observed by W. E. Harper. Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	56·6440	......	......	....	2	53·0990	....	... .	....
2	54 7198	....	... .	....	2	45·2880	·2815	0328	+34 34
2	53·9780	9830	·0264	+30·46	2	45·2821	....	.....	....
1	53·4356	·4380	·0478	54·79					

Weighted mean..........		+34·89
V_a	−13·21	
V_d	− ·16	
Curvature .	− ·28	
Radial velocity		21·2

β ORIONIS 2105.

1909. Jan. 7. G. M. T. $12^h\ 49^m$ — Observed by / Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	54 7033	......	....	....	2	53·0832	....	.. ....	...
2	53·9964	....	....	....	1	45·2868	....	....	......
3	53·9532	·9600	·0168	+19·43	2	45·2834	·2902	·0313	+32·87
1½	53·4150	·4215	·0433	49·76					

Weighted mean....		+30·57
V_a ...	−13·59	
V_d ...	− ·11	
Curvature ...	− ·28	
Radial velocity............		+16·8

β ORIONIS 2106.

1909 Jan. 7.
G. M. T. 13ʰ 01ᵐ

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7102	....	....	....	2	53·0883	....	....	....
2	54·0042	....	....	....	2	45·2895	....	....	....
3	53·9710	·9725	·0293	+33·89	1½	45·2880	·2920	·0331	+34·76
2	53·4114	·4125	·0343	39·41					

Weighted mean...........	+35·79
V_a..................	−13·59
V_d..........	·11
Curvature..........	− ·28
Radial velocity...........	+21·9

β ORIONIS 2107.

1909. Jan. 7.
G. M. T. 13ʰ 04ᵐ

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7028	....	....	....	2	53·0852	....	....	....
2	54·0000	....	....	....	2	36·2832	....	....	....
3	53·9603	·9653	·0221	+25·56	1½	36·2708	·2810	·0221	+23·21
1½	53·4016	·4060	·0278	31·94					

Weighted mean..............	+26·57
V_a..........	13·59
V_d..........	− ·11
Curvature.......	− ·28
Radial velocity............	+12·8

β ORIONIS 2108.

1909. Jan. 7.
G. M. T. 13ʰ 07ᵐ

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7190	....	....	....	2	53·0925	....	....	....
1	54·0072	....	....	....	2	45·2938	....	....	....
2½	53·9772	·9715	·0283	+32·73	2	45·2933	2931	·0342	+35.91
1½	53·4133	·4097	·0315	36·20					

Weighted mean.................	+34·66
V_a...............	−13·59
V_d............	− ·11
Curvature.......	− ·28
Radial velocity........	+20·7

β ORIONIS 2111.

1909. Jan. 7.
G. M. T. 16ʰ 27ᵐ

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3019	...	...	...	2	58·7700	...	...	...
2	61·3278	...	...	...	1½	36·2038	2023	·0693	+24·46
2	61·2471	·2315	·0829	34·37	2	36·2253	...	...	...
1	59·6883	·6760	·1068	43·81					

Weighted mean	+	33·16
V_a	−	13·59
V_d	−	·11
Curvature	−	·28
Radial velocity		+19·2

β ORIONIS 2112.

1909. Jan. 7.
G. M. T. 16ʰ 37ᵐ

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·2779	...	...	...	2	58·7484	...	...	...
2	61·3033	...	...	...	1½	36·2003	·2120	·0790	+27·86
3	61·2146	·2236	·0750	+31·51	2	36·2131	...	...	...
2	59·6353	·6455	0763	31·30					

Weighted mean	+	30·60
V_a	−	13·59
V_d	−	·11
Curvature		·28
Radial velocity		+16·6

β ORIONIS 2114.

1909. Jan. 7.
G. M. T. 16ʰ 56ᵐ

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·2829	...	...	...	1	58·7582	...	...	...
2	61·3072	...	...	...	1½	36·1955	·2045	·0715	+25·22
3	61·2181	·2220	·0734	+30·43	2	36·2146	...	...	...
1½	59·6679	·6695	·1003	41·14					

Weighted mean	+	31·80
V_a	−	13·59
V_d	−	·11
Curvature	−	·28
Radial velocity		+17·8

β ORIONIS 2117.

1909. Jan. 8.
G. M. T. 15h 48m

Observed by T. H. Parker.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·6880	.....	.....	.....	2	53·0662	.....	.....	.....
1	53·9760	.....	.....	.....	2	45·2638	2850	·0261	+27·41
2	53·9517	·9750	·0318	−36·78	2	45·2622	.....	.....	.....
1	53·3882	·4113	·0331	38·04					

Weighted mean	− 33·28
V_a	− 13·96
V_d	·09
Curvature	·28
Radial velocity	−18·9

β ORIONIS 2118.

1909. Jan. 8.
G. M. T. 15h 52m

Observed by T. H. Parker.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7077	.....	.....	.....	2	53·0872	.....	.....	.....
2	53·9948	.....	.....	.....	2	45·2898	·2935	·0346	+36·33
2	53·9690	·9730	·0298	−34 47	2	45·2837	.....	.....	.....
1	53·4030	·4060	·0278	31·84					

Weighted mean	+ 34·69
V_a	13·96
V_d	− ·09
Curvature	− ·28
Radial velocity	+ 20·3

β ORIONIS 2122.

1909. Jan. 12.
G. M. T. 11h 55m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7074	.....	.....	.....	2	53·0858	.....	.....	.....
2	53·9968	.....	.....	.....	2	45·2886	.....	.....	.....
1½	53·9694	·9735	·0303	+33·80	2	45·2856	·2905	·0316	+34·92
2	53·4238	·4275	·0493	54·97					

Weighted mean	+ 41·91
V_a	− 15·39
V_d	+ ·23
Curvature	− ·28
Radial velocity	+ 26·5

β ORIONIS 2123.

1909. Jan. 12.
G. M. T. 11ʰ 59ᵐ

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7088	.....	....	....	2	53 0880	.....	....	....
2	53 9990	.....	.....	....	2	45·2791	.....	.....	....
3	53·9836	·9836	·0428	47·75	1	45·2727	2890	·0301	-33 26
2	53·4085	·4105	0323	36·01					

Weighted mean .... + 41·42
V_a .... − 15·39
V_d .... ·23
Curvature .... ·28

Radial velocity .... − 26·0

β ORIONIS 2124.

1909. Jan. 12.
G. M. T. 12ʰ 09ᵐ

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7008	....	....	....	2	53·0750	....	....	....
2	53·9928	....	....	....	2	45·2813	....	.....	....
3	53·9598	·9700	·0268	+29·90	2	45·2783	·2905	·0316	+34 92
1½	53·4100	·4225	0443	49·39					

Weighted mean .... + 35·97
V_a .... 15·39
V_d .... + ·23
Curvature .... − ·28

Radial velocity .... − 20·5

β ORIONIS 2125.

1909. Jan. 12.
G. M. T. 12ʰ 12ᵐ

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7110	......	....	....	2	53·0858	....	....	....
2	54·0045	....	....	.....	2	45·2870	....	....	......
4	53·9770	·9775	·0343	+38·27	2	45·2840	·2905	·0316	+34·92
3	53·4077	·4105	·0323	36·01					

Weighted mean .... +36·77
V_a .... −15·39
V_d .... + ·23
Curvature .... − ·28

Radial velocity .... +21·3

β ORIONIS 2126.

1909. Jan. 12.
G. M. T. 12h 15m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7047	......	......	......	2	53·0813	......	......	......
2	54·0000	......	......	......	2	45·2910	......	......	......
2½	53·9770	·9830	·0398	+44·40	1	45·2885	2910	·0321	+35·47
1½	53·4113	·4180	·0398	44·37					

Weighted mean		+42·60
V_a	−15·39	
V_d		+ ·23
Curvature	− ·28	
Radial velocity		+27.2

β ORIONIS 2127.

1909. Jan. 12
G. M. T. 12h 18m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7144	......	......	......	2	53·0960	......	......	......
2	54·0082	......	......	......	2	45·2991	......	......	......
2½	53·9767	·9765	·0333	+37·15	2	45·3000	·2945	·0356	+39·34
1½	53·4291	4224	·0442	49·28					

Weighted mean		+40·91
V_a	−15·39	
V_d		+ 23
Curvature	− ·28	
Radial velocity		+25·5

β ORIONIS 2128.

1909. Jan. 13.
G. M. T. 15h 36m

Observed by J. B. CANNON.
Measured by J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7086	......	......	......	2	53·0920	......	......	......
2	54·0031	......	......	......	2	45·2968	......	......	......
2	53,9775	·9790	·0358	+41·41	2	45·3012	2980	0391	+41·06
2	53·4281	·4275	0493	56·65					

Weighted mean		+46·37
V_a	−15·81	
V_d	− ·09	
Curvature	− ·28	
Radial velocity		+30·2

β ORIONIS 2129.

1909. Jan. 13.
G. M. T. 15ʰ 41ᵐ

Observed by W. E. Harper.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7082	....	......	......	2	53·0893	......	......	.....
2	54·0002	....	......	....	2	45·2978	......	......	.....
2½	53·9730	·9748	·0316	+36·54	1½	45·2852	·2810	·0221	+23·20
1½	53·4061	·4068	·0286	32·86					

Weighted mean......		+31·90
V_a	15·81	
V_d	·09	
Curvature	·28	
Radial velocity		+15·7

β ORIONIS 2130.

1909. Jan. 13.
G. M. T. 15ʰ 46ᵐ

Observed by W. E. Harper.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·6985	......	......	......	2	53·0813	......	......	.....
2	53·9934	......	......	......	2	45·2892	......	......	.....
2	53·9782	·9880	·0448	+51·82	2	45·2940	·2984	·0395	+41·48
1	53·4029	·4115	·0333	38·26					

Weighted mean.........		+44·97
V_a	−15·81	
V_d	−·09	
Curvature	−·28	
Radial velocity......		+28·8

β ORIONIS 2142.

1909. Jan. 15.
G. M. T. 15ʰ 11ᵐ

Observed by J. B. Cannon.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7058	......	......	......	2	53·0911	......	......	.....
2	53·9996	......	......	......	2	45·2970	......	......	.....
1	53·9752	·9790	·0358	+41·40	2	45·3055	3021	·0432	+45·36
2	53·4083	·4105	·0323	37·14					

Weighted mean......		+41·28
V_a	−16·50	
V_d	−·04	
Curvature........	−·28	
Radial velocity...		+24·5

β ORIONIS 2141.

1909. Jan. 15.
G. M. T. 14h [illegible]

Observed by J. B. Cannon.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in Revns	Velocity.
2	56·6150				2	53·0735			
2	54·7025				2	45·2772			
2	53·9628	·9778	·0346	−40·02	3	45·2777	·2940	·0351	36·86
1	53·3821	·3975	·0193	22·18					

Weighted mean .... +35·47
V_a .... − 16·50
V_d .... − ·04
Curvature .... − ·28

Radial velocity .... 18·6

β ORIONIS 2143.

1909. Jan. 15.
G. M. T. 15h 15m

Observed by J. B. Cannon.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7162				2	53·0946			
2	54·0069				2	45·2937			
3	53·9895	9844	·0412	+47·65	2	45·3062	·3061	0472	−49·56
1½	53·4092	·4040	·0258	29·65					

Weighted mean .... + 44·08
V_a .... 16·50
V_d .... − ·04
Curvature .... − ·28

Radial velocity .... +27·2

β ORIONIS 2144.

1909. Jan. 15.
G. M. T. 15h 19m

Observed by J. B. Cannon.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7053				2	53·0782			
2	53·9945				2	45·2864			
1	53·9672	·9750	·0318	+36·78	2	45·2847	·2920	·0331	+34·76
1	53·4103	4200	·0418	48·03					

Weighted mean .... + 38·58
V_a .... − 16·50
V_d .... ·04
Curvature .... − ·28

Radial velocity .... +21·8

β ORIONIS 2151.

1909. Jan. 16.
G. M. T. 12h 25m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revn	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revn	Velocity.
2	54·6926	....	......	......	2	53·0657	......	......	......
2	53·9756	....	......	......	2	45·2780	......	......	......
1	53·9598	·9850	·0418	+48·25	3	45·2970	·3130	·0541	−56·61
2	53·3854	·4104	·0322	36·00					

Weighted mean..		+48·35
V_a	−16·82	
V_d....	...	·13
Curvature. ...	·28	
Radial velocity.	...	+31·4

β ORIONIS 2152.

1909. Jan. 16.
G. M. T. 12h 36m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·6990	......	......	......	2	53·0859	......	......	......
2	53·9982	......	......	......	2	45·2919	......	......	......
2	53·9738	·9820	·0388	+44·78	2	45·2978	·2995	·0406	+42·63
1	53·4168	·4210	·0428	48·18					

Weighted mean......		+44·60
V_a	−16·82	
V_d		+ ·13
Curvature.. .	− ·28	
Radial velocity. . .	...	+27·6

β ORIONIS 2153.

1909. Jan. 16.
G. M. T. 12h 44m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7003	......	......	......	2	53·0787	......	......	......
2	54·0022	......	......	......	2	45·2970	......	......	......
2	53·9786	·9886	·0454	52·51	3	45·3131	·3100	·0511	−53·66
1	53·4072	·4160	·0378	43·44					

Weighted mean.....		−51·38
V_a	−16·82	
V_d		− ·13
Curvature......	− ·28	
Radial velocity.............		+34·4

β ORIONIS 2154.

1909. Jan. 16.
G. M. T. 12h 52m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	56·6114	....	....	....	2	53·0724	....	....	....
2	54·6911	....	....	....	2	45·2845	....	....	....
2	53·9844	·0025	·0593	+68·59	2	45·3008	·3100	·0511	+53·66
1½	53·4059	·4220	·0438	49·23					

Weighted mean.................. + 57·88
V_a.................. −16·82
V_d.................. + ·13
Curvature.................. − ·28

Radial velocity.................. + 40·9

β ORIONIS 2155.

1909. Jan. 16.
G. M. T. 12h 59m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	56·6278	....	....	....	2	53·4202	·4220	·0438	49·23
2	54·7078	....	....	....	2	53·0880	....	....	....
2	54·0014	....	....	....	2	45·2940	....	....	....
2	53·9853	·9875	·0443	+51·03	2	45·3136	·3130	·0541	+53·66

Weighted mean.................. + 51·01
V_a.................. −16·82
V_d.................. + ·13
Curvature.................. − ·28

Radial velocity.................. + 33·0

β ORIONIS 2156.

1909. Jan. 16.
G. M. T. 13h 12m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	54·7101	....	....	....	2	53·0934	....	....	....
2	54·0028	....	....	....	2	45·3008	....	....	....
4	53·9856	·9845	·0413	+47·77	3	45·3214	·3140	·0551	+58·91
2	53·4297	·4250	·0468	53·78					

Weighted mean.................. + 52·82
V_a.................. −16·82
V_d.................. + ·13
Curvature.................. − ·28

Radial velocity.................. + 35·8

β ORIONIS 2157.

1909. Jan. 17.
G. M. T. 13h 48m

Observed by } Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·6992	...	...	...	2	53 0802	...	...	...
2	53·9936	...	...	...	2	45·2896	...	...	...
3	53·9741		·0418	+48·34	2	45·3062	·3102	·0513	+53 87
1	53·3965	[illegible]	·0273	31·37					

Weighted mean........................ + 47 35
V_a .... −17·17
V_d .... + 05
Curvature...... . . ·28

Radial velocity .... +29·9

β ORIONIS 2158.

1909. Jan. 17.
G. M. T. 13h 56m

Observed by } Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·6898	...	...	...	2	53·0742	...	...	...
2	53·9898	...	...	...	2	45·2874	...	...	...
2	53·9655	·9835	·0403	+46·61	2	45·2947	·3010	·0421	+44 21
2	53·3969	·4130	·0348	39·99					

Weighted mean. .... +43·60
V_a . ... −17·17
V_d .... + ·05
Curvature . ... . − ·28

Radial velocity................ ... +26·2

β ORIONIS 2161.

1909. Jan. 18.
G. M. T. 12h 41m

Observed by } Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7073	...	...	...	2	53·0908	...	...	...
2	53 9976	...	...	...	2	45·2916	...	...	...
2	53·9851	·9880	·0448	+51·81	2½	45·3141	·3160	·0571	+59·96
1½	53·4217	·4220	·0438	50·37					

Weighted mean................. .... +54·84
V_a . . .. −17·17
V_d . ... + ·05
Curvature .... . − ·28

Radial velocity. ... . +37·1

β ORIONIS 2162.

1909. Jan. 18.
G. M. T. 12^h 46^m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	54·7174	....	......	......	2	53·0979	......	....	......
2	54·0111	....	....	....	2	45·3097	....	....	....
3	53·9987	·9900	·0468	+54·12	2	45·3267	·3105	·0516	+54·19
2	53·4185	·4098	·0316	36·34					

Weighted mean		+49·06
V_a	−17·17	
V_d		+ ·05
Curvature	− ·28	
Radial velocity		+31·3

β ORIONIS 2163.

1909. Jan. 18.
G. M. T. 12^h 51^m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	54·7067	....	....	......	2	53·0858	......	......	......
2	53·9965	....	....	....	2	45·2994	....	....	....
3	53·9771	·9820	·0388	+44·87	2	45·3122	·3064	·0475	+49·88
1	53·4107	·4147	·0365	41·94					

Weighted mean		+46·05
V_a	−17·51	
V_d		+ ·08
Curvature	− ·28	
Radial velocity		+28·3

β ORIONIS 2164.

1909. Jan. 18.
G. M. T. 13^h 06^m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	54·7077	......	......	......	2	53·0867	....	......	....
2	53·9990	......	....	....	2	45·2983	......	....	......
2	53·9926	·9954	·0521	+59·16	3	45·3107	·3060	·0471	+49·46
2	53·4235	·4261	·0479	54·04					

Weighted mean		+53·54
V_a	−17·57	
V_d		+ ·08
Curvature	− ·28	
Radial velocity		+35·8

β ORIONIS 2165.

1909. Jan. 18.
G. M. T. 13h 10m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7128	....	....	....	2	53·0967	....	....	....
2	54·0073	....	....	....	2	45·3114	....	....	....
3	53·9885	·9830	·0398	+45·93	2	45·3277	·3100	·0571	+53·66
1	53·4284	·4215	·0433	48·66					

Weighted mean		+48·96
V_a	−17·57	
V_d		+ ·08
Curvature	− ·28	
Radial velocity		+31·2

β ORIONIS 2166.

1909. Jan. 18.
G. M. T. 13h 14m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7106	....	....	....	2	53·0896	....	....	....
2	53·9998	....	....	....	2	45·3060	....	....	....
1½	53·9796	·9805	·0373	+43·14	3	45·3184	·3065	·0471	+49·46
1½	53·4221	·4225	·0443	50·95					

Weighted mean		+48·25
V_a	−17·57	
V_d		+ ·08
Curvature	− ·28	
Radial velocity		+30·5

β ORIONIS 2177.

1909. Jan. 26.
G. M. T. 10h 36m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7218	....	....	....	2	53·0968	....	....	....
2	54·0098	....	....	....	2	45·2904	....	....	....
2	53·9936	·9856	·0424	49·04	2	45·2922	·2954	·0365	+38·33
1	53·4276	·4200	·0418	48·03					

Weighted mean		+44·55
V_a	−19·95	
V_d		+ ·22
Curvature	− ·28	
Radial velocity		+24·6

β ORIONIS 2178.

1909. Jan. 26.
G. M. T. 10h 51m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	54·7527	…	…	…	2	53·1294	…	…	…
2	54·0433	…	…	…	2	45·3207	…	…	…
3	54·0181	·9766	·0334	+38·63	1	45·3132	·2861	·0272	+28·56
1½	52·4554	·4150	·0368	42·29					

Weighted mean … +37·80
V_a … −19·95
V_d … + ·22
Curvature … − ·28

Radial velocity … +17·8

β ORIONIS 2179.

1909. Jan. 26.
G. M. T. 10h 56m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	54·7468	…	…	…	2	53·1221	…	…	…
2	54·0423	…	…	…	2	45·3160	…	…	…
2	54·0140	53·9780	·0348	+40·25	2	45·3215	·2990	·0401	+42·11
1½	53 4594	·4260	·0478	54·93					

Weighted mean … +44·93
V_a … −19·95
V_d … + ·22
Curvature … − ·28

Radial velocity … +24 9

β ORIONIS 2180.

1909. Jan. 26.
G. M. T. 11h 01m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	54·7250	…	…	…	2	53·1036	…	…	…
2	54·0212	…	…	…	2	45·2950	…	…	…
2½	53·9934	·9770	·0338	+39·09	1½	45·3008	·2994	·0405	+42·53
1	53·4420	·4270	·0488	56·08					

Weighted mean … +43·52
V_a … −19·95
V_d … + ·22
Curvature … − ·28

Radial velocity … +23·5

β ORIONIS 2181.

1909. Jan. 26. G. M. T. 11h 11m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7250	...	...	...	2	53·0986	...	...	...
2	54·0155	...	...	...	2	45·2998	...	...	...
3	53·9908	·9780	·0358	+41·40	1½	45·3051	·2990	·0401	+42·11
1	53·4287	·4180	·0398	45·73					

Weighted mean ... +42·38
V_a ... −19·95
V_d ... ·22
Curvature ... −·28

Radial velocity ... +22·4

β ORIONIS 2182.

1909. Jan. 26. G. M. T. 11h 16m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7440	...	...	...	2	53·1178	...	...	...
2	54·0407	...	...	...	2	45·3090	...	...	...
2	54·0083	·9770	·0338	+39·09	2	45·3066	·2912	·0323	+33·92
½	53·4372	·4080	·0298	34·24					

Weighted mean ... +36·25
V_a ... −19·95
V_d ... + ·22
Curvature ... − ·28

Radial velocity ... +16·2

β ORIONIS 2183.

1909. Jan. 26. G. M. T. 11h 21m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7394	...	...	...	2	53·1107	...	...	...
2	54·0262	...	...	...	2	45·2972	...	...	...
3	54·0003	·9760	·0328	+37·93	2	45·3035	·3000	·0411	+43·16
½	53·4399	·4175	·0393	45·14					

Weighted mean ... +40·49
V_a ... −19·95
V_d ... + ·22
Curvature ... − ·28

Radial velocity ... +20·5

β ORIONIS 2184.

1909. Jan. 28.
G. M. T. 11h 21m

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	54·7322	....	....	....	2	53·1120	....	....	....
2	54·0224	....	....	....	2	45·3111	....	....	....
3	54·0007	·9800	·0368	+42·56	2	45·3122	·2947	·0358	+37·59
1	53·4160	·3940	·0158	18·16					

Weighted mean .... +36·84
V_a .... −20·51
V_d .... + ·21
Curvature ..... − ·28

Radial velocity .... −16·3

β ORIONIS 2185.

1909. Jan. 28.
G. M. T. 11h 25m

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	54·7073	....	....	....	2	53·0869	....	....	....
2	53 9993	....	....	....	2	45·2864	....	....	....
2	53·9800	9830	·0398	+46·03	2	45·2882	·2954	·0365	+38·33
1	53·4194	·4220	·0438	50·33					

Weighted mean .... +43 81
V_a .... −20·51
V_d .... + ·21
Curvature .... − ·29

Radial velocity ..... +23·2

β ORIONIS 2186.

1909. Jan. 28.
G. M. T. 11h 29m

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	54·7073	....	....	....	2	53·0851	....	....	....
2	54·0002	....	....	....	2	45·2893	....	....	....
2	53·9697	·9735	·0303	+35·04	2	45·2888	·2930	·0341	+35·81
1	53·4020	4060	·0278	31·94					

Weighted mean .... +34·73
V_a .... −20·51
V_d .... + ·21
Curvature ..... − 28

Radial velocity .... +14·2

β ORIONIS 2187.

1909. Jan. 28.
G. M. T. 11h 41m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7131	.... ..	....	....	2	53·6944	... .	... .	... .
2	54·0015	.. ...	.. ..	....	2	45·2911	....	......	... .
2	53·9731	·9705	0273	+31·57	2	45·2883	·2908	0318	+33·39
1½	53·4183	·4140	·0358	41·14					

Weighted mean		+34·84
V_a	−20·51	
V_d		21
Curvature	− ·28	
Radial velocity		+14 3

β ORIONIS 2188.

1909. Jan. 28.
G. M. T. 11h 44m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7128	....	....	....	2	53 0905	....	....	....
2	54 0033	....	....	....	2	45·2924	....	... .	....
2	53·9628	·9614	·0182	+21·05	1½	45·2857	·2869	·0280	+29·40
1½	53·4200	·4187	·0405	46·54					

Weighted mean		+31·20
V_a	−20·51	
V_d		+ ·21
Curvature	− ·28	
Radial velocity		+10·6

β ORIONIS 2189.

1909. Jan. 28.
G. M. T. 11h 47m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7175	....	... .	....	2	53·1003	....	....	.. ... .
2	54·0085	....	....	.. ..	2	45·2987	.. ..	... .	... .
2	53·9802	·9730	·0298	+34·46	1½	45·2937	·2886	·0397	+41·69
1½	53·4243	·4150	·0368	42·29					

Weighted mean		+38·98
V_a	−20·51	
V_d		+ ·21
Curvature	·28	
Radial velocity		+18·4

β ORIONIS 2195.

1909. Jan. 29.
G. M. T. 12h 53m.

Observed by J. B. Cannon.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	54·7212	...	...	...	2	53·1014	...	...	...
2	54·0176	...	...	...	2	45·2906	...	...	...
2	53·9840	·9710	·0278	+32·15	1	45·2928	·2958	·0369	+38·75
1	53·4261	·4135	·0353	40·56					

Weighted mean .... +35·90
V_a .... −20·79
V_d .... + ·05
Curvature.... − ·28

Radial velocity .... +14·9

β ORIONIS 2196.

1909. Jan. 29.
G. M. T. 12h 57m.

Observed by J. B. Cannon.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	54·7168	...	...	...	2	53·0946	...	...	...
2	54 0073	...	...	...	2	45·2894	...	...	...
3	53·9817	·9762	·0330	+38 16	1½	45·2877	·2919	0330	+34·65
⅓	53·4324	·4270	·0488	56·08					

Weighted mean .... +38·90
V_a .... −20·79
V_d .... + ·05
Curvature.... − ·28

Radial velocity .... +17·9

β ORIONIS 2197.

1909. Jan. 29.
G. M. T. 13h 01m

Observed by J. B. Cannon.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	54·7222	...	...	...	2	53·0981	...	...	...
2	54·0097	...	...	...	2	45·2919	...	...	...
2	53·9881	·9790	·0358	+41·40	1	45·3034	·3050	·0461	+48·41
½	53·4480	4390	·0608	69·87					

Weighted mean .... +47·47
V_a .... −20·79
V_d .... + ·05
Curvature........ − ·28

Radial velocity .... +26·4

β ORIONIS 2198.

1909. Jan. 29.
G. M. T. 13h 05m

Observed by J. B. Cannon.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7170	...	...	...	2	53·0924	...	...	...
2	54·0100	...	...	...	2	45·2871	...	...	...
2	53·9896	9840	·0408	+47·18	2	45 2927	2992	·0403	42·32
1½	53 4164	·4120	0338	38·84					

Weighted mean ... + 43·14
V_a ... − 20·79
V_d ... 05
Curvature ... ·28

Radial velocity ... +22·1

β ORIONIS 2201.

1909. Jan. 30.
G. M. T. 12h 29m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7150	...	...	...	2	53·0957	...	...	...
2	54·0093	...	...	...	2	45·2906	...	...	...
3	53·9791	·9730	0298	+34·46	2	45·2884	2914	0325	+34·13
1	53 4193	·4130	·0348	39 99					

Weighted mean ... + 35·27
V_a ... − 21·05
V_d ... + ·06
Curvature ... − ·28

Radial velocity ... +14·0

β ORIONIS 2202.

1909. Jan. 30.
G. M. T. 12h 41m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7150	...	...	...	2	53·5937	...	...	...
2	54·0022	...	...	...	2	45·2878	...	...	...
1½	53·9764	·9710	0268	+30·99	2	45·2963	·3020	·0431	+45·26
1	53·4141	·4100	·0318	36·54					

Weighted mean ... + 38·57
V_a ... − 21·05
V_d ... + ·06
Curvature ... − ·28

Radial velocity ... + 17·3

β ORIONIS 2203.

1909. Jan. 30.
G. M. T. 12h 45m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp[t] in rev[ns]	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp[t] in rev[ns]	Velocity.
2	54·7115	......	....	....	2	53·0902	....	....	....
2	53·9970	....	....	. . . ...	2	45·2808	....	. . ..	....
1	53·9941	·9950	·0518	+59·91	2	45 2822	2950	·0361	+37·91
½	53·4224	·4240	·0458	52 63					

Weighted mean.... . ... +46·29
V_a .... −21·05
V_d .... + ·06
Curvature.......... − ·28

Radial velocity. ... . +25·0

β ORIONIS 2204.

1909. Jan. 30.
G. M. T. 12h 48m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp[t] in rev[ns]	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp[t] in rev[ns]	Velocity.
2	54·7152	......	.. ....	....	2	53·0917	....	....	....
2	54·0046	... .	....	....	2	45·2933	....	..... .	....
1	53·9739	·9712	0280	−32·38	2	45·2969	·2972	·0383	+40·22
1	53·4059	·4034	·0252	28·96					

Weighted mean...... .... +35·45
V_a ... ... −21 05
V_d .... + 06
Curvature...... ... − ·28

Radial velocity ... . +14·2

β ORIONIS 2205.

1909. Jan. 30.
G. M. T. 15h 47m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp[t] in rev[ns]	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp[t] in rev[ns]	Velocity.
2	63·3385	....	....	....	2	58·7894	... .	....	....
2	61·3585	....	....	. .. .	2	36·1737	....	... .	....
3	61 2878	·2744	·0939	+38 82	1½	36·1979	·2180	·1275	+44·83
1½	59·7215	·7140	·1175	48·07					

Weighted mean..... .. .. +42·63
V_a .... −21·05
V_d .... + ·06
Curvature...... .. . − ·28

Radial velocity... .... +21·0

β ORIONIS 2206.

1909. Jan. 30.
G. M. T. 16h 04m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63 3436	......	......		2	58·7994	......	......	......
2	61·3644	......	......	......	2	36·1900	......	......	......
2	61 3040	·2850	·1045	+43·20	1½	36·2046	2088	·1173	+41·24
1½	59·7313	·7150	·1185	48·48					

Weighted mean....		+44 20
V_a	21·10	
V_d	− 24	
Curvature.....	− ·28	
Radial velocity.........		+22·6

β ORIONIS 2207.

1909, Jan. 30.
G. M. T. 16h 24m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3410	......	......	......	2	58·7983	......	......	......
2	61·3604	......	......	......	2	36·1943	......	......	......
3	61·3037	·2880	·1075	+44·44	2	36·2027	·2026	·1121	+39·41
1½	59·7308	·7160	·1195	48 89					

Weighted mean..		+43·92
V_a	21·10	
V_d	− ·24	
Curvature..	− ·28	
Radial velocity		+22·3

β ORIONIS 2211.

1909, Jan. 31.
G. M. T. 17h 16m

Observed by W. E. HARPER.
Measured by J. S. PLASKETT.

Wt.	Mean of Settings	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	54·7191	......	......	......	2	53·0951	......	......	......
2	54·0068	......	......	......	2	45·2834	......	......	......
2	53·9870	·9800	·0368	+42·56	2	45·2806	·2908	·0319	+33·50
1	53·4342	·4275	0493	56·65					

Weighted mean.......		+41·75
V_a	−21·33	
V_d	− ·31	
Curvature.........	− ·28	
Radial velocity. ...		+19·8

β ORIONIS 2212.

1909. Jan. 31.
G. M. T. 17ʰ 20ᵐ

Observed by W. E. Harper.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7084	....	....	....	2	53·0894	....	....	....
2	54·0012	....	....	....	2	45·2894	....	....	....
2	53·9833	·9835	·0403	−46·61	1½	45·2886	2928	·0339	−35·60
1	53·4274	4273	0491	56·42					

Weighted mean		−45·12
V_a	−21·33	
V_d	− ·31	
Curvature	− 28	
Radial velocity		−23 2

β ORIONIS 2213.

1909. Jan. 31.
G. M. T. 17ʰ 24ᵐ

Observed by W. E. Harper.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7118	....	....	....	2	53·0904	....	....	....
2	54·0115	....	....	....	2	45·2938	....	....	....
2	53·9797	9737	·0305	+35·27	2	45·2925	2923	0334	−35·07
1	53·4258	·4190	0408	46·88					

Weighted mean		−37·91
V_a	−21·33	
V_d	− ·31	
Curvature	− ·28	
Radial velocity		−16·0

β ORIONIS 2214.

1909. Jan. 31.
G. M. T. 17ʰ 29ᵐ

Observed by W. E. Harper.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7065	....	....	....	2	53·0873	....	....	....
2	53·9988	....	....	....	2	45·2835	....	....	....
1½	53·9808	9840	·0408	+47·18	2	45·2763	·2864	·0275	+28·88
1	53·4149	·4174	·0392	45·04					

Weighted mean		+38·57
V_a	−21·33	
V_d	− ·31	
Curvature	− 28	
Radial velocity		+16 6

β ORIONIS 2215.

1909. Feb. 2.
G. M. T. 11ʰ 14ᵐ

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7098	....	....	....	2	53·0885	....	....	....
2	54·0038	....	....	....	2	45·2951	....	....	....
2	53·9791	·9803	·0371	+42·90	2	45·3072	·3067	·0478	+50·19
2	53·4182	·4192	·0410	47·11					

Weighted mean		+46·73
V_a	−21·79	
V_d		+·14
Curvature	−·28	
Radial velocity		+24·8

β ORIONIS 2216.

1909. Feb. 2.
G. M. T. 11ʰ 23ᵐ

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7162	....	....	....	2	53·0940	....	....	....
2	54·0091	....	....	....	2	45·3030	....	....	....
3	53·9864	·9810	·0378	+43·72	2	45·3047	·2953	·0364	+38·22
2	53·4299	4250	·0468	53·78					

Weighted mean		+45·02
V_a	−21·79	
V_d		+·14
Curvature	−·28	
Radial velocity		+23·1

β ORIONIS 2217.

1909. Feb. 2.
G. M. T. 11ʰ 26ᵐ

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7143	....	....	....	2	53·0916	....	....	....
1	54·0053	....	....	....	2	45·2940	....	....	....
3	53·9820	·9790	·0358	+41·40	2	45·3032	·3028	·0439	+46·10
1	53·4303	·4277	·0495	56·88					

Weighted mean		+45·35
V_a	−21·79	
V_d		+·14
Curvature	−·28	
Radial velocity		+23·6

β ORIONIS 2218.

1909. Feb. 2.
G. M. T. 11h 29m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	54·7101	....	....	....	2	53·0910	....	....	....
2	54·0023	....	....	....	2	45·2961	....	....	....
2	53·9848	·9845	·0413	+47·76	2	45·3020	·2995	·0406	+42·63
1	53·4172	·4160	·0378	43·44					

Weighted mean.................................. +44·44
V_a.................. −21·97
V_d.................................. + ·14
Curvature............ − ·28

Radial velocity.................. +22·5

β ORIONIS 2219.

1909. Feb. 2.
G. M. T. 11h 41m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	54·7180	....	....	....	2	53·0937	....	....	....
2	54·0106	....	....	....	2	45·3002	....	....	....
3	53·9813	·9740	·0308	+35·62	2	45·3032	2966	·0377	+39·59
1½	53·4213	4150	·0368	42·29					

Weighted mean.................................. +38·39
V_a.................. −21·79
V_d.................................. + ·14
Curvature............ − ·28

Radial velocity.................. +16.5

β ORIONIS 2220.

1909, Feb. 2.
G. M. T. 11h 45m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	54·7143	....	....	....	2	53·0952	....	....	....
2	54·0073	....	....	....	2	45·2903	....	....	....
3	53·9847	·9800	·0368	+42·56	2	45·2967	3000	·0411	+43·16
1	53·4305	4250	·0468	53·78					

Weighted mean.................................. +44·63
V_a.................. −21·79
V_d.................................. + ·14
Curvature............ − ·28

Radial velocity.................. +22·7

β ORIONIS 2220*

1909, Feb. 2.
G. M. T. 11ʰ 45ᵐ

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7580	...	...	...	3	53·1366	...	...	...
2	54·0249	·9779	·0347	+40·03	2	45·3355	3006	·0417	+43·78
1½	53·4623	·4151	·0369	42·40	3	45·3285	...	...	...

Weighted mean		+42·04
V_a	21 79	
V_d		+ ·14
Curvature	− ·28	
Radial velocity		+20·2

* Check.

β ORIONIS 2236.

1909, Feb. 6.
G. M. T. 12ʰ 29ᵐ

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7129	...	...	...	2	53·0895	...	...	...
2	54·0040	...	...	...	2	45·2921	...	...	...
2	53·9767	·9750	·0318	+36·78	3	45·2985	·3000	·0411	+43 16
1	53·4149	·4143	·0361	41·48					

Weighted mean		+40·75
V_a	−22·07	
V_d	− ·24	
Curvature	− ·28	
Radial velocity		+18·2

β ORIONIS 2239.

1909, Feb. 6.
G. M. T. 12ʰ 50ᵐ

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7144	...	...	...	2	53·0925	...	...	...
2	54·0085	...	...	...	2	45·2967	...	...	...
2	53·9843	·9810	·0378	+43·72	2	45·3043	·3012	·0423	+44·42
1½	53·4083	·4052	·0270	31·03					

Weighted mean		+42·62
V_a	−22·07	
V_d	− ·24	
Curvature	− ·28	
Radial velocity		+20·0

β ORIONIS 2240.

1909. Feb. 6.
G. M. T. 12^h 52^m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	54·7160	....	....	....	2	53·0936	....	....	....
2	54·0066	....	....	....	2	45·2951	....	....	....
2	53·9845	·9800	·0368	−42·56	1	45·2950	·2935	·0346	+36·33
2	53·4254	·4210	·0428	49·18					

Weighted mean .... +43·96
V_a .... −22·07
V_d .... − ·24
Curvature .... − ·28

Radial velocity .... +21·0

β ORIONIS 2241.

1909. Feb. 6.
G. M. T. 16^h 12^m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	63·3172	....	....	....	2	58·7726	....	....	....
2	61·3357	....	....	....	2	36·1652	....	....	....
2	61·2768	·2858	·1053	+43·53	1½	36·1710	·2000	·1095	+38·00
1½	59·7176	·7280	·1315	54·10					

Weighted mean .... +45·19
V_a .... −22·73
V_d .... − ·30
Curvature .... − ·28

Radial velocity .... +21·9

β ORIONIS 2242.

1909. Feb. 6.
G. M. T. 16^h 43^m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean. of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	63·3249	....	....	....	2	58·7845	....	....	....
2	61·3494	....	....	....	2	36·1810	....	....	....
2	61·2686	·2670	·0865	+35·76	1½	36·1972	·2104	·1199	+42·16
1½	59·7224	·7220	·1255	51·34					

Weighted mean .... +42·36
V_a .... −22·73
V_d .... − ·30
Curvature .... − ·28

Radial velocity .... +19·1

β ORIONIS 2243.

1909. Feb. 7.
G. M. T. 15ʰ 11ᵐ

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings	Dispᵗ in revⁿˢ	Velocity.
2	63·3350	.....	....	....	2	58·7918	....	....	....
2	61·3619	....	....	....	2	36·1731	....	....	....
2	61·2972	·2872	·1065	+44·03	2	36·1874	2085	·1180	+41·7[illegible]
1½	59·7234	·7150	·1185	48·48					

Weighted mean.................... +44·42
V_a.................. –22·93
V_d.................. – ·23
Curvature.......... – 28

Radial velocity.................. +21·0

β ORIONIS 2244.

1909. Feb. 7.
G. M. T. 15ʰ 25ᵐ

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3380	....	....	....	2	58·7900	.....	....	....
2	·61·3554	....	....	....	2	36·1752	.....	....	....
2	61·2952	·2855	·1050	+43·41	1½	36·1830	·2020	·1115	+39·20
1	59·7458	·7388	·1423	58·21					

Weighted mean.................... + 45·30
V_a.................. – 22·93
V_d.................. – ·23
Curvature.......... – ·28

Radial velocity.................. +21·9

β ORIONIS 2245.

1909. Feb. 7.
G. M. T. 15ʰ 37ᵐ

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3424	....	....	....	2	58·7988	....	....	....
2	61·3620	....	....	....	2	36·1867	....	....	....
1½	61·2862	·2692	·0887	+35·97	1	36·1858	·1963	·1058	+37·20
1	59·7488	·7338	·1373	56·05					

Weighted mean.................... + 41·45
V_a.................. – 22·93
V_d.................. – ·23
Curvature.......... – ·28

Radial velocity.................. +18·0

β ORIONIS 2249.

1909. Feb. 8.
G. M. T. 13h 32m

Observed by T. H. Parker.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings	Dispt in revns	Velocity.
2	54·7050	......	......	......	2	53·0824	......	......	......
2	53·9998	......	......	......	2	45·2868	......	......	......
3	53·9795	·9845	·0413	47·76	2	45·3024	·3092	·0503	+52·82
2	53·4276	·4375	·0593	68 14					

Weighted mean .... + 55·03
V_a .... −23·11
V_d .... − ·08
Curvature .... − ·28

Radial velocity.................... +31·6

β ORIONIS 2250.

1909. Feb. 8.
G. M. T. 13h 36m

Observed by T. H. Parker.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·6972	......	......	......	2	53·0777	......	......	......
2	53·9910	......	......	......	2	45·2869	......	......	......
2	53·9713	·9835	·0403	+46·61	1½	45·2950	·3027	·0438	+45·99
1	53·4184	·4304	·0522	59·98					

Weighted mean........................ + 49 37
V_a .... − 23·11
V_d .... − ·08
Curvature ... − ·28

Radial velocity.................... +25 9

β ORIONIS 2251.

1909. Feb. 8.
G. M. T. 13h 41m

Observed by T. H. Parker.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7049	......	......	......	2	53·0838	......	......	......
2	53·9982	......	......	......	2	45·2878	......	......	......
2	53 9698	·9755	·0323	+37·35	1½	45·2914	·2972	·0383	+40·22
3	53·4168	·4225	·0443	50·91					

Weighted mean .... +44 27
V_a .... 23·11
V_d .... − ·08
Curvature ..... − ·28

Radial velocity.................... +21·8

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β ORIONIS 2252.

1909. Feb. 8.
G. M. T. 14ʰ 01ᵐ

Observed by T. H. Parker.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7056	....	....	....	2	53·0882	....	....	....
2	53·9980	....	....	....	2	45·2960	....	....	....
1½	53·9779	·9815	·0383	+44·29	1½	45·2982	·2958	·0369	+38·75
½	53·4076	·4095	·0313	35·97					

Weighted mean	+41·05
V_a	23·11
V_d	·08
Curvature	·28
Radial velocity	+17·6

β ORIONIS 2253.

1909. Feb. 8.
G. M. T. 14ʰ 05ᵐ

Observed by T. H. Parker.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7217	....	....	....	2	53·1030	....	....	....
2	54·0110	....	....	....	2	45·3090	....	....	....
2	53·9862	·9762	·0330	+38·16	2	45·3240	·3086	·0497	+52·19
3	53·4354	·4230	·0448	51·48					

Weighted mean	+47·88
V_a	−23·11
V_d	− ·08
Curvature	− ·28
Radial velocity	+24·1

β ORIONIS 2254.

1909. Feb. 8.
G. M. T. 14ʰ 09ᵐ

Observed by T. H. Parker.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7152	....	....	....	2	53·0993	....	....	....
2	54·0084	....	....	....	2	45·3112	....	....	....
2	53·9930	·9860	·0428	+49·50	2	45·3142	·2966	·0377	+39·59
1	53·4357	·4265	·0483	55·50					

Weighted mean	+46·74
V_a	−23·11
V_d	− ·08
Curvature	− ·28
Radial velocity	+23·3

β ORIONIS 2265.

1909. Feb. 10.
G. M. T. 12h 07m

Observed by W. E. Harper.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	54·6987	....	....	....	2	53·0767	....	....	....
2	53·9911	....	....	....	2	45·2770	....	....	....
2	53·9691	·9800	·0368	+42·56	2	45·2980	·3146	·0557	+58·49
1½	53·4197	·4310	·0528	60·67					

Weighted mean ... . +53·29
V_a .... −23·48
V_d .... + ·05
Curvature .... − ·28

Radial velocity .... +29·6

β ORIONIS 2266.

1909. Feb. 10.
G. M. T. 12h 12m

Observed by W. E. Harper.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	54·7090	....	....	....	2	53·0932	....	....	....
2	54·0052	....	....	....	2	45·2916	....	....	....
2	53·9815	·9780	·0348	+40·25	2	45·2989	·3009	·0420	+44·10
2	53·4312	·4275	·0493	56·65					

Weighted mean .... +47·00
V_a .... −23·48
V_d .... + ·05
Curvature .... − ·28

Radial velocity .... +23·3

β ORIONIS 2267.

1909. Feb. 10.
G. M. T. 12h 16m

Observed by W. E. Harper.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	54·7055	....	....	....	2	53·0868	....	....	....
2	53·9982	....	....	....	2	45·2923	....	....	....
2	53·9744	·9780	·0348	+40·25	2	45·2994	·3007	·0418	+43·89
1½	53·4070	·4100	·0318	36·54					

Weighted mean .... +40·56
V_a .... −23·48
V_d .... + ·05
Curvature .... − ·28

Radial velocity .... +16·9

β ORIONIS 2268.

1909. Feb. 10.
G. M. T. 12ʰ 21ᵐ

Observed by W. E. Harper.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7108	....	....	....	2	53·0920	....	....	....
2	54·0029	....	....	....	2	45·2948	....	....	....
2	53·9702	·9690	·0258	+29·84	2	45·2962	·2950	·0361	+37·91
1½	53·4186	·4160	·0378	43·44					

Weighted mean .... +36·48
V_a .... −23·48
V_d .... + ·05
Curvature .... − ·28

Radial velocity .... +12·8

β ORIONIS 2269.

1909. Feb. 10.
G. M. T. 12ʰ 33ᵐ

Observed by W. E. Harper.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7094	....	....	....	2	53·0894	....	....	....
2	53·9959	....	....	....	2	45·2919	....	....	....
3	53·9814	·9830	·0398	+46·03	2	45·2979	·2996	0407	+42·74
2	53·4142	·4145	·0363	41·71					

Weighted mean .... + 44·00
V_a .... −23·48
V_d .... + ·05
Curvature .... − ·28

Radial velocity .... + 20·3

β ORIONIS 2270.

1909. Feb. 10.
G. M. T. 12ʰ 37ᵐ

Observed by W. E. Harper.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7124	....	....	....	2	53·0940	....	....	....
2	54·0066	....	....	....	2	45·2995	....	....	....
2	53·9901	·9870	0438	+49·50	2	45·3078	·3019	·0430	+45·15
1	53·4211	·4167	·0385	44·24					

Weighted mean .... + 46·71
V_a .... −23·48
V_d .... + ·05
Curvature .... − ·28

Radial velocity .... + 23·0

β ORIONIS 2272.

1909. Feb. 11.
G. M. T. 11ʰ 26ᵐ

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7167	......	....	....	2	53·0917	....	....	....
2	54·0032	.. ....	....	....	2	45·2881	....	....	....
2	53·9806	·9785	·0353	+40·82	2	45·2997	·3052	·0463	+48·62
1½	53·4114	·4092	·0310	35·62					

Weighted mean .... + 42·78
V_a .... 23·65
V_d .... ·10
Curvature.... ... − ·28

Radial velocity .... − 18·9

β ORIONIS 2273.

1909. Feb. 11.
G. M. T. 11ʰ 32ᵐ

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7138	....	....	......	2	53·0875	...	....	....
2	54·0025	....	....	....	2	45·2844	....	....	....
2	53·9970	·9960	·0528	+61·06	2	45·3006	·3098	·0509	+53·45
1	53·4268	·4280	·0498	57·23					

Weighted mean...... .. .. 57·25
V_a .... − 23·65
V_d .... + ·10
Curvature........ ·28

Radial velocity.......... .... + 33·4

β ORIONIS 2274.

1909. Feb. 11.
G. M. T. 11ʰ 35ᵐ

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7114	......	....	....	2	53·0881	....	....	....
2	54·0044	....	....	....	2	45·2877	....	....	....
2	53·9812	·9810	·0378	+43·72	2	45·3071	·3130	·0540	+56·81
1½	53·4353	·4360	·0578	66·42					

Weighted mean.......... .... + 43·72
V_a ... . −23·65
V_d .... + ·10
Curvature. .. ... − ·28

Radial velocity .. .. +30·8

β ORIONIS 2275.

1909. Feb. 11.
G. M. T. 11h 38m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7133	......	....	....	2	53·0921	...	....	....
2	54·0063	....	....	....	2	45·2911	....	....	....
3	53·9782	·9760	·0328	−36·78	2	45·2979	·3024	·0435	−45·68
2	53·4256	·4230	·0448	51·48					

Weighted mean....		−43·52
V_a ...	23·65	
V_d		·10
Curvature	·28	
Radial velocity........		−19·7

β ORIONIS 2276.

1909. Feb. 11.
G. M. T. 11h 46m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7082	....	....	....	2	53·0893	....	....	.....
2	53·9963	....	....	....	2	45·2824	......	....	.....
2	53·9792	·9840	·0408	−47·19	2	45·2835	·2947	·0358	−37·59
1	53·4083	·4095	·0313	35·97					

Weighted mean..................		−41·11
V_a	−23·65	
V_d		−·10
Curvature	−·28	
Radial velocity............ ...		−17·3

β ORIONIS 2277.

1909. Feb. 11.
G. M. T. 11h 49m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7099	....	....	....	2	53·0878	....	....	.....
2	54·0019	....	....	....	2	45·2944	....	....	.....
2	53·9798	·9810	·0378	−43·72	$1\frac{1}{2}$	45·3021	·3013	·0424	−44·52
1	53·4279	·4294	0512	58·83					

Weighted mean		−47·34
V_a	23·65	
V_d		−·10
Curvature.......	−·28	
Radial velocity.		−23·5

β ORIONIS 2278.

1909. Feb. 13.
G. M. T. 12h 27m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	63·3466	......	......	......	2	58·8021	......	......	......
2	61·3632	......	......	......	2	36·1817	......	......	......
3	61·3156	·2975	·1175	+48·37	1	36·1930	·2055	1150	+40·31
2	59·7290	·7110	·1145	46·84					

Weighted mean		+46·52
V_a	−24·00	
V_d	·00	
Curvature	− ·28	
Radial velocity		+22·2

β ORIONIS 2279.

1909. Feb. 13.
G. M. T. 12h 40m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	63·3312	......	......	......	2	58·7858	......	......	......
2	61·3531	......	......	......	2	36·1657	......	......	......
3	61·3032	·2970	·1165	+48 16	1½	36·1698	1983	·1078	+37·78
2	59·7212	·7180	·1215	49·71					

Weighted mean		+46·24
V_a	−24·00	
V_d	00	
Curvature	− ·28	
Radial velocity		+22·0

β ORIONIS 2280.

1909. Feb. 13.
G. M. T. 12h 53m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	63 3520	......	......	......	2	58·8035	......	......	......
2	61·3710	......	......	......	2	36·1748	......	......	......
3	61 3192	·2940	·1135	+46·92	1	36·1848	·2042	·1137	+39·85
2	59·7314	·7105	·1140	46·64					

Weighted mean		+45·65
V_a	−24·00	
V_d	·00	
Curvature	− ·28	
Radial velocity		+21·4

β ORIONIS 2284.

1909. Feb. 20.
G. M. T. 12ʰ 29ᵐ

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3507				2	58·8010			
2	61·3686				2	36·1520			
3	61·2988	·3100	·0977	+40·27	2	36·1728	·1730	·1249	+43·78
1	59·7346	·7440	·1202	49·33					

Weighted mean		+42·95
V_a	−24·82	
V_d	− ·08	
Curvature	− ·28	
Radial velocity		+17·7

β ORIONIS 2285.

1909. Feb. 20.
G. M. T. 13ʰ 05ᵐ

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3177				2	58·7696			
2	61·3352				2	36·1246			
2	61·2860	·3278	·1155	+47·61	1½	36·1377	·1653	·1172	+41·08
1	59·7262	·7665	·1427	58·21					

Weighted mean		+47·79
V_a	−24·82	
V_d	− ·08	
Curvature	− ·28	
Radial velocity		+22·6

β ORIONIS 2286.

1909. Feb. 20.
G. M. T. 15ʰ 12ᵐ

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3440				2	58·7989			
2	61·3648				2	36·1571			
2	61·3160	·3320	·1197	+49·34	1½	36·1733	·1684	·1203	+42·16
1	59·7233	·7245	·1007	41·08					

Weighted mean		+45·14
V_a	−24·82	
V_d	− ·08	
Curvature	− ·28	
Radial velocity		+19·8

β ORIONIS 2288.

1909. Feb. 21.
G. M. T. 12h 57m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	63·3644	...	...	...	2	58·8118	...	...	...
2	61·3779	...	...	...	2	36·1550	...	...	...
2	61·3268	3250	·1127	+46·45	1	36·1798	·1770	·1770	+45·18
½	59·7422	·7400	·1162	47·40					

Weighted mean		– 46.45
V_a	25·04	
V_d	09	
Curvature	– ·28	
Radial velocity		+ 21·0

β ORIONIS 2289.

1909. Feb. 21.
G. M. T. 13h 07m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings	Disp^t in rev^{ns}	Velocity.
2	63·3543	...	...	...	2	58·8071	...	...	...
2	61·3695	...	...	...	2	36·1572	...	...	...
2	61·3040	·3105	·0982	+40·48	2	36·1726	1676	·1195	+41·88
1	59·7518	·7545	·1307	53·39					

Weighted mean		+ 45·62
V_a	25·04	
V_d	– ·09	
Curvature	– ·28	
Radial velocity		+ 18·2

β ORIONIS 2290.

1909. Feb. 21
G. M. T. 13h 17m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	63·3632	...	...	...	2	58·8130	...	...	...
2	61·3830	...	...	...	2	36·1631	...	...	...
2	61·3238	·3200	·1077	+44·39	2	36·1767	·1658	·1177	+41·25
1	59 7450	·7415	·1177	48·01					

Weighted mean		+43·86
V_a	–25 04	
V_d	– ·09	
Curvature	– ·28	
Radial velocity		+18·4

β ORIONIS 2291.

1909, Feb. 21.
G. M. T. 13h 27m

Observed by } J. S. PLASKETT.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3650				2	58·8109			
2	61·3777				2	36·1475			
3	61·3190	·3170	·1047	43·16	2	36·1659	·1706	·1225	- 42·94
1½	59·7433	·7416	·1168	47·64					

Weighted mean		44·13
V_a	25·04	
V_d	·09	
Curvature	− ·28	
Radial velocity		−18·7

β ORIONIS 2292.

1909, Feb. 22.
G. M. T. 12h 02m

Observed by T. H. PARKER.
Measured by J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3642				2	58·8102			
2	61·3755				2	36·1595			
2	61·3167	·3157	·1034	+ 42·62	1	36·1831	·1758	·1277	− 44·76
1	59·7493	·7483	·1245	50·78					

Weighted mean		− 45·19
V_a	−25·14	
V_d	− ·02	
Curvature	·28	
Radial velocity		+ 19·7

β ORIONIS 2293.

1909, Feb. 22
G. M. T. 12h 15m

Observed by T. H. PARKER.
Measured by J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3503				2	58·8000			
2	61·3637				2	36·1558			
2	61·3018	·3125	·1002	+ 41·30	½	36·1807	·1771	·1290	+ 45·21
1	59·7474	·7570	·1332	54·33					

Weighted mean		+ 45·58
V_a	− 25·14	
V_d	− ·02	
Curvature	− ·28	
Radial velocity		+ 25·1

β ORIONIS 2294.

1909. Feb. 22.
G. M. T. 12h 30m

Observed by T. H. Parker.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3495	....	....	....	2	58·8022	....	....	....
2	63·3678	....	....	....	2	36·1610	....	....	....
2	61·3121	·3210	·1087	+44·81	2	36·1809	·1720	·1239	+43·43
1½	59·7381	·7458	·1220	49·76					

Weighted mean	+45·66
V_a	−25·14
V_d	− ·02
Curvature	− ·28
Radial velocity	+20·2

β ORIONIS 2295.

1909. Feb. 22.
G. M. T. 12h 42m

Observed by T. H. Parker.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3622	....	....	....	2	58·8095	....	....	....
2	61·3780	....	....	....	2	36·1677	....	....	....
2	61·3248	·3280	·1157	+47·69	1½	36·1881	·1726	·1245	+43·64
2	59·7345	·7344	·1106	45·11					

Weighted mean	+45·65
V_a	−25·14
V_d	− ·02
Curvature	− ·28
Radial velocity	+20·2

β ORIONIS 2309.

1909. Feb. 27.
G. M. T. 11h 35m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3682	....	....	....	2	58·8129	....	....	....
2	61·3790	....	....	....	2	36·1491	....	....	....
2	61·3288	·3240	·1117	+46·04	2	36·1814	1845	·1364	+47·81
1½	59·7498	·7460	·1222	49·85					

Weighted mean	+47·71
V_a	−25·48
V_d	·00
Curvature	− ·28
Radial velocity	+22·0

β ORIONIS 2311.

1909. Feb. 28.
G. M. T. 11h 56m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3272	....	....	....	2	58·7792	....	....	....
2	63·3402	....	....	....	2	36·1567	....	....	....
2	61·2899	·2940	·1135	+46·92	1½	36·1805	·2180	·1275	+44·83
1½	59·7215	7250	·1285	52·63					

Weighted mean.... +48·01
V_a .... 25·53
V_d .... − ·02
Curvature.... − ·28

Radial velocity.... +22·2

β ORIONIS 2312.

1909. Feb. 28.
G. M. T. 12h 07m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·2345	....	....	....	2	58·7913	....	....	....
2	61·3567	....	....	....	2	36·1739	....	....	....
3	61·2980	·2890	·1085	+44·85	2	36·2048	·2251	·1346	+47·33
2	59·7342	·7260	·1295	53·04					

Weighted mean.... +47·90
V_a .... −25·53
V_d .... − ·02
Curvature.... − ·28

Radial velocity.... +22·0

β ORIONIS 2313.

1909. Feb. 28.
G. M. T. 12h 18m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3394	....	....	....	2	58·7911	....	....	....
2	61·3602	....	....	....	2	36·1740	....	....	....
2	61·3112	·3000	·1195	+49·40	1	36·1806	·2026	·1121	+39·41
1	59·7515	·7435	·1470	60·21					

Weighted mean.... +49·61
V_a .... −25·53
V_d .... − ·02
Curvature.... − ·28

Radial velocity.... +23·7

β ORIONIS 2314.

1909. Feb. 28.
G. M. T. 12ʰ 27ᵐ

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3298	....	....	......	2	58·7866	....	....	....
2	61·3467	....	....	....	2	36 1742	...	....	....
2	61·3037	·3005	·1200	−49·61	1½	36·1998	·2198	·1293	−45·46
1½	59·7434	·7408	·1443	59·11					

Weighted mean		+51·22
V_a	−25·53	
V_d	− ·02	
Curvature	− ·28	
Radial velocity		+25·3

β ORIONIS 2315.

1909. Feb. 28.
G. M. T. 12ʰ 39ᵐ

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3247	....	....	......	2	58 7759	....	....	....
2	61·3422	....	....	....	2	36·1541	....	....	....
3	61·2979	·3005	·1200	+49·61	2	36·1757	2158	·1253	+44 06
1½	59·7148	·7215	·1250	51·14					

Weighted mean		+48 26
V_a	−25·53	
V_d	− ·02	
Curvature	− ·28	
Radial velocity		+22·4

β ORIONIS 2316.

1909. Feb. 28.
G. M. T. 12ʰ 50ᵐ

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3355	....	....	....	2	58·7887	....	....	....
2	61·3528	....	....	....	2	36·1782	....	....	....
2	61·2998	·2920	·1115	−46·09	1½	36 1944	·2105	·1200	+42·19
1½	59·7455	·7400	·1435	58 71					

Weighted mean		+48·71
V_a	−25·53	
V_d	− ·02	
Curvature	·28	
Radial velocity		+22·8

β ORIONIS 2317.

1909. Mar. 2.
G. M. T. 11ʰ 20ᵐ

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3647				2	58·8147			
2	61·3807				2	36·1744			
2	61·3360	·3320	·1197	+49·34	1½	36·1960	·1738	·1257	+44·06
2	59·7707	·7655	·1417	57·80					

Weighted mean.. ... +50·97
V_a ..... 25·61
V_d ..... − ·02
Curvature ..... − ·28

Radial velocity ..... +25·9

β ORIONIS 2318.

1909. Mar. 2.
G. M. T. 11ʰ 19ᵐ

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3626				2	59·8075			
2	61·3804				2	36·1516			
2	61·3217	·3210	·1087	+44·81	1½	36·1860	·1866	·1385	+48·54
2	59·7622	7640	·1402	57·19					

Weighted mean..... +50·33
V_a ..... −25·61
V_d ..... − ·02
Curvature..... − ·28

Radial velocity..... +24·4

β ORIONIS 2319.

1909. Mar. 2.
G. M. T. 11ʰ 29ᵐ

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	63·3438				2	58·7920			
2	61·3600				2	36·1442			
2	61·3090	3260	·1137	+46·87	2	36·1763	·1843	·1363	+47·77
1½	59·7476	·7650	·1412	57·59					

Weighted mean..... +50·12
V_a ..... −25·61
V_d ..... − ·02
Curvature..... − ·28

Radial velocity..... +24·2

β ORIONIS 2320.

1909. Mar. 2.
G. M. T. 11h 36m

Observed by } Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3522	....	....	....	2	58·7996	....	....	....
2	61·3707	....	....	....	2	36·1541	....	....	....
2	61·3197	·3290	·1167	+48·10	2	36·1921	1902	·1421	+49·81
1½	59·7315	7312	·1074	43·81					

Weighted mean............ .... . +47·55
V_a........... −25·61
V_d........... − ·02
Curvature.... − ·28

Radial velocity .... +21·6

β ORIONIS 2364.

1909. Mar. 13
G. M. T. 12h 12m

Observed by } Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3696	....	....	....	2	58·8115	....	....	....
2	61·3870	....	....	....	2	36·1448	....	....	....
2	61·3327	·3250	·1127	+46·5	1½	36·1611	·1685	·1204	+42·2
1½	59·7380	·7320	·1082	44·1					

Weighted mean .. .. +44·50
V_a..... .... −25·45
V_d .... − ·16
Curvature.... − ·28

Radial velocity .... +18·6

β ORIONIS 2365.

1909. Mar. 13
G. M. T. 12h 24m

Observed by } Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3760	....	....	....	2	58·8161	....	....	....
2	61·3876	....	....	....	2	36·1348	....	....	....
3	61·3228	·3120	·0997	+41·1	1½	36·1591	·1765	·1284	+45·0
2	59·7507	·7425	·1187	48·4					

Weighted mean.................... +44·25
V_a.......... −25·45
V_d.......... − ·16
Curvature.... − ·28

Radial velocity..... ... . +18·4

β ORIONIS 2366.

1909. Mar. 13
G. M. T. 12h 36m

Observed by }
Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3662	... .	....	....	2	58·8112	....	....	....
2	61·3821	....	.. ...	. .. ..	2	36 1400	.. . ...	.. ..	....
2	61·3198	·3160	·1037	+42·7	1½	36·1692	·1814	·1333	+46·7
1½	59 7506	·7475	·1237	50·4					

Weighted mean....... .... +46·21
V_a .... −25·45
V_d .... − ·16
Curvature.... − 28

Radial velocity.... .... +20 3

β ORIONIS 2367.

1909. Mar. 13.
G. M. T. 12h 46m

Observed by }
Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3600	... .	....	... .	2	58·7981	... .	....	....
2	61·3738	. . . .	....	....	2	36·1272	... .	....	.... ..
2½	61 3086	·3125	·1002	+41·30	1½	36·1460	·1710	·1229	+43·10
1½	59·7297	·7400	·1162	47·40					

Weighted mean ... ... +43·45
V_a .... −25·45
V_d .... − ·16
Curvature..... . − ·28

Radial velocity .... +17·6

β ORIONIS 2368.

1909. Mar. 13.
G. M. T. 12h 57m

Observed by }
Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3640	....	....	....	2	58·8093	....	....	....
2	61·3800	....	.. ...	.. . ...	2	36·1354	....	... . ..	... ..
2	61·3300	·3280	·1157	+47·7	1½	36·1578	·1746	·1265	+44·3
2	59·7306	·7300	·1062	43·3					

Weighted mean........................ +45·17
V_a .... −25·45
V_d .. .. − ·16
Curvature....... .. − ·28

Radial velocity............... .... +19·3

β ORIONIS 2372.

1909. Mar. 15.
G. M. T. 11h 45m

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3472	....	....	....	2	58·8015	....	....	....
2	61·3664	....	....	....	2	36 1624	....	....	....
2	61·3098	·2890	·1085	−44 85	1½	36·1712	2030	·1125	+39·55
1	59·7205	·7015	·1050	42·96					

Weighted mean .... +42·66
V_a .... −25·34
V_d .... − ·14
Curvature.......... − ·28

Radial velocity.......... +16·9

β ORIONIS 2373.

1909. Mar. 15.
G. M. T. 11h 56m

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3475	....	....	....	2	58 7985	....	....	....
2	61·3660	....	....	....	2	36·1478	....	....	....
2½	61·3094	·2890	·1085	−44·85	1½	36·1697	·2161	·1256	+44·16
1	59·7421	·7260	·1295	52·98					

Weighted mean.......... +46·27
V_a .... −25·34
V_d.......... − ·14
Curvature.......... − ·28

Radial velocity.......... +20·5

β ORIONIS 2374.

1909. Mar. 15.
G. M. T. 12h 05m

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3415	....	....	....	2	58·7942	....	....	....
2	61·3612	....	....	....	2	36·1598	....	....	....
2	61·2924	2764	·0959	−39·65	1½	36·1784	·2128	·1223	+43·00
1	59·7336	·7220	·1255	51·34					

Weighted mean.......... +43·36
V_a .... −25·34
V_d.......... − ·14
Curvature.......... − ·28

Radial velocity.......... +17·6

β ORIONIS 2375.

1909. Mar. 15.
G. M. T. 12h 13m

Observed by / Measured by: J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3430	....	....	... .	2	58·7960	... .	....	....
2	61 3618	... .	....	... .	2	36·1654	. .	....	....
2	61·3146	·2976	·1171	+ 48·41	1½	36·1837	·2125	·1223	+ 43·00
1½	59·7102	6972	·1007	41 20					

Weighted mean		+ 44·62
V_a	− 25·34	
V_d	− ·14	
Curvature	− ·28	
Radial velocity		+ 18·9

β ORIONIS 2376.

1909. Mar. 15.
G. M. T. 12h 21m

Observed by / Measured by: J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3492	. . . . . .	.....	. ...	2	58·8022	....	... .	....
2	61·3678	... .	....	..... .	2	36·1743	....	....	....
2	61·3032	·2800	·0995	+ 41·13	1	36·1771	·1970	·1065	+ 37·45
1½	59·7281	·7088	·1123	45·94					

Weighted mean		+ 41·92
V_a	− 25·34	
V_d	− ·14	
Curvature	− ·28	
Radial velocity		+ 16·2

β ORIONIS 2386.

1909. Mar. 18.
G. M. T. 11h 42m

Observed by / Measured by: J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3427	.. ....	.....	....	2	58 7936	... .	....	... .
2	61·3610	.. .	....	....	2	36·1518	....	... .	... .
3	61·3020	·3185	·1062	+ 43·78	1	36·1820	·1824	·1343	+ 47·07
2	59·7188	·7346	1108	45·20					

Weighted mean		+ 44·98
V_a	− 25·09	
V_d	− ·15	
Curvature	− ·28	
Radial velocity		+ 19·5

β ORIONIS 2387.

1909. Mar. 18.
G. M. T. 11h 52m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3645	...	...	...	2	58·8071	...	...	...
2	61·3782	...	...	...	2	36·1581	...	...	...
2	61·3205	·3200	·1077	+44·39	1	36·1684	·1625	·1144	+40·10
1½	59·7465	·7480	·1242	50·66					

Weighted mean		+45·53
V_a	−25·09	
V_d	− ·15	
Curvature	− ·28	
Radial velocity		+20·0

β ORIONIS 2388.

1909. Mar. 18.
G. M. T. 12h 02m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3541	...	...	...	2	58·8001	...	...	...
2	61·3718	...	...	...	2	36·1635	...	...	...
2	61·3210	·3280	·1157	+47·69	1½	36·1828	·1715	·1235	+43·29
1½	59·7396	·7480	·1242	50·66					

Weighted mean		+47·26
V_a	−25·09	
V_d	− ·15	
Curvature	− ·28	
Radial velocity		+21·7

β ORIONIS 2389.

1909. Mar. 18.
G. M. T. 12h 12m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3492	...	...	...	2	58·7998	...	...	...
2	61·3646	...	...	...	2	36·1597	...	...	...
1½	61·2927	·3050	·0927	+38·21	1½	36·1954	·1879	·1398	+49·00
2	59·7380	·7485	·1247	50·86					

Weighted mean		+46·51
V_a	−25·09	
V_d	− ·15	
Curvature	− ·28	
Radial velocity		+21·0

β ORIONIS 2390.

1909. Mar. 20. G. M. T. 12h 16m

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3657	....	....	....	2	58·8128	....	....	....
2	61·3836	....	....	....	2	36·1496	....	....	....
2½	61·3307	·3260	·1137	+46·86	1½	36·1655	·1681	·1200	+42·06
1½	59·7601	·7561	·1323	53·96					

Weighted mean		+47·49
V_a	−24·88	
V_d	− ·12	
Curvature	− ·28	
Radial velocity		+22·2

β ORIONIS 2391.

1909. Mar. 20. G. M. T. 12h 26m

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3724	....	....	....	2	58·8192	....	....	....
2	61·3859	....	....	....	2	36·1414	....	....	....
2	61·3292	·3192	·1069	+44·06	1½	36·1637	·1745	·1264	+44·30
1½	59·7392	·7292	·1054	42·99					

Weighted mean		+43·81
V_a	−24·88	
V_d	− ·12	
Curvature	− ·28	
Radial velocity		+18·3

β ORIONIS 2392.

1909. Mar. 20. G. M. T. 12h 38m

Observed by / Measured by } J. S. PLASKETT.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3775	....	....	....	2	58·8197	....	....	....
2	61·3892	....	....	....	2	36·1569	....	....	....
3	61·3352	·3320	·1197	+49·34	2	36·1862	·1815	·1334	+46·76
1½	59·7575	·7460	·1222	49·85					

Weighted mean		+48·66
V_a	−24·88	
V_d	− ·12	
Curvature	− ·28	
Radial velocity		+23·4

β ORIONIS 2393.

1909. Mar. 20.
G. M. T. 12h 48m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3659	....	....	....	2	58·8108	....	....	....
2	61·3800	....	....	....	2	36·1480	....	....	....
2	61·3215	·3184	·1061	+43·73	1½	36·1857	·1900	·1419	+49.74
1½	59·7468	·7448	·1210	49·36					

Weighted mean.... .... +47·22
V_a........ .... −24·88
V_d............ ... ·12
Curvature.. .... − ·28

Radial velocity .... +21·9

β ORIONIS 2394.

1909. Mar. 20.
G. M. T. 12h 58m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3661	....	....	....	2	58·8130	....	....	....
2	61·3815	....	....	....	2	36·1565	....	....	....
2½	61 3319	·3275	·1152	+47·49	1½	36·1806	·1763	·1282	+44·93
1½	59·7587	·7547	·1309	53·39					

Weighted mean.. .... +48 40
V_a... .... −24 88
V_d.... .... − ·12
Curvature........... − ·28

Radial velocity..... ... ... +23·1

β ORIONIS 2397.

1909. Mar. 21.
G. M. T. 13h 38m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3695	....	....	....	2	58·8189	....	....	....
2	61·3856	....	....	....	2	36·1752	....	....	....
2	61·3328	·3240	·1117	+46·07	1½	36·2220	·1999	·1509	+52·89
2	59·7550	·7460	·1222	49·85					

Weighted mean..... .... +49·30
V_a ... . −24 76
V_d .... − ·32
Curvature.. .... − ·28

Radial velocity............ ..... +23·9

β ORIONIS 2398.

1909. Mar. 21.
G. M. T. 13h 48m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3667				2	58·8120			
2	61·3818				2	36·1571			
2	61·3396	·3350	·1227	+50·60	2	36·2053	·2004	·1523	+53·38
2	59·7441	·7410	·1172	47·81					

Weighted mean .... +50·60
V_a .... −24·76
V_d .... − ·32
Curvature .... − ·28

Radial velocity .... +25·2

β ORIONIS 2399.

1909. Mar. 21.
G. M. T 14h

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3483				2	58·7972			
2	61·3664				2	36·1511			
2	61·3124	·3245	·1122	+46·27	1	36 1884	·1894	·1414	+49·56
2	59·7452	·7572	·1334	54·41					

Weighted mean .... +50·18
V_a .... −24 76
V_d .... − ·32
Curvature .... − ·28

Radial velocity .... +24 8

β ORIONIS 2400.

1909. Mar. 21.
G. M. T. 14h 14m

Observed by / Measured by } J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3505				2	58·8071			
2	61·3712				2	36·1516			
2	61·3198	·3300	·1177	+48·54	½	36·1855	·1861	1380	+48.37
1½	59·7490	·7580	·1342	54·74					

Weighted mean .... +50·84
V_a .... −24 76
V_d .... − ·32
Curvature .... − ·28

Radial velocity .... +25·5

β ORIONIS 2402.

1909. Mar. 22.
G. M. T. 11h 51m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3584	.....	......	......	2	58·8043	....	....	......
2	61·3737	....	....	....	2	36·1447	......	....	....
2	61·3370	·3410	·1287	+53·05	1½	36·1712	·1787	·1307	+45·81
1½	59·7510	·7560	·1322	53·92					

Weighted mean........		+51·14
V_a	−24·66	
V_d	− ·16	
Curvature	− ·28	
Radial velocity ...		+26·0

β ORIONIS 2403.

1909. Mar. 22.
G. M. T. 12h 02m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3517	....	....	......	2	58·8009	....	....	....
2	61·3688	....	....	....	2	36·1536	....	....	....
2	61·3260	·3355	·1232	+50·78	1½	36·1846	·1832	·1832	+47·35
1½	59·7423	·7573	·1275	52·01					

Weighted mean........		+50·12
V_a	−24·66	
V_d	− ·16	
Curvature	− ·28	
Radial velocity ...		+25·0

β ORIONIS 2404.

1909. Mar. 22.
G. M. T. 12h 13m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3608	....	......	....	2	58·8094	......	....	....
2	61·3126	....	....	....	2	36·1640	....	....	....
2	61·3242	·3260	·1137	+46·87	1½	36·1917	·1800	·1319	+46·23
1½	59·7329	·7335	·1107	45·15					

Weighted mean........		+46·16
V_a	−24·66	
V_d	− ·16	
Curvature	− ·28	
Radial velocity ...		+21·1

β ORIONIS 2405.

1909. Mar. 22.
G. M. T. 12h 35m

Observed by, Measured by — J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63 3570	......	......	......	2	58·8019	......	......	......
2	61 3713	......	......	......	2	36·1480	......	......	......
2	61·3138	·3228	·1105	+45·55	1½	36·1698	·1740	·1259	+44 13
1½	59·7375	·7450	1212	49 44					

Weighted mean	+46·29
V_a	−24 66
V_d	− 16
Curvature	− ·28
Radial velocity	+21·2

β ORIONIS 2420.

1909. Mar. 23.
G. M. T. 11h 46m

Observed by, Measured by — J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63·3586	......	......	......	2	58 8059	......	......	......
2	61·3757	......	......	......	2	36·1332	......	......	......
1½	61·3160	·3190	·1067	+43 99	2	36·1699	·1889	·1408	+49·35
1½	59 7445	7480	·1242	50·66					

Weighted mean	+48 14
V_a	− 24·54
V_d	− ·19
Curvature	− ·28
Radial velocity	+23·1

β ORIONIS 2421.

1909. Mar. 23.
G. M. T. 11h 57m

Observed by, Measured by — J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	63 3700	......	......	......	2	58·8151	......	......	......
2	61·3800	......	......	......	2	36·1310	......	......	......
2½	61·3418	·3358	·1235	+50·92	2	36·1608	·1820	·1339	+46·93
1½	59·7447	·7390	1152	49·99					

Weighted mean	+49·36
V_a	− 24·54
V_d	·19
Curvature	− ·28
Radial velocity	+24·4

β ORIONIS 2422.

1909. Mar. 23.
G. M. T. 12h 05m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3572	....	....	....	2	58·8081	....	....	....
2	61·3728	....	....	....	2	36·1372	....	....	....
2	61·3253	·3290	·1177	48·53	2	36·1920	·2070	·1589	+55·69
1	59·7348	·7370	·1132	46·17					

Weighted mean		+50·92
V_a	−24·54	
V_d	− ·19	
Curvature	− ·28	
Radial velocity		+25·9

β ORIONIS 2423.

1909. Mar. 23.
G. M. T. 12h 13m

Observed by } J. S. Plaskett.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3787	....	....	....	2	58·8225	....	....	....
2	61·3936	....	....	....	2	36·1500	....	....	....
2	61·3330	·3170	·1047	+43·17	2	36·2082	·2104	·1623	+56·89
2	59·7696	·7551	·1313	53·56					

Weighted mean		+51·21
V_a	−24·54	
V_d	− ·19	
Curvature	− ·28	
Radial velocity		+26·2

β ORIONIS 2424.

1909. Mar. 23.
G. M. T. 12h 27m

Observed by J. B. Cannon.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity
2	63·3774	....	....	....	2	58·8212	....	....	....
2	61·3930	....	....	....	2	36·1341	....	....	....
1½	61·3425	·3275	·1152	+47·51	2	36·1822	·1997	·1516	+53·14
1½	59·7590	·7465	·1227	50·35					

Weighted mean		+50·52
V_a	−24·54	
V_d	− ·19	
Curvature	− ·28	
Radial velocity		+25.5

β ORIONIS 2425.

1909. Mar. 23.
G. M. T. 12h 38m

Observed by J. B. Cannon.
Measured by J. S. Plaskett.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	63·3650	....	....	....	2	58·8098	....	....	....
2	61·3793	....	....	....	2	36·1269	....	....	....
2	61·3350	·3327	1204	+49·65	1½	36·1707	·1960	·1479	−51·84
1½	59·7498	·7490	·1252	51·07					

Weighted mean..........	....	−50·72
V_a..........	−25·54	
V_d..........	− ·19	
Curvature..........	− ·28	
Radial velocity..........	....	−25·7

P.—Plaskett.
P[1].—Parker.
H.—Harper.
C.—Cannon.
T.—Tribble.

OBSERVING RECORD AND DETAILED MEASURES OF θ AQUILÆ.

RECORD OF SPECTROGRAMS.

Star.	No. of Negative.	Camera.	Plate.	Date.	Middle of Exposure. G.M.T.	Duration.	Hour Angle at end.	Temperature Centigrade. Room. Beginning.	Room. End.	Prism Box. Beginning.	Prism Box. End.	Slit Width.	Seeing.	Observer.	Remarks.
				1907.	h. m.	m.	h. m.								
θ Aquilæ	1038	IL	Seed 27	Sept. 12	15 15	41	1 55 W.	16·8	15·7	20·9	20·9	·0012	Good	T	
"	1050	"	"	" 18	14 45	37	1 40 "	12·5	11·7	17·0	17·0	·0014	Unsteady.	T	
				1908											
"	1533	"	"	May 15	20 54	25	28 E.	11·0	10·5	18·0	17·9	·0017	Good	H	
"	1544	"	"	" 18	20 49	22	25 "	15·0	15·0	23·4	23·4	·0016	Hazy	H	
"	1576	"	"	June 3	20 35	25	30 W.	12·5	13·0	18·3	18·3	·0015	Fair	H	
"	1583	"	"	" 5	19 42	45	10 E.	14·5	14·1	24·5	24·4	·0016	"	P[1]	
"	1604	"	"	" 12	19 32	35	10 W.	15·5	14·7	24·8	24·6	·0017	"	P[1]	
"	1605	"	"	" 12	20 15	40	45 "	14·7	14·4	24·6	24·5	"	Good	P[1]	
	1626	"	"	" 22	18 35	40	10 E.	17·5	17·5	23·8	23·8	·0015	Hazy	P[1]	
"	1634	"	"	" 24	19 46	39	1 07 W.	18·5	18·0	27·5	27·5	"	Good	H	
"	1643	"	"	" 26	19 42	35	1 15 "	17·5	17·3	30·0	30·0	·0016	"	P[1]	
"	1651	"	"	" 27	18 45	30	20 "	19·1	18·7	23·4	23·3	·0014	"	P	
"	1659	"	"	July 3	17 30	60	25 "	21·5	20·5	25·4	25·1	·0016	Hazy	H-P[1]	
"	1679	"	"	" 8	18 49	30	1 02 "	17·5	17·0	21·6	21·6	·0015	Good	H	
"	1691	"	"	" 10	19 30	40	2 .. "	20·4	19·3	28·0	26·6	·0016		P[1]	
"	1696	"	"	" 11	19 10	40	1 40 "	25·4	24·4	29·7	29·7	·0015		P	
"	1704	"	"	" 13	19 37	35	2 15 "	18·0	17·6	23·0	23·0	"	Good	P[1]	
"	1708	"	"	" 14	18 19	23	52 "	20·0	19·5	20·6	20·6	·0016	"	H	
"	1716	"	"	" 15	19 24	22	2 02 "	14·5	14·5	22·0	22·0	·0015	"	H	
"	1727	"	"	" 25	16 20	42	5 E.	21·4	20·6	24·7	24·6	·0015	Fair	P	
"	1730	"	"	" 26	17 38	24	58 W.	22·0	21·5	23·6	23·6	"	Good	H	
"	1731	"	"	" 26	18 07	33	1 32 "	21·5	21·5	"	"	"	"	H	
"	1732	"	"	" 27	18 15	130	1 50 "	25·5	24·0	29·7	29·5	"	No good	P	Clouds 100m
"	1733	"	"	" 27	20 10	40	3 45 "	23·4	23·0	29·5	29·5	"	Fair	P[1]	
"	1735	"	"	" 28	17 49	22	1 17 "	25·0	24·0	29·8	29·7	·0016	Good	H	
"	1736	"	"	" 28	18 08	17	1 34 "	24·0	25·0	29·7	29·7	"	"	H	
"	1747	"	"	" 30	17 47	25	1 25 "	26·0	26·0	31·1	31·0	·0015	"	H	

. ..	1755	"	" ..	"	31..	17	52	25	1	36	"	19·0	18·7	25·5	25·6	"	" ...	P¹-H	
" ..	1756	"	" ..	"	31..	18	19	21	2	..	"	18·7	18·5	25·6	"	"	"	H	
" ..	1762	"	" ..	Aug.	5..	14	05	50	1	30	"	22·6	22·6	27·0	27·0	"	Fair	P	
" ..	1766	"	" ..	"	5..	16	29	38		35	"	21·6	21·6	26·8	26·8	"	....	P	
" ..	1767	"	" ..	"	5.	17	18	48	1	25	"	21·3	20·8	26·8	26·7	"	.....	P	
" ..	1769	"	" ..	"	5..	18	48	30	2	47	"	20·5	20·	26·5	26·5	"	.. ..	C	Windy.
" ..	1776	"	" ..	"	7..	17	00	40	1	15	"	19·0	19·3	23·6	23·6	"	Fair......	P¹	
" .	1777	"	" ..	"	7..	17	45	40	2	02	"	19·2	18·8	23·5	23·4	"	"	P¹-C	
" ..	1789	"	" ..	"	17..	18	18	34	3	11	"	21·5	20·5	26·2	26·1	"	Unsteady.	H	
" ..	1794	IIIL	" ..	"	19..	16	45	90	2	12	"	14·5	14·0	23·3	23·2	·0017	Good...	H	Cloudy 26ᵐ
" ..	1799	IL	" ..	"	20..	15	15	39		20	"	18·0	17·0	22·6	22·4	0015	Fair......	H	
" ..	1800	"	" ..	"	20..	15	47	25		47	"	17·0	17·0	22·4	22·3	"	Good. ..	H	
" .	1801	"	" ..	"	20..	16	42	29	1	43	"	17·0	16·5	22·3	22·2	"	Fair	H	
" ..	1807	"	" ..	"	21..	13	57	35	1	..	E.	20·2	19·8	25·4	25·2	"	"	C	Off 5ᵐ
" ..	1808	"	" ..	"	21..	14	32	30		26	"	19·8	18·8	25·2	25·0	"	Good....	C	
" .	1810	"	" ..	"	21..	15	28	30		30	W.	18·4	18·4	25·4	25·4	"	"	C	
" ..	1811	"	" ..	"	22..	15	29	26		37	"	16·0	15·5	18·0	17·8	"	"	H	
" ..	1812	"	" ..	"	22..	15	56	25	1	03	"	15·5	16·0	17·8	"	"	"	H	
" ..	1813	"	" ..	"	22..	16	21	26	1	29	"	16·0	"	"	"	"	"	H	
" ..	1814	"	" ..	"	23..	15	48	27	1	02	"	18·0	17·5	20·5	20·5	"	Fair	H	
" ..	1815	"	" ..	"	23..	16	18	30	1	30	"	17·5	17·0	"	20·3	"	"	H	
" ..	1822	"	" .	"	24..	16	56	32	2	15	"	14·7	14·4	23·0	22·8	"	Good. ...	H	
" ..	1835	"	" ..	"	27..	14	02	35		25	.	18·6	18·6	23·2	23·2	"	"	C	
" ..	1864	"	" ..	Sept.	3..	16	17	55	2	30	W.	14·8	14·0	20·5	20·4	"	Smoky ...	P	
" ..	1875	"	" ..	"	8..	12	42	45		55	E.	21·0	20·4	22·9	22·9	"	Fair	P	
" ..	1876	"	" .	"	8..	13	40	69		20	W.	20·4	18·6	"	22·7	"	Hazy . . .	P	
" ..	1878	"	" .	"	11..	15	00	60	1	47	"	22·6	20·5	28·2	28·0	"	"	C	

θ AQUILÆ 1038.

1907. Sept. 12.
G. M. T. 15ʰ 15ᵐ

Observed by J. N. Tribble.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7334	.....	.....	.....	½	27·3601	4161	·0035	3·04
1	53·9733	·9818	·0120	+13·81	2	27·1906	.....	.....	.....
2	53 1041	.....	.....	.....	1½	11·7684	·8670	·0156	+11·68
2	45·2469	.....	.....	.....	2	11·4086	.....	.....	.....
1½	45·2273	·2540	·0153	15·97					

Weighted mean .... +12·62
V_a .... −20 23
V_d .... − ·14
Curvature .... − ·28

Radial velocity .... − 8·0

θ AQUILÆ 1050.

1907. Sept. 18.
G. M. T. 14ʰ 45ᵐ

Observed by } J. N. Tribble.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings	Displacement in Revolutions.	Velocity.
2	73·0318	.....	.....	.....	2	45·2738	.....	.....	.....
1	72·8699	·8031	·0156	−22·66	1½	45·2139	·2237	·0250	26·17
2	72·4635	.....	.....	.....	½	27·3813	·4591	·0374	−32·59
2	54·0294	.....	.....	.....	2	27·2441	.....	.....	.....

Weighted mean .... −26·06
V_a .... 22·14
V_d .... − ·14
Curvature .... ·28

Radial velocity .... −48·6

θ AQUILÆ 1050.*

1907. Sept. 18.
G. M. T. 14ʰ 45ᵐ

Observed by J. N. Tribble.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0040	.....	.....	.....	2	53·1850	.....	.....	.....
½	72·8394	·8450	·0198	−28·73	2	45·2417	.....	.....	.....
1	72·4318	.....	.....	.....	1½	45·1800	·2119	·0268	27·98
2	54·7082	.....	.....	.....	¼	27·3593	·3996	·0130	−11·28
½	53·9314	·9651	·0044	5·06	2	27·2063	.....	.....	.....

Weighted mean .... −22·43
V_a .... −22·14
V_d .... − ·14
Curvature .... − ·28

Radial velocity .... −45·0

* Check measurement.

θ AQUILÆ 1533.

1908. May 15.
G. M. T. 20h 54m

Observed by | Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7742				2	27·2579			
½	53·9093	·8781	·0917	105·54	1½	15·3876	·3776	·0956	−73·99
2	53·1421				2	15·4086			
2	45·2974				½	11·7542	·7520	·0994	−74·45
1½	45·1779	·1541	·0846	−88·32	2	11·5091			
1½	27·3612	·3498	·0628	−54·51					

Weighted mean		−75·50
V_a	+26·05	
V_d	+·06	
Curvature		−·28
Radial velocity		−49·7

θ AQUILÆ 1544.

1908. May 18.
G. M. T. 20h 49m

Observed by | Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7267				2	45·2655			
2½	53·8990	·9160	·0538	−61·92	½	45·1692	·1773	·0614	−64·10
2	53·0932								

Weighted mean		−62·30
V_a	+25·50	
V_d	+·04	
Curvature		−·28
Radial velocity		−37·0

θ AQUILÆ 1576.

1908. June 3.
G. M. T. 20h 35m

Observed by | Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions	Velocity.
2	54·7369				¾	45·1970	·1900	·0487	−50·84
2	53·8906	·8976	·0722	−83·10	1	11·8670	·7770	·0744	−55·72
2	53·1029				2	11·5975			
2	45·2806								

Weighted mean		−69·34
V_a	+21·62	
V_d		−·02
Curvature		−·28
Radial velocity		−48·0

θ AQUILÆ 1583.

1908. June 5.
G. M. T. 9h 42m

Observed by T. H. Parker.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9953	......	......	......	2	45·2607	......	......	......
1	72·8212	·8347	·0301	−43·68	1½	45·1648	·1776	·0611	−63·79
2	72·4342	......	......	......	1	27·3467	·3418	·0708	−61·45
2	54·7250	......	......	......	2	27·2518	......	......	......
2	53·9156	·9287	·0411	−47·31	2	11·8084	·7915	·0599	−44·87
2	53 1028	......	......	......	2	11·5245	......	......	......

Weighted mean		−51·35
V_a	+20·91	
V_d	+ ·04	
Curvature		− ·28
Radial velocity		−30·7

θ AQUILÆ 1604.

1908. June 12.
G. M. T. 19h 32m

Observed by T. H. Parker.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73 0475	......	......	......	2	45·2995	......	......	......
½	72·8819	·8436	·0212	−30 76	1	45·2281	·2022	·0365	−38·11
2	72·4848	......	......	......	1	37 7627	·7265	·0282	−27·21
2	57·8373	·7895	·0373	−44·91	2	37·9955	......	......	......
1	57·7974	......	......	......	1	27·4133	·3852	·0274	−23·78
2	54 7562	......	......	......	2	27·2746	......	......	......
2	53·9652	·9492	·0206	−23·71	1	11·8637	·8173	·0341	−25·54
2	53 1298	......	......	......	2	11·5542	......	......	......

Weighted mean		−29·64
V_a	+18·58	
V_d		− ·04
Curvature		− ·28
Radial velocity		−11·4

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θ AQUILÆ 1605.

1908. June 12.
G. M. T. 20h 15m

Observed by } T. H. PARKER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revns.	Velocity.
2	72·9907	......	......	......	2	53·0714	......	......	......
½	72·8128	·8345	·0303	−43·96	2	45·2430	......	......	......
2	72·4181	......	......	......	1	45·1817	·2124	·0263	−27·45
2	57·7935	......	......	......	2	43·5027	......	......	......
1	57·7576	·7934	·0334	−40·21	1	27·3562	·3619	·0507	44·00
1	56·6375	......	......	......	2	27·2410	......	......	......
2	54·7059	......	......	......	1	11·7999	·7969	·0545	−41·56
1	53·9117	·9500	·0198	−22·78	2	11·5103	......	......	......

Weighted mean..........		−32·99
V_a............	+18·58	
V_d............		− ·04
Curvature............		− ·28
Radial velocity............		−14·7

θ AQUILÆ 1626.

1908. June 22.
G. M. T. 18h 35m

Observed by T. H. PARKER.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revns.	Velocity.
1	57·8274	......	......	......	½	37·7445	7260	·0287	−27·67
½	57·7977	·7957	·0311	−37·44	½	29·7998	·7680	·0629	−55·92
2	54·7455	......	......	......	2	29·6306	......	......	......
2	53·9400	·9377	·0321	−36·95	1	27·3906	·3481	·0645	−55·98
2	53·1130	......	......	......	2	27·2891	......	......	......
2	45·2851	......	......	......	2	11·8445	.7902	·0612	−58·39
1½	45·2209	·2094	·0293	−30·60	2	11·5615	......	......	......
2	37·9777	......	......	......					

Weighted mean..........		−44·13
V_a............	+15·01	
V_d............	− ·04	
Curvature............		·28
Radial velocity............		−29·0

θ AQUILÆ 1626.*

1908. June 22.
G. M. T. 18h 35m

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revns.	Velocity.
1	57·8369	....	....	....	½	37·7667	·7262	·0383	−36·92
½	57·8165	8025	·0243	−29·26	½	29·8124	·7624	·0685	−60·90
2	54·7682	....	....	....	2	29·6441	....	....	....
2	53·9534	·9294	·0404	−46 50	1	27·4266	·3746	·0380	−32·98
2	53·1347	....	....	....	2	27·3062	....	....	....
2	45·3077	....	....	....	2	11·8604	·7864	·0650	−48·68
1½	45·2463	·2123	·0264	−27·56	2	11·5823	....	....	....
2	38·9962	....	....	....					

Weighted mean.............		−41·03
V_a.....	+15·01	
V_d........	+ ·04	
Curvature......		− ·28
Radial velocity.....		−26·3

*Check measurement.

θ AQUILÆ 1634.

1908. June 24
G. M. T. 19h 46m

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings	Corrected Star Settings.	Displacement in Revns.	Velocity.
2	57·9245	....	....	....	1	37·8255	·7200	·0347	−33·45
½	57 8639	·7688	·0580	−69·83	2	30·0385	....	....	....
2	54·8405	....	....	....	1	29·8974	·7819	·0490	−43·56
3	54 0327	9347	·0351	−40·40	1½	27·4733	·3561	·0565	−49·04
2	53·2094	....	....	....	2	27·3638	....	....	....
2	45·3719	....	....	....	2½	11·9231	·8011	·0503	−37·67
2	45·2924	·1941	·0446	−46·56	2	11·6292	....	....	....
2	38·0650	....	....	....					

Weighted mean.........		−42·95
V_a..............	+14·12	
V_d		− 06
Curvature..................		− ·28
Radial velocity..................		−29·2

θ AQUILÆ 1643.

1908. June 26.
G. M. T. 19h 42m

Observed by T. H. Parker.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revns.	Velocity.
2	57·8751				2	38·0110			
2	57·8285	·7742	·0526	−63·33	2	37·7647	·7131	·0416	−40·10
2	54·7850				1	27·4172	·3588	·0538	−46·70
2	53·9798	·9370	·0328	−37·75	2	27·3150			
2	53·1545				3	11·8629	·8040	·0474	−35·50
2	45·3226				2	11·5661			
2	45·2498	·2008	·0379	−39·57					

Weighted mean		−42·90
V_a	+13·22	
V_d		−·09
Curvature		−·28
Radial velocity		−30·0

θ AQUILÆ 1651.

1908. June 27.
G. M. T. 18h 45m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revns.	Velocity.
2	57·8640				1	30·8717	·8126	·0630	−56·57
1	57·8292	·7946	·0322	−38·77	2	29·6583			
2	54·7825				1	29·6105	·5510	·0479	−42·53
2½	53·9715	·9320	·0378	−43·51	1½	27·4256	·3590	·0536	−46·52
2	53·1535				2	27·3135			
2	45·3175				1½	15·4903	·4182	·0551	−42·65
1½	45·2365	·1926	0461	−48·13	2	15·4707			
2	38·0075				3	11·8646	·7958	·0556	−41·64
1	37·7459	·6973	·0554	−53·40	2	11·5760			
2	30·9295								

Weighted mean		−45·06
V_a	+12·83	
V_d		·00
Curvature		−·28
Radial velocity		−32·5

θ AQUILÆ 1659.

1908, July 3.
G. M. T. 17h 30m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revns.	Velocity.
2	54·6001	....	....	....	2	11·6263	11·7883	·0631	−47·26
2	53·7884	53·9309	·0389	44·77	2	11·3448	....	....	....
2	52·9687	....	....	....					

Weighted mean		−46·01
V_a	+10·32	
V_d		00
Curvature		−·18
Radial velocity		−35·9

θ AQUILÆ 1679

1908, July 8.
G. M. T. 18h 49m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revns.	Velocity.
1	73·1291	....	....	....	2	45·3990	....	....	....
1	72·9478	·8298	·0350	−50·78	1	45·3177	·1923	·0464	−48·44
1	72·5626	....	....	....	1	27·4959	·3539	0587	−50·95
2	54·8610	....	....	....	2	27·3903	....	....	....
2	54·0581	·9390	·0308	−35·45	1½	11·9333	·7803	·0711	−53·25
2	53·2311	....	....	....	2	11·6602	....	....	....

Weighted mean		−46·30
V_a	−8·05	
V_d		·09
Curvature		−·28
Radial velocity		−38·6

θ AQUILÆ 1691.

1908. July 10.
G. M. T. 19h 30m

Observed by }
Measured by } T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9970	....	....	....	1½	53·9308	·9368	·0330	−37·98
½	72·8227	·8352	·0296	−42·94	2	53·1036	....	....	....
2	72·4327	....	....	....	2	45·2729	....	....	....
2	57·7960	....	....	....	½	45·1767	·1777	·0610	−63·68
1	57·7501	·7831	·0463	−55·74	½	27·3741	·3471	0655	−56·85
2	56·6372	....	....	....	2	27·2739	....	....	....
2	54·7314	....	....	....					

Weighted mean		48·88
V_a	−7·14	
V_d		·12
Curvature		−·28
Radial velocity		−42·1

θ AQUILÆ 1691*.

1908. July 10. G. M. T. 19h 30m

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings	Displacement in Revolutions	Velocity.
1	73·0001	....	....	....	1½	53·9446	·9446	·0252	−29·00
½	72·8210	·8277	·0371	−53·83	2	53·1121	....	....	....
1	72·4443	....	....	....	2	45·2831	....	....	....
2	57·8282	....	....	....	1½	45·1971	·1874	·0513	−53·56
1	57·7688	·7700	·0568	−68·39	½	27·4088	·3658	·0468	−39·62
2	54·7417	....	....	....	2	27·2902	....	....	....

Weighted mean		−47·79
V_a	+7·14	
V_d		−·12
Curvature		−·28
Radial velocity		−41·0

* Check measurement.

θ AQUILÆ 1696.

1908. July 11. G. M. T. 19h 10m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings	Displacement in Revolutions.	Velocity.
2	57·8543	....	....	....	1½	45·2351	·1991	·0396	−41·34
1	57·8215	·7968	·0300	−36·12	2	29·6333	....	....	....
2	54·7744	....	....	....	1	29·6020	·5676	·0313	−27·54
2	53·9587	·9274	·0424	−48·80	2	11·8235	·7982	·0532	−39·85
2	53·1422	....	....	....	2	11·5325	....	....	....
2	45·3096	....	....	....					

Weighted mean		−40·40
V_a	+6·60	
V_d		−·12
Curvature		−·28
Radial velocity		−34·2

θ AQUILÆ 1704.

1908. July 13.
G. M. T. 19h 37m

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0441	....	....	....	2	53·1318	....	....	....
½	72·8608	·8565	·0083	−12·05	2	45·3027	....	....	....
1	72·4491	....	....	....	1	45·2546	·2156	·0231	−24·12
2	57·8483	....	....	....	½	27·4155	·3555	·0561	−48·69
½	57·8073	·7883	0385	−46·35	2	27 3060	....	....	....
2	54·7666	....	....	....	1½	11·8718	·7958	·0556	−41·64
2	53·9556	·9296	·0402	−46·27	2	11·5838	....	....	....

Weighted mean.		−38·78
V_a	+5·77	
V_d		− ·16
Curvature............		− ·28
Radial velocity.		−33·5

θ AQUILÆ 1708.

1908, July 14.
G. M. T. 18h 19m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0051	....	....	....	2	45·2705	....	....	....
1	72·8307	·8351	·0297	−43·09	2	45·2015	·2045	·0342	−35·70
1	72·4410	....	....	....	1½	27·3918	·3786	·0430	−37·32
2	54·7316	....	....	....	2	27·2622	....	....	....
2	53·9435	·9505	·0193	−22·21	2	11·8489	·8199	·0315	−23·58
2	53·1072	....	....	....	2	11·5364	....	....	....

Weighted mean......		−30·83
V_a	+5·34	
V_d		·00
Curvature.....		− ·28
Radial velocity........		−25·8

θ AQUILÆ 1716.

1908, July 15.
G. M. T. 19h 24m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0426	....	....	....	2	45·3046	....	....	....
½	72·8798	·8475	·0173	−25·10	1	45·2469	·2159	·0228	23·80
1	72·4764	....	....	....	2	29·6384	....	....	....
	57·8582	....	....	....	1½	29·6106	·5716	·0273	24·22
	57·8243	·7943	·0313	37·68	1½	27·4356	·3871	·0255	22·15
2	54·7774	....	....	....	2	27·2951	....	....	....
2	53·9873	·9543	·0155	17·84	1½	11·8697	·8197	·0317	−23·74
2	53·1427	....	....	....	2	11·5523	....	....	....

Weighted mean		−23·88
V_a	+4·86	
V_d		− ·16
Curvature		− ·28
Radial velocity		−19·5

θ AQUILÆ 1727.

1908, July 25.
G. M. T. 16h 29m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0229	....	....	....	2	45·2811	....	....	....
1	72·8498	·8385	·0263	−38·16	2	45·2157	·2082	·0305	31·84
1	72·4507	....	....	....	½	27·3982	·3715	·0411	35·67
2	54·7506	....	....	....	2	27·2733	....	....	....
2	53·9420	·9323	·0375	43·16	2½	11·8282	·8011	·0503	−37·67
2	53·1227	....	....	....	2	11·5343	....	....	....

Weighted mean		−37·52
V_a	+ ·25	
V_d	+ ·04	
Curvature		− ·28
Radial velocity		−37·5

θ AQUILÆ 1730.

1908, July 26.
G. M. T. 17h 38m

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0205				2	45·2945			
½	72·8350	8244	·0404	−58·62	1½	45·2203	·1994	0393	41·02
2	72·4551				1	27·4096	·3642	0484	42·01
2	57·8380				2	27·2920			
2	54·7570				2	11·8572	·8032	·0482	−36·10
2	53·9564	·9427	·0271	31·19	2	11·5612			
2	53·1243								

Weighted mean.................. −38·20
V_a.................... 24
V_d.................... − ·11
Curvature........ 28

Radial velocity......... 38·8

θ AQUILÆ 1731.

1908. July 26.
G. M. T. 18h 07m

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	57·8287				1½	45·1997	·1980	·0407	42·49
½	57·7975	·7982	0286	−41·50	½	27·3970	·3792	·0334	29·00
2	54·7409				2	27·2644			
2	53·9365	·9368	·0330	38·00	½	11·8173	·7869	·0645	−48·31
2	53·1122				2	11·5376			
2	45·2753								

Weighted mean......... −39·83
V_a.................... − ·24
V_d.................... ·11
Curvature........ − ·28

Radial velocity......... −40·5

θ AQUILÆ 1732.

1908. July 27.
G. M. T. 18h 15m

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	57·6860				1	45·0540	·2035	·0352	36·75
⅓	57·6422	·7856	·0412	−49·60	2	29·4545			
2	54·5924				1½	29·4224	·5668	·0321	28·47
2	53·7915	·9405	·0293	33·72	¼	11·6850	·8415	·0099	−7·41
2	52·9636				2	11·3507			
2	45·1239								

Weighted mean	−32·23
V_a	− ·73
V_d	− ·12
Curvature	− ·28
Radial velocity	−33·4

θ AQUILÆ 1733.

1908. July 27.
G. M. T. 20h 10m

Observed by T. H. PARKER.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	57·8173				1	53·9094	·9241	·0457	−52·60
2	57·7872	·7993	·0273	−32·87	2	53·1007			
2	54·7239								

Weighted mean	−39·45
V_a	− ·73
V_d	− ·24
Curvature	− ·28
Radial velocity	−40·7

θ AQUILÆ 1735.

1908. July 28.
G. M. T. 17h 49m

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	57·7810				2	37·9067			
1	57·7302	·7786	·0482	−57·91	½	37·6760	·7285	·0262	25·26
2	54·6993				2	29·5479			
2	53·8959	·9391	·0307	35·33	1	29·4960	·5470	·0519	46·14
2	53·0681				½	27·3178	·3688	·0438	−38·02
2	45·2233				2	27·1956			
1	45·1554	·2057	·0330	34·45					

Weighted mean	−40·13
V_a	− 1·20
V_d	− ·10
Curvature	− ·28
Radial velocity	−42·7

θ AQUILÆ 1736.

1908. July 28.
G. M. T. 18^h 08^m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7038	....	....	....	2	37·9039	....	....	....
1½	53·9012	·9418	·0280	−32·23	½	37·6815	·7368	·0179	−17·25
2	53·0684	....	....	....					

Weighted mean .... −28·48
V_a .... − 1·20
V_d .... − ·12
Curvature .... − ·28

Radial velocity .... −30·1

θ AQUILÆ 1747.

1908. July 30.
G. M. T. 17^h 47^m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0586	....	....	....	2	45·2720	....	....	....
½	72·8916	·8438	·0210	−30·47	1½	45·1954	·1970	0417	43·53
2	72·4899	....	....	....	½	27·3662	3783	·0343	29·77
2	54·7537	....	....	....	2	27·2345	....	....	....
2	53·9640	·9538	0160	18·42	½	11·7805	8237	0287	−21·50
2	53·1210	....	....	....	2	11·4640	....	....	....

Weighted mean .... −28·60
V_a .... − 2·13
V_d .... − ·10
Curvature .... − ·28

Radial velocity .... −31·1

θ AQUILÆ 1755.

1908. July 31.
G. M. T. 17^h 52^m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	57·9005	....	....	....	2	29·6870	....	....	....
1	57·8680	·7968	·0300	−36·12	1	27·4678	·3771	·0355	30·81
2	45·3421	....	....	....	2	27·3373	....	....	....
1	45 2829	·2144	·0243	25·37	1	11·8987	·8159	·0355	−26·59
1½	29·6625	·5744	·0245	21·78	2	11·5900	....	....	....

Weighted mean .... −27·56
V_a .... − 2·59
V_d .... − ·11
Curvature .... − ·28

Radial velocity .... −30·5

θ AQUILÆ 1756.

1908. July 31.
G. M. T. 18^h 19^m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·1090	....	....	....	2	45·3718	....	....	....
½	72·9433	·8464	·0184	−26·70	2	45·3132	·2150	·0237	24·74
2	72·5395	....	....	....	1½	27·5107	·3881	·0245	21·27
2	54·8279	....	....	....	2	27·3692	....	....	....
1½	54·0425	·9526	·0172	19·80	2	11·9418	·8239	·0275	−20·60
2	53·2057	....	....	....	2	11·6251	....	....	....

Weighted mean..................	−23·42
V_a..............................	− 2·59
V_d..............................	− ·15
Curvature..........................	− 28
Radial velocity	−26·4

θ AQUILÆ 1762.

1908. Aug. 5.
G. M. T. 14^h 50^m

Observed by J. S. Plaskett.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0445	....	....	....	2	37·9735	....	....	....
½	72·9019	·8689	·0041	+ 5·94	½	37·8169	·8026	·0479	46·17
2	72·4763	....	....	....	½	30·9439	·9214	·0458	41·12
2	54·7639	....	....	....	2	30·8932	....	....	....
1	54·0333	·0153	·0455	52·37	1	27·4672	·4477	·0351	30·46
2	54·0467	....	....	....	2	27·2659	....	....	....
2	53·1283	....	....	....	1	11·9221	·9161	·0647	+48·46
2	45·2915	....	....	....	2	11·5123	....	....	....
1½	45·2840	·2661	·0274	28·60					

Weighted mean..................	+39·69
V_a.............................. − 4·91	
V_d..............................	+ ·09
Curvature........ − ·28	
Radial velocity	+34·6

θ AQUILÆ 1766.

1908. Aug. 5.
G. M. T. 16h 29m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7555				2	37 9696			
1½	54·0175	0058	0360	–41·44	1	37 8146	8042	·0495	47·72
2	53·1220				2	11 9212	9096	·0582	–43 59
2	45·2833				2	11 5188			
1½	45 2691	·2594	0207	21·61					

Weighted mean . . . . –38·25
V_a 4 91
V_d 02
Curvature . . . . . – ·28

Radial velocity . . . . –33 0

θ AQUILÆ 1767.

1908. Aug. 5.
G. M. T. 17h 18m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7650				1	37·7837	7738	·0191	16·98
1	54 0152	·9958	·0260	+29·93	½	27·4480	·4226	·0100	8 68
2	53·1277				2	27·2720			
2	45·2725	·2545	·0158	16·50	½	11·9180	8968	·0454	+34 00
2	45·2916				2	11 5284			
2	37·9791								

Weighted mean . . . . +21·19
V_a . . . . – 4·91
V_d . . . . – ·09
Curvature . . . . – ·28

Radial velocity . . . . +15·9

θ AQUILÆ 1769.

1908. Aug. 5.
G. M. T. 18h 48m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0800				2	54 0263	·9743	0045	+ 5·18
½	72·9310	8618	0030	– 4·35	2	53·1625			
2	72·5112				2	45·3224			
2	54·7953				1	45·2968	·2476	0089	+ 9·29

Weighted mean . . . . + 5·00
V_a . . . . – 4·91
V_d . . . . ·19
Curvature . . . . – ·28

Radial velocity . . . . – 0 4

θ AQUILÆ 1776.

1908, Aug. 7.
G. M. T. 17h

Observed by T. H. PARKER.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0105	...	...	...	2	53·1270	...	...	...
½	72·8287	·8311	·0337	−48·90	2	45·2947	...	...	...
2	72·4393	...	...	...	1	45·2207	1994	·0393	41·03
2	54·7527	...	...	...	2	11·8727	·8100	·0414	−30·64
1½	53·9542	9413	·0285	32·80	2	11·5703	...	...	...

Weighted mean	−35·19
V_a	− 5·87
V_d	− ·08
Curvature	− ·28
Radial velocity	−41·4

θ AQUILÆ 1777.

1908. Aug. 7.
G. M. T. 17h 45m

Observed by T. H. PARKER.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0173	...	...	...	2	45·3157	...	...	...
½	72·8345	·8281	·0367	−53·25	1	45·2536	2117	0270	28·19
2	72·4482	...	...	...	1	27·4414	·3756	·0370	32·12
2	57·8521	...	...	...	2	27·3125	...	...	...
1	57·8257	·8028	·0240	28·90	1½	11·9090	8208	·0306	22·64
2	54·7686	...	...	...	2	11·5960	...	...	...
1½	53·9666	·9371	·0327	37·64	1	29·8450	·7881	·0428	−38·05
2	53·1442	...	...	...	2	29·6558	...	...	...

Weighted mean	−32·57
V_a	− 5·87
V_d	− ·14
Curvature	− ·28
Radial velocity	−38·9

θ AQUILÆ 1789.

1908. Aug. 17.
G. M. T. 18h 18m

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1½	57·8885	8148	·0120	13·81	2	45·3395	...	...	...
2	57·9031	...	...	...	1	45·2972	·2313	·0074	7·72
2	54·8125	...	...	...	2	38·0187	...	...	...
2	54·0320	9614	·0084	9·67	1	37·8079	·7484	·0063	−6·07
2	53·1826	...	...	...					

Weighted mean	− 9·78
V_a	−10·39
V_d	− ·21
Curvature	− ·28
Radial velocity	−20·7

θ AQUILÆ 1789.*

1908. Aug. 17.
G. M. T. 18h 18m

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	57·8769	....	....	....	1	45·2667	·2271	·0116	12·11
1	57·8580	·8105	·0163	−20·15	2	37·9966	....	....	....
2	54·7899	....	....	....	1	37·7900	·7526	·0021	2·02
2½	54·0078	·9618	·0080	9·21	½	29·8666	·8260	·0049	− 4·36
2	53·1557	....	....	....	2	29·6395	....	....	....
2	45·3130	....	....	....					

Weighted mean	− 9·91
V_a	−10·39
V_d	− ·21
Curvature	− ·28
Radial velocity	−20·8

* Inadvertently remeasured.

θ AQUILÆ 1794*.

1908. Aug. 19.
G. M. T. 16h 45m

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	111·6998	....	....	....	2	68·7143	....	....	....
½	111·3210	·1330	·0193	−11·19	2	63·3902	....	....	....
2	110·2983	....	....	....	4	61·2072	·2159	·0286	11·75
2	71·8920	....	....	....	2	60·3880	....	....	....
1	71·8568	·8664	·0392	17·29	2	36·0921	....	....	....
½	69·5153	·5373	·0155	6·73	½	35·9450	·9631	·0427	−14·90

Weighted mean	−12·41
V_a	−11·21
V_d	− ·12
Curvature	− ·28
Radial velocity	−24·0

* Plate made with three-prism spectrograph.

θ AQUILÆ 1799.

1908. Aug. 20.
G. M. T. 15h 15m

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9899	.....	.....	.....	2	45·2480	·2644	·0257	+26 83
½	72·8610	8811	0163	+23·65	2	37 9470	.....	.....	.....
2	72·4241	.....	.....	.....	1	37.7533	·7655	·0108	+10·41
2	57·8022	.....	.....	.....	1	29·6165	·6164	·0175	+15·56
1	57·8095	8387	0119	−14·33	2	29.5990	.....	.....	.....
2	54·7204	.....	.....	.....	½	27·4145	·4051	·0075	6·51
2	53·9533	·9751	·0053	+ 6·11	2	27·2560	.....	.....	.....
2	53 0898	.....	.....	.....	?½	11·8457	·8229	0185	−13·90
2	45·2572	.....	.....	.....	2	11·5300	.....	.....	.....

Weighted mean		+12·45
V_a	−11·63	
V_d	·00	
Curvature	− ·28	
Radial velocity		+ 0·4

θ AQUILÆ 1800.

1908. Aug. 20.
G. M. T. 15h 47m

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0033	.....	.....	.....	1½	45·2531	·2537	·0150	+15·66
½	72 8582	·8648	·0000	0·00	1	27·4586	·4290	·0164	+14·23
2	72·4383	.....	.....	.....	2	27·2762	.....	.....	.....
2	54·7375	.....	.....	.....	2	11·9005	·8700	·0186	+13·93
1	53·9710	·9747	0049	+ 5 64	1	59·8045	.....	.....	.....
2	53·1090	.....	.....	.....	1	59·6690	·6736	·0009	− 1·23
2	45·2729	.....	.....	.....					

Weighted mean	+10 00	
V_a		−11·63
V_d		− ·05
Curvature		− ·28
Radial velocity		− 2·0

θ AQUILÆ 1801.

1908. Aug. 20.
G. M. T. 16ʰ 42ᵐ

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7354	....	....	....	1	29·6294	·6194	·0205	18·24
2	53·9787	·9881	·0183	+21·06	2	29·6095	....	....	....
2	53·0997	....	....	....	1	27·4557	·4361	·0235	20.39
2	45·2665	....	....	....	2	27·2662	....	....	....
1½	45·2453	2524	0137	14·30	½	11·8902	·8614	·0100	+ 7·49
2	29·9322	....	....	....	2	11·5362	....	....	....
1	29·8670	·8575	·0266	23·67					

Weighted mean..............		+18·52
V_a	−11·63	
V_d	− ·12	
Curvature..............	− ·28	
Radial velocity..............		− 6·5

θ AQUILÆ 1807.

1908. Aug. 21.
G. M. T. 13ʰ 57ᵐ

Observed by J. B. CANNON.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0196	....	....	....	¾	45·3011	·2689	·0302	31·52
¼	72·9000	·8880	·0232	−33·66	2	29·6480	....	....	....
2	72·4635	....	....	....	1	29·9315	·8830	·0521	46·32
2	54·7685	....	....	....	?¼	27·4940	·4406	·0280	24·30
1½	54·0400	·0124	·0426	49·03	2	27·3002	....	....	....
2	53·1406	....	....	....	?¼	11·9607	·8964	·0410	+30·71
2	45·3058	....	....	....	2	11·5717	....	....	....

Weighted mean		+41·42
V_a	−12·04	
V_d	− ·11	
Curvature..............	− ·28	
Radial velocity..............		+28·7

θ AQUILÆ 1808.

1908. Aug. 21.
G. M. T. 14h 32m

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9966	.....	.....	.....	2	45·2823	.....	.....	.....
½	72·8700	·8818	·0170	+24·67	1	45·2779	·2692	·0305	31·84
2	72·4343	.....	.....	.....	2	37·9791	.....	.....	.....
2½	57·8783	·8783	·0515	62·00	1	37·8077	·7978	·0431	41·55
2	57·8294	.....	.....	.....	½	27·4542	·4226	·0100	8·68
2	54·7475	.....	.....	.....	2	27·2782	.....	.....	.....
1½	54·0150	·0110	·0412	47·42	1	11·9453	·9014	·0500	+37·45
2	53·1145	.....	.....	.....	2	11·5512	.....	.....	.....

Weighted mean		+38·27
V_a	−12·04	
V_d		+ ·06
Curvature	·28	
Radial velocity		+26·0

θ AQUILÆ 1810.

1908. Aug. 21.
G. M. T. 15h 28m

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7201	.....	.....	.....	2	29·5981	.....	.....	.....
3	53·9840	·0054	·0356	+40·97	2½	27·4505	·4459	·0333	28·90
2	53·0910	.....	.....	.....	2	27·2512	.....	.....	.....
2	45·2620	.....	.....	.....	½	11·8967	·8831	·0317	+23·74
2	45·2523	·2659	·0272	28·40	2	11·5218	.....	.....	.....
½	29·8745	·8753	·0414	39·47					

Weighted mean		+34·73
V_a	−12·04	
V_d	− ·02	
Curvature	− ·28	
Radial velocity		+22·4

θ AQUILÆ 1811.

1908. Aug. 22.
G. M. T. 15h 29m

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9587	....	....	....	2	45·2600	. ...	....	....
½	72·8387	·8901	·0253	+36·71	1	45·2775	·2911	·0524	54·70
2	72·3930	....	....	....	1	27·4871	·4580	·0454	39·43
2	54·7138	... .	....	....	2	27·2762	....	....	....
2	53·9876	·0134	·0436	50·18	2	11·9679	·9170	·0656	+49·13
2	53·0885	. .. ...	....	....	2	11·5587	... .	....	....

Weighted mean............ ... . +47·86
V_a .... −12·50
V_d .... − ·03
Curvature... .... − ·28

Radial velocity............... . .... +35 0

θ AQUILÆ 1812.

1908. Aug. 22.
G. M. T. 15h 56m

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9892	....	....	....	2	45·2531	....	....	......
½	72·8897	·9116	·0468	+67·91	1	45·2633	·2838	·0451	47·08
2	72·4190	.. ....	.. ... .	... .	¾	27·5378	·4728	·0602	52·25
2	54·7430	....	....	....	2	27·3121	.. ..	....	....
1	54·0200	·0182	·0484	55·71	2	12·0073	·9163	·0649	+48·61
2	53·1145	....	.. . .	....	2	11·5988	....	... .	....

Weighted mean.................... ... .. +52·03
V_a.... .... −12·50
V_d .... − 08
Curvature............. − ·28

Radial velocity .... +39·1

θ AQUILÆ 1813.

1908. Aug. 22.
G. M. T. 16ʰ 21ᵐ

Observed by, Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9817				2	45·2804			
½	72·8487	·8779	·0131	+19·01	1	45·2807	·2739	·0352	36·75
2	72·4145				½	29·7215	·6886	·0897	79·74
½	57·8665	·8839	·0571	68·75	2	29·6318			
2	57·8120				½	27·4825	·4387	·0221	19·18
2	54·7342				2	27·2904			
1	54·0030	·0118	·0420	48·34	2½	11·9879	·9218	·0704	+52·73
2	53·1022				2	11·5733			

Weighted mean	+47·73
V_a	−12·50
V_d	− ·11
Curvature	− ·28
Radial velocity	+34·8

θ AQUILÆ 1814.

1908. Aug. 23.
G. M. T. 15ʰ 48ᵐ

Observed by, Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0102				2	53·1312			
½	72·8535	·8541	·0103	−14·94	2	45·3009			
2	72·4415				1	45·2574	·2301	·0086	8·98
2	57·8425				1	27·4527	·3856	·0270	23·44
1	57·8224	8093	·0175	21·07	2	27·3137			
2	54·7607				2	11·9226	·8286	·0228	−17·08
2	53·9771	·9581	·0117	13·47	2	11·6012			

Weighted mean	−16·27
V_a	−12·95
V_d	− ·08
Curvature	− ·28
Radial velocity	−29·6

θ AQUILÆ 1815.

1908. Aug. 23.
G. M. T. 16h 18m

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0307				1½	45·2666	·2192	·0195	20·36
½	72·8645	·8438	·0210	30·47	2	38·0157			
2	72·4655				½	37·7910	·7348	·0199	19·18
2	57·8525				½	29·6320	·5663	·0336	29·87
1½	57·8167	·7936	·0332	39·97	2	29·6646			
2	54·7766				2½	27·4726	·4035	·0091	7·90
1½	54·0057	·9686	·0012	1·38	2	27·3157			
2	53·1516				2	11·9125	·8329	·0185	−13·86
2	45·3210				2	11·5870			

Weighted mean	−19·30
V_a	−12·95
V_d	− ·10
Curvature	− ·28
Radial velocity	−32·6

θ AQUILÆ 1822.

1908. Aug. 24.
G. M. T. 16h 51m

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0206				3	45·2872			
1	72·8615	·8505	·0143	−20·75	1½	45·2305	·2169	·0218	22·76
2	72·4567				2	37·9830			
2	57·8371				1	37·7598	·7360	·0187	18·03
1	57·8167	·8090	·0178	21·43	1	27·4280	·3884	·0232	20·14
2	54·7477				2	27·2862			
2	53·9567	·9471	·0227	26·13	2½	11·8689	·8272	·0242	−18·12
2	53·1254				2	11·5489			

Weighted mean	−21·20
V_a	−13·40
V_d	− ·16
Curvature	− ·28
Radial velocity	−35·0

θ AQUILÆ 1835.

1908. Aug. 27.
G. M. T. 14h 02m

Observed by } J. B. CANNON.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73 0129	......	......	......	2	45·2808	......	......	......
½	72 8466	·8451	0197	−28·58	1½	45·2153	·2081	·0306	31·95
1	72 4418	......	......	......	1	27·3961	·3662	·0536	45·42
2	54·7388	......	......	......	2	27·2768	......	......	......
1	53 9403	9413	·0285	32 80	1	11·8524	·8125	·0389	−29 14
2	53 1131	......	......	......	2	11·5472	......	......	......

Weighted mean........	−33·92
V_a	−14·56
V_d	− ·06
Curvature	− ·28
Radial velocity........	−48 8

θ AQUILÆ 1864.

1908. Sept. 3.
G. M. T. 16h 17m

Observed by J. S PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73 0322	......	......	......	1½	45 2772	2317	0070	7·33
1	72·8740	8526	0122	17 73	2	29·9972	......	......	......
2	72 4635	......	......	......	1½	29·8930	·8174	0135	12·08
2	57 8686	......	......	......	1	29·6557	·5860	·0129	11·49
½	57 8351	·7959	·0309	37·26	2	29·6787	......	......	......
2	54 7801	......	......	......	1	27·4700	·3816	·0310	27·03
2½	54·0005	·9616	0082	9·46	2	27·3355	......	......	......
2	53 1516	......	......	......	1½	11·9352	8254	·0260	−19·58
2	45·3191	......	......	......	2	11 6205	......	......	......

Weighted mean........	−14·96
V_a	−17·37
V_d	− ·16
Curvature	− ·28
Radial velocity........	−32·8

θ AQUILÆ 1864.*

1908. Sept. 3.
G. M. T. 16h 17m

Observed by J. S. Plaskett.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9854	....	....	....	2	45 2737	....	....	....
½	72·8295	·8541	·0107	−15·52	1	45·2348	·2347	·0040	4·16
2	72·4198	....	....	....	½	29·8500	·8107	·0202	17·80
2	57·8199	....	....		2	30·9097	....	....	....
½	57·8027	·8122	·0172	20·70	1	29·6055	5660	·0181	16·05
2	54·7376	....	....	....	1	11·8883	·8258	·0256	−19·17
1½	53·9573	·9618	·0080	9·20	2	11·5697	....	....	....
2	53·1065	....	....	....					

Weighted mean..	−15·34
V_a ..	−17·37
V_d	− ·16
Curvature	− ·28
Radial velocity	−33·1

* Independent measurement.

θ AQUILÆ 1875.

1908. Sept. 8.
G. M. T. 12h 42m

Observed by J. S. Plaskett.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73 0022	....	....	....	2	45 2770	....	....	....
½	72·8789	·8850	·0202	+29·31	1½	45·3101	·3067	·0680	70·99
1	72·4437	....	....	....	1	27·5014	·4694	·0568	49·34
2	54·7440	....	....	....	2	27·2778	....	....	....
1	54·0395	·0356	·0658	75·73	1	12·0038	·9496	·0982	−73·55
2	53·1178	....	....	....	2	11·5614	....	....	....

Weighted mean........		+67·85
V_a	−17·08	
V_d		− ·09
Curvature........	− ·28	
Radial velocity...........		+50·6

θ AQUILÆ 1875*.

1908. Sept. 8.
G. M. T. 12h 42m

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7676	....	....	....	2	29·6453	....	....	....
2	54·0485	·0218	·0520	+59·85	1½	29·7430	·6966	·0977	86·66
2	53·1396	....	....	....	1	12·0185	·9417	·0903	+67·63
2	45·3024	....	....	....	2	11·5840	....	....	....
1½	45·3295	·3007	·0620	64·73					

Weighted mean.................... +69·07
V_a .... −17·08
V_d ... . + ·09
Curvature..... − ·28

Radial velocity......... .. .... +51·8

* Check measurement.

θ AQUILÆ 1876.

1908. Sept. 8.
G. M. T. 13h 40m

Observed by J. S. PLASKETT.
Measured by T. H. PARKER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0136	....	....	....	1½	45·3045	·3014	·0627	65·45
½	72·9175	·9105	·0457	+66·31	1	27·5001	·4706	·0580	50·34
2	72·4645	....	....	....	2	27·2761	....	....	....
2	54·7428	....	....	....	1½	11·9869	·9574	·1060	+79·39
1½	54·0359	·0350	·0652	75·04	2	11·5444	....	....	....
2	45·2767	....	....	....					

Weighted mean..... .... +68·88
V_a ... . −17·08
V_d .. .. ·00
Curvature..... − ·28

Radial velocity............ .... +51·5

θ AQUILÆ 1878.

1908. Sept. 11.
G. M. T. 15h

Observed by J. B. CANNON.
Measured by T. H. PARKER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0192	....	....	....	2	45·2692	....	....	....
½	72·8480	·8396	·0252	−36·56	1	45·2233	·2277	·0110	11·48
2	72·4503	....	....	....	1	27·3789	·3712	·0414	35·93
2	54·7399	....	....	....	2	27·2541	....	....	....
2	53·9497	·9515	·0183	21·06	1½	11·8400	·8283	·0231	17·30
2	53·1104	....	....	....	2	11·5249	....	....	....

Weighted mean .... −22·29
V_a ... . −20·21
V_d .... − ·09
Curvature... ... ... − ·28

Radial velocity .... −47·7

P.—Plaskett.
H.—Harper.
C.—Cannon.
Pl—Parker.
T.—Tribble.

OBSERVING RECORD AND DETAILED MEASURES OF ε HERCULIS.

RECORD OF SPECTROGRAMS.

Star.	No. of Negative.	Camera.	Plate.	Date.	Middle of Exposure G. M. T.	Duration.	Hour Angle at end.	Temperature Centigrade. Room. Beginning.	Room. End.	Prism Box. Beginning.	Prism Box. End.	Slit Width.	Seeing.	Observer.	Remarks.
				1907.	h. m.	m.	h. m.								
ε Herculis..	786	IL.	Seed 27 ..	May 24..	18 25	20	0 40 W.	8·5	9·5	16·4	16·4	·001	Fair..	P	
" ..	801	"	"	" 31..	17 38	20	25 W.	12·7	12·6	18·8	18·8	·001	Good. ...	P	
" .	810	"	" ..	June 8..	19 28	30	2 45 W.	13·0	13·0	16·9	16·8	·001	....	P	
" .	816	"	" ..	" 10..	17 47	35	1 20 W.	13·1	12·8	17·9	17·9	·001	Good.....	P	
" .	827	"	" ..	" 11..	15 39	26	55 E.	15·6	15·5	19·1	19·1	·001	"	H	
" .	838	"	" ..	" 12..	18 35	30	2 10 W.	15·4	15·2	19·0	18·9	·0012	Fair.....	P	
" .	847	"	" ..	" 13..	18 25	10	1 55 W.	19·0	19·0	25·8	25·8	·0015	"	H	
"	851	"	" ..	" 14.	17 43	34	1 30 W.	20·5	19·8	23·1	23·1	·0012	Good. ...	P	
" ..	862	"	" ..	" 20..	16 37	31	46 W.	21·5	21·0	25·4	25·4	·0012	"	H	
" ..	871	"	" ..	" 21.	18 10	35	2 25 W.	23·1	22·6	29·0	29·0	·001	....	P	
" ..	881	"	" ..	" 25..	16 04	28	30 W.	23·8	23·8	27·3	27·3	·0012	Good.....	H	
" .	893	"	" ..	" 27.	16 32	35	1 10 W.	20·9	20·0	24·5	24·5	·0012	Fair..	H	
"	913	"	" ..	July 4.	16 18	40	1 25 W.	20·0	19·5	28·6	28·4	·0012	Poor. ..	H	
" .	920	"	" ..	" 8..	16 00	35	1 30 W.	21·2	21·2	22·4	22·4	·0012	Fair.....	P	
"	928	"	" ..	" 9.	15 15	38	40 W.	22·2	22·2	24·8	24·8	·0012	Good.....	T	
" .	937	"	" ..	" 10..	14 55	70	40 W.	24·5	23·6	24·7	24·6	·0012	Poor.	P	
" .	952	"	"	" 18..	16 10	60	2 22 W.	22·5	22·5	28·5	28·3	·0014	Hazy	H	
" .	957	"	" .	" 20..	16 39	32	2 45 W.	18·6	18·8	21·5	21·5	·0012	Good....	P	
" .	976	"	" ..	Aug. 1..	17 20	50	4 24 W.	20·0	20·0	24·8	24·8	·0012	Very hazy	T	
"	979	"	" ..	" 3.	13 28	34	30 W.	20·8	20·3	24·1	24·0	·0012	.....	P	
" .	987	"	" .	" 6.	17 35	80	5 13 W.	19·4	18·0	23·3	23·3	·0013	Poor.....	T	
" ..	1018	"	" .	" 22..	15 49	53	4 15 W.	18·5	18·0	24·2	24·2	·0014	Fair......	H	
"	1062	"	" ..	Sept. 20.	14 37	45	4 54 W.	22·3	22·3	22·9	22·8	·0014	Poor..	H	
				1908.											
" .	1391	"	" .	Mar. 9.	20 50	60	1 31 E.	12·5	13·0	1·0	1·0	·0013	.	H	
" ..	1403	"	"	" 16..	21 42	50	16 E.	13·0	13·5	2·3	2·3	·0014	Good.....	H	
" .	1483	"	" ..	Apr. 13..	21 35	60	1 36 W.	– 0·5	1·5	8·0	8·0	·0018	Poor.....	H	

"	.	1494	"	"	"	15	20	40	41		40 W.	3·6	2·6	7·6	7·6	·0015	Good	P
"		1511	"	"	"	22	20	33	40	1	00 W.	5·2	3·5	12·5	12·6	·0017	"	P
"	..	1531	"	"	May	15	19	29	48	1	28 W.	13·0	11·5	17·8	18·0	·0017	"	H
"	..	1540	"	"	"	18	18	25	40		36 W.	16·6	16·5	23·4	23·4	·0016	Fair	P^1
"	..	1545	"	"	"	20	17	15	70		15 W.	18·0	16·9	21·0	21·0	·0016	St'dy, hazy	P
"	.	1547	"	"	"	22	18	28	57		58 W.	20·0	20·0	25·0	25·0	·0017	Fair	P^1H
"	..	1567	"	"	June	1	19	30	40	2	45 W.	13·6	12·5	21·2	21·2	·0015	"	P^1
"	..	1573	"	"	"	3	17	56	62	1	15 W.	14·2	13·7	18·3	18·3	·0015	"	P-H
"	.	1582	"	"	"	5	18	40	60	2	15 W.	16·6	15·5	24·5	24·5	·0016	"	P^1
"	.	1603	"	"	"	12	18	35	60	2	35 W.	17·0	15·7	24·9	24·9	·0017	Good	P^1
"	.	1625	"	"	"	22	17	27	65	2	00 W.	18·0	17·6	23·8	23·8	·0015	"	P
"	.	1630	"	"	"	24	16	27	45	1	00 W.	21·5	20·5	27·5	27·6	·0015	"	P
"		1640	"	"	"	26	16	46	53	1	43 W.	20·0	17·7	30·0	30·0	·0016	"	H.C
"	..	1648	"	"	"	27	17	07	55	2	00 W.	20·5	19·8	23·8	23·7	·0014	Fair	P
"		1653	"	"	July	1	16	15	80	1	30 W.	23·5	21·0	25·8	26·8	·0015	Cloudy	P
"	.	1658	"	"	"	3	16	18	69	1	40 W.	21·9	21·5	25·4	25·4	·0016	Good	H
"		1661	"	"	"	3	19	40	60	5	05 W.	20·0	19·5	25·1	25·1	·0016	Hazy	P^1
"	..	1666	"	"	"	6	17	35	60	3	00 W.	25·8	23·6	26·4	26·4	·0015	Good	P.P½
"	.	1675	"	"	"	8	15	47	40	1	15 W.	19·0	18·0	21·8	21·6	·0015	"	C
"	..	1676	"	"	"	8	16	32	45	2	05 W.	18·0	17·5	21·6	21·6	·0015	"	C
"	..	1682	"	"	"	9	17	12	50	2	47 W.	20·0	19·7	21·5	21·5	·0015	"	H
"	..	1685	"	"	"	10	14	37	60		22 W.	24·5	24·0	27·5	27·4	·0016	"	C
"	..	1686	"	"	"	10	15	34	52	1	12 W.	24·0	22·5	27·4	27·3	·0016	"	H
"	..	1693		"	"	11	16	58	53	2	45 W.	27·5	26·5	30·1	29·9	·0015	Fair	P
"	..	1699	"	"	"	13	16	19	52	2	15 W.	19·6	19·5	23·1	23·1	·0015	"	P
"	..	1707	"	"	"	14	17	42	48	3	37 W.	20·5	20·0	20·6	20·6	·0016	Good	H
"	..	1712	"	"	"	15	17	00	40	2	55 W.	17·0	16·3	21·6	22·3	·0015	"	C
"	..	1713	"	"	"	15	17	45	40	3	40 W.	16·3	15·0	22·3	22·0	·0015	"	H
"	..	1719	"	"	"	16	17	25	43	3	26 W.	18·0	17·0	19·6	20·0	·0015	"	H
"	..	1720	"	"	"	22	17	00	145	5	00 W.	22·6	21·0	24·7	24·7	·0015	Very poor	P-H
"	.	1723	"	"	"	24	14	00	60		40 W.	24·0	23·0	26·3	26·2	·0016	Fair	H
"		1728	"	"	"	25	17	29	85	4	30 W.	20·6	20·5	24·6	24·5	·0015	Poor	P
"		1729	"	"	"	26	16	58	47	3	40 W.	23·0	22·0	23·6	23·6	·0015	Good	H
"	.	1734	"	"	"	28	17	12	45	4	02 W.	24·0	25·0	29·8	29·8	·0016	"	H
"	.	1737	"	"	"	29	14	22	55	1	20 W.	27·5	27·0	30·3	30·2	·0015	Hazy	P
"	.	1738	"	"	"	29	15	08	30	1	53 W.	27·0	26·6	30·2	30·2	·0015	Fair	P
"	.	1743	"	"	"	29	18	05	60	4	58 W.	25·6	25·0	30·1	30·0	·0015	"	P-C
"		1746	"	"	"	30	17	06	33	4	00 W.	27·0	26·0	31·1	31·1	·0015	"	H
"	..	1751	"	"	"	31	15	40	39	2	40 W.	21·0	20·0	26·0	26·0	·0015	Good	P^1
"	.	1757	"	"	"	31	19	05	60	6	14 W.	18·5	17·0	25·6	25·3	·0015	"	H
"	..	1760	"	"	Aug.	1	16	49	82	4	15 W.	20·6	20·4	23·2	23·2	·0015	Fair	P
"	..	1761	"	"	"	5	14	05	50	1	30 W.	22·6	22·6	27·0	27·0	·0015	"	P
"	..	1774	"	"	"	7	15	35	80	3	25 W.	20·2	19·1	23·6	23·6	·0015	Very hazy	P^1
"	..	1782	"	"	"	15	16	50	50	4	50 W.	18·6	18·0	22·8	22·6	·0015	Fair	P
"	..	1793	H.H.L.	"	"	19	14	41	98	3	17 W.	16·5	14·5	23·8	23·6	·002	"	H
"	..	1818	H.L.	"	"	24	14	03	52	2	45 W.	17·5	17·0	23·3	23·2	·0015	Good	H
"	..	1838	"	"	"	27	15	50	45	4	36 W.	17·0	16·3	23·0	22·8	·0015	"	C
"	..	1841	"	"	"	28	14	07	45	3	00 W.	18·5	17·0	23·2	23·2	·0015	"	C
"	.	1853	"	"	"	31	13	52	46	2	55 W.	24·0	22·0	28·0	27·8	·0015	Fair	H
"	..	1866	"	"	Sept.	4	14	32	56	3	53 W.	19·3	18·8	23·5	23·4	·0015	"	C

P.—Plaskett.
H.—Harper.
C.—Cannon.
P[1]—Parker.
T.—Tribble.

RECORD OF SPECTROGRAMS—*Concluded.*

Star.	No. of Negative.	Camera.	Plate.	Date.	Middle of Exposure G. M. T.	Duration.	Hour Angle at end.	Temperature Centigrade. Room. Beginning.	Room. End.	Prism Box. Beginning.	Prism Box. End.	Slit Width.	Seeing.	Observer.	Remarks.
				1908.	h. m.	m.	h. m.								
c Herculis..	1903	H.	Seed 27...	Oct. 1..	13 12	60	4 30 W.	13·5	12·5	19·0	18·8	·0015	Bad......	H	
" ..	1905	"	"	" 2..	12 23	44	3 40 W.	9·2	8·0	13·2	13·1	·0015	Clear	P[1]	
" ..	1906	"	"	" 2.	13 18	44	4 30 W.	8·0	7·3	13·1	13·0	·0015	Good.....	P[1]	
" ..	1917	"	"	" 5.	12 45	50	4 10 W.	9·7	8·5	14·5	14·5	·0015	Hazy	P[1]	
" ..	1926	"	"	" 12..	14 15	60	6 25 W.	5·9	5·5	6·6	7·2	·0016	Good.....	P[1]	
" .	1961	"	"	Nov. 13..	10 33	53	4 32 W.	3·5	3·0	8·3	7·3	·0015	"	H	
" .	1983	"	"	" 26..	10 07	45	4 52 W.	11·0	12·0	12·0	13·0	·0016		H	
" ..	1993	"	"	Dec. 2..	11 05	57	6 15 W.	− 7·5	8·2	2·0	− 2·0	·0016	Windy ..	C	
				1909.											
" ..	2263	"	"	Feb. 8..	22 08	45	2 12 E.	−19·0	−18·0	5·3	−5·1	·0016	Fair .	H	
" ..	2264	"	"	" 8..	23 00	56	1 15 E.	18·0	−19·0	−5·1	−5·0	·0016	"	H	
" .	2305	"	"	" 22..	21 34	62	1 45 E.	6·0	−7·8	0·8	0·6	·0016	"	C	
" ..	2306	"	"	" 22..	22 36	60	43 E.	−7·8	−7·5	0·6	0·6	·0016	" ...	C	
" ..	2327	"	"	Mar. 3.	21 12	75	1 25 E.	5·8	−6·4	−0·6	−0·7	·0016	"	C	
" ..	2328	"	"	" 3..	22 26	68	10 E.	−6·4	−6·4	−0·7	−0·7	·0016	Poor.....	C	
" ..	2370	I.	"	" 13..	18 55	30	3 25 E.	2·0	1·9	3·0	2·9	·002	Fair	P	
" ..	2371	"	"	" 13..	19 23	24	3 00 E.	−1·9	−2·0	2·9	2·8	·002	"	P	
" ..	2384	"	"	" 15..	19 32	27	2 29 E.	5·0	5·2	−0·8	−1·2	·002	Good.....	H	
" ..	2385	"	"	" 15..	20 00	27	2 13 E.	−5·2	−5·0	−1·2	−1·2	·002	"	H	
" ..	2454	"	"	" 31..	20 05	30	1 00 E.	1·0	0·6	9·8	9·8	·002	"	C	
" ..	2455	"	"	" 31..	20 39	32	25 E.	0·6	0·0	9·8	9·7	·002	" ...	C	

ε HERCULIS 786.

1907. May 24.
G. M. T. 18^h 25^m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected wave length.	Normal wave length.	Displacement in revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected wave length.	Normal wave length.	Displacement in revolutions.	Velocity.
2	73·9685	4891·134	....	.....	.....	....	3	52·5955	4460·292	......	.....	.....	....
1½	73·1420	4871·413	......	......	......	......	3	47·6274	4379·348	.....	.....	.....	....
2	72·6821	4860·564	·607	·527	·920	−56·76	2	45·0505	4339·626	·714	·634	·920	−63·48
2	56·5256	4528·760	...	..	......	....	3	44·1325	4325·827	.....	.....	....	....
½	53·8061	4480·945	·985	·400	·415	−27·76							

Weighted mean...... .... −56·53
V_a .... + 1·45
V_d .... − ·04
Curvature .... − ·28

Radial velocity...... . ..... −55·4

ε HERCULIS 801.

1907. May 31.
G. M. T. 17^h 38^m

Observed by J. S. Plaskett.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0174	... .	....	....	1	53·9504	·9078	·0620	71·36
2	72·8193	·8105	·0543	−78·79	2	53·1565	....	....	....
2	72·4559	....	. ...	....	2	45·2192	·1557	·0830	−86·65
2	54·7825	....	....	. ...	2	45·3368	....	....	... .

Weighted mean................ ... −80·45
V_a .... − ·68
V_d .... − ·02
Curvature.................. − ·28

Radial velocity........... ..... −81·4

ε HERCULIS 810.

1907. June 8.
G. M. T. 19^h 28^m

Observed by J. S. Plaskett.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9982	....	....	....	3	53·9506	·8942	·0756	−87·02
1	72·8130	·8281	·0367	−53·25	2	53·1734	... .	....	....
2	72·4367	....	....	....	2	45·3626	. .. .	....	... .
2	54·7931	.... . .	... .	....	1	45·2450	·1556	0831	−86·76

Weighted mean... .... −80·21
V_a .... − 3·00
V_d ... . − ·19
Curvature............... .. − ·28

Radial velocity... . ... −83·7

ε HERCULIS 816.

1907. June 10.
G. M. T. 17h 47m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected wave length.	Normal wave length.	Displacement.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected wave length.	Normal wave length.	Displacement.	Velocity.
2	73 3707	4875·671					1½	53·2681	4470·617				
1½	72·9235	4865·085					2	45·2728	4341·820				
1	72 7904	4861·951	807	·527	·320	+19 74	2	45·2356	4341·256	·594	·634	·040	− 2·76
2	54 3881	4489·915					½	27·4999	4102 238	·106	890	·216	+15 60
1	53·9850	4482·931	·150	400	·750	+50·17	3	27·3170	4100·053				

Weighted mean. −16·04
V_a − 3·57
V_d − ·07
Curvature − ·28

Radial velocity +12 7

ε HERCULIS 827.

1907. June 11.
G. M. T. 15h 39m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9503				1	54·0175	·0146	0448	−51·56
1	72·8122	·8724	·0076	+11·02	3	45·3037			
2	72 3825				½	45·2540	·2237	·0150	−15·66
2	54 0317								

Weighted mean. −21·90
V_a −3 86
V_d − ·07
Curvature − ·28

Radial velocity −17 8

ε HERCULIS 838.

1907. June 12.
G. M. T. 18h 35m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions	Velocity.
2	72 9986				2½	45·2585	·1957	·0430	44·89
1½	72·8160	·8258	·0390	−56·59	2	45·3356			
2	72·4380				½	27·4375	·3116	·1010	−87·67
2	54·0675				2	27·3726			
½	53·9500	·9113	·0585	67·33					

Weighted mean. −54 93
V_a − 4·15
V_d − ·14
Curvature − ·28

Radial velocity −59·5

ε HERCULIS 838.

1907. June 12.
G. M. T. 18ʰ 35ᵐ

Observed by J. S. Plaskett.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	72·9608	......	......	......	1	45·2100	·1853	·0534	55·74
1	72·7742	·7756	·0392	−56·87	2	43·5655	......	......	......
1½	72·3915	......	......	......	½	27·4011	·3175	·0951	82·54
2	45·2982	......	......	......	2	27·33 3	......	......	......

Weighted mean.................. −61·55
V_a .... − 4·15
V_d .... − ·14
Curvature .... − ·28

Radial velocity .... −66·1

The mean of the two measurements, −61·7 used.

ε HERCULIS 847.

1907. June 13.
G. M. T. 18ʰ 25ᵐ

Observed by W. E. Harper.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7738	......	......	......	2	45·3226	......	......	......
2	53·9268	·8948	0750	−86·32	2	45·1962	·1472	·0915	−95·52
2	53·1442	......	......	......					

Weighted mean .... −90·87
V_a .... 4·43
V_d .... − ·16
Curvature .... ·28

Radial velocity .... 95·7

ε HERCULIS 847.

1907. June 13.
G. M. T. 18ʰ 25ᵐ

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72 9662	......	......	......	1	52·2373	......	......	......
½	72·7752	·8186	·0462	−67·03	2	48·7615	......	......	......
1	72·4080	......	......	......	½	45·2105	·2068	·0319	−33·30
1	54·0198	......	......	......	1	45·2774	......	......	......
1	53·8890	·8990	·0708	−81 48					

Weighted mean.................. −65 82
V_a .... − 4·43
V_d .... ·16
Curvature .... − ·28

Radial velocity .... −70·7

Mean of two measurements, −83·2 used.

ε HERCULIS 851.

1907. June 14.
G. M. T. 17h 43m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Measured Wave Length.	Normal wave length.	Displacement.	Velocity.	Wt.	Mean of Settings.	Measured Wave Length.	Normal wave length.	Displacement.	Velocity.
2	73·3997	4875·675	.....	.....	.....	1½	53·9475	4482·744	·400	·344	+23·74
1½	72·9468	4864·956	.....	.....	.....	2	45·2453	4341·337	.....	.....	.....
1	72·8165	4861·887	.527	·360	+22·21	1½	45·2036	4340·534	·634	·100	− 6·90
1	72·3854	4851·790	.....	.....	.....	1	27·4152	4101·900	·890	·010	+ 0·73
1	53·9856	4482·656	.....	.....	.....	2	27·2529	4099·650	.....	.....	.....

Weighted mean .... + 9·64
V_a .... − 4·72
V_d .... − ·09
Curvature .... − ·28

Radial velocity .... + 4·5

ε HERCULIS 851.

1907. June 14
G. M. T. 17h 43m

Observed by J. S. Plaskett.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0227	.....	.....	.....	1	53·1210	.....	.....	.....
1	72·8756	·8898	·0250	+36·27	½	45·2536	·2267	·0120	−12·52
½	72·4630	.....	.....	.....	2	45·3006	.....	.....	.....
1	54·7568	.....	.....	.....	2	27·2977	.....	.....	.....
1	54·0085	·9991	·0293	+33·72	1	27·4617	·1108	·0018	− 1·56

Weighted mean .... +17·76
V_a .... − 4·72
V_d .... − ·09
Curvature .... − ·28

The mean of two measurements, +7·0 used.

Radial velocity .... +12·7

ε HERCULIS 862.

1907. June 20,
G. M. T. 16h 37m

Observed by W. E. Harper.
Measured by J. N. Tribble.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1½	72·9908	.....	.....	.....	2	53·1120	.....	.....	.....
2	72·4301	.....	.....	.....	2	45·2676	.....	.....	.....
1	72·8461	·8644	·0004	− 0·29	1	45·1917	1977	·0410	−42·79
2	54·7464	.....	.....	.....	2	27·2746	.....	.....	.....
½	53·9312	·9290	·0408	−46·96	¼	27·3742	·3462	·0764	−57·70

Weighted mean .... − 31·26
V_a .... − 6·33
V_d .... − ·07
Curvature .... − ·28

Radial velocity .... −37·9

ε HERCULIS 862.

1907. June 20.
G. M. T. 16h 37m

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions	Velocity.
1	73·0166				1	45·2182	·1950	·0437	45·62
1	72·8604	·8527	·0121	−17·55	2	43·5599			
2	72·4557				1	27·4358	·3833	·0293	−25·43
2	45·2969				2	27·2991			

Weighted mean	−27·53
V_a	− 6·33
V_d	− ·07
Curvature	− ·28
Radial velocity	−34·2

Mean of measurements,—34·5 used.

ε HERCULIS 871.

1907. June 21.
G. M. T. 18h 10m

Observed by J. S. Plaskett.
Measured by J. N. Tribble.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1½	72·9582				1½	45·1420	·1655	·0732	76·39
2	72·3957				1½	27·2546			
1½	72·7847	·8357	·0291	−42·22	½	27·3658	·3578	·0641	−55·63
2	45·2501								

Weighted mean	−58·78
V_a	− 6·49
V_d	− ·19
Curvature	− ·28
Radial velocity	−65·7

ε HERCULIS 881.

1907 June 25.
G. M. T. 16h 04m

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	49·4200				½	27·3185	·3189	·1030	−89·40
1	45·2146	·1775	·0612	−63·89	1	27·2462			
2	44·2931								

Weighted mean	−72·40
V_a	− 7·64
V_d	− ·04
Curvature	− ·28
Radial velocity	−80·4

ε HERCULIS 893.

1907. June 27.
G. M. T. 16h 32m

Observed by W. E. Harper.
Measured by J. N. Tribble.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1½	73·2721				1	53·9786	·9741	·0043	4·95
2	72·9900				2	45·2810			
½	72·8555	·8745	·0097	+14·07	½	45·2918	·2843	·0456	– 47·59
2	54·0335								

Weighted mean	+12·64
V_a	– 8·22
V_d	– ·11
Curvature	– ·28
Radial velocity	4·0

ε HERCULIS 913.

1907. July 4.
G. M. T. 16h 18m

Observed by W. E. Harper.
Measured by J. N. Tribble.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·0216				2	45·2683			
2	53·9485	·9557	·0141	– 16·22					

Weighted mean	– 16·22
V_a	– 9·98
V_d	– ·14
Curvature	– ·28
Radial velocity	– 26·6

ε HERCULIS 920.

1907. July 8.
G. M. T. 16h

Observed by J. S. Plaskett.
Measured by J. N. Tribble.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9265				2	45·2319			
2	72·3632				1	45·1886	·2403	·0084	8·79
1½	72·7804	·8172	·0015	– 2·17	2	27·2471			
1½	53·9754				½	27·4015	·4763	·0202	– 17·60
½	53·9156	·9556	·0010	– 1·15					

Weighted mean	– 6·12
V_a	– 10·92
V_d	·14
Curvature	– ·28
Radial velocity	– 17·5

ε HERCULIS 928.

1907. July 9.
G. M. T. 14ʰ 32ᵐ

Observed by } J. N. Tribble.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1½	54·0232				1	45·2855	·2775	·0388	49·90
½	54·0319	·0375	·0677	−77·91	1½	30·9135			
2	45·2815				1	29·6773	·6342	·0501	+44·42

Weighted mean		+53·31
V_a	−11·26	
V_d	−·11	
Curvature	−·28	
Radial velocity		+41·6

ε HERCULIS 928.*

1907. July 9.
G. M. T. 14ʰ 32ᵐ

Observed by J. N. Tribble.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity
2	72·9585				2	53·9874			
1½	72·8250	·8764	·0116	+ 16·83	½	53·9415	·9829	·0131	+15·08
1	72·3931				2	45·2441			
½	57·8595	8969	·0700	[− 84·28]	1½	45·2136	·2431	·0044	+ 3·82
1	57·7826				2	29·6396	·6406	·0417	+37·00
½	57·6674	7048	·1220	[−144·48]	2	29·5979			

Weighted mean		+20·60
V_a	−11·26	
V_d	−·11	
Curvature	−·28	
Radial velocity		+ 9·0

* This result used.

ε HERCULIS 937.

1907. July 10.
G. M. T. 14ʰ 55ᵐ

Observed by J. S. Plaskett.
Measured by J. N. Tribble.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	72·9735				1	45·2284	·2288	·0199	−20·83
1	72·8361	·8261	·0054	+ 7·84	2	27·2965			
2	45·2832				½	27·4291	·4545	·0420	−36·60

Weighted mean	−20·86
V_a	−11·49
V_d	− ·09
Curvature	− ·28
Radial velocity	−32·7

ε HERCULIS 937.

1907. July 10.
G. M. T. 14^h [illegible]

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	54 6678	...	...	...	2	45·2121	...	...	...
1	53·8654	·9382	·0316	−36 37	1	45·1485	·2100	·0287	−29·96
1	53·0405	...	...	...					

Weighted mean	−33·16
V_a	−11·49
V_d	− ·09
Curvature	− ·28
Radial velocity	−45·0

Mean of measurements, −39·0 used.

ε HERCULIS 952.

1907. July 18.
G. M. T. 16^h 10^m

Observed by W. E. Harper.
Measured by J. N. Tribble.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72 9883	...	...	...	½	53·9283	·9333	0365	42·01
2	72·4271	...	...	...	2	45 2698	...	...	...
1	72·8008	·8208	·0440	−63·85	1	45·2109	·2147	0240	−25·05
2	54·0238	...	...	...					

Weighted mean	−43 96
V_a	−13·18
V_d	− ·19
Curvature	− ·28
Radial velocity	57·6

ε HERCULIS 957.

1907. July 20.
G. M. T. 16^h 39^m

Observed by J. S. Plaskett.
Measured by J. N. Tribble.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9599	...	...	...	2	45·2827	...	...	...
2	72·3852	...	...	...	1	45·2473	·2482	·0000	0 00
1	72·8265	·8315	0128	+18·34	2	27·3141	...	...	...
2	54·0154	...	...	...	½	27·5080	·5158	·0193	+16·82
1	53·9642	·9642	·0076	+ 8·77					

Weighted mean	+10·15
V_a	−13·57
V_d	− ·19
Curvature	− ·28
Radial velocity	− 3·9

ε HERCULIS 976.

1907. Aug. 1.
G. M. T. 17h 20m

Observed by / Measured by } J. N. Tribble.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0008	.... .	....	....	2	45·2806	....	....	.. ..
½	72·8353	8443	·0205	−29·74	1	45·2454	·2384	·0003	0 00
2	54·0320	....	....	. ...	2	27·2821	....	......	.. .. ..
2	53 9627	·9595	·0103	11·85	½	27·4465	4110	0109	− 9 46

Weighted mean		10·79
V_a	-	15 51
V_d	−	27
Curvature	−	·28
Radial velocity	−	26·8

ε HERCULIS 979.*

1907. Aug. 3.
G. M. T. 13h 28m

Observed by J. S. Plaskett.
Measured by Tribble & Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9868	....	....	..... .	½	27·4924	·4509	0290	+25·17
½	72·8703	·8953	·0305	+44·26	2	54·7430	.. ....	....	....
2	54·0237	... .	....	....	1½	54·0280	0278	0620	+71 36
2	54·0309	0360	0662	+76·19					red.
2	54·7369	....	. .. .	.. . .	C'ntre	53·9537	·9535	·0163	+18·76
2	45·2775	... .	....	... .	½	53·8760	8758	0940	−108·19
1	45·2820	·2780	·0393	+41·08					violet.
2	27·2883	....	... .	....	2	53 1113	....	.. . ..	....

*Plate not used in the results.

ε HERCULIS 987.

1907. Aug. 6.
G. M. T. 17h 35m

Observed by / Measured by } J. N. Tribble.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·6897	... .	....	....	2	44·9542	... .	.. . .	....
½	72·5573	·7843	·0122	+17·75	1	44·9849	2833	·0244	+25·63

Weighted mean		+22·96
V_a	−	16·16
V_d	−	28
Curvature... .	−	·28
Radial velocity		+6 2

ε HERCULIS 1018.

1907. Aug. 22.
G. M. T. 10h 49m

Observed by W. E. Harper.
Measured by J. N. Tribble.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54 0698	....	....	....	2	45·2977	....	....	....
1	54·0566	·0156	·0458	+52·71	½	45·3014	·2774	·0387	+40·39

Weighted mean ... . +48·60
V_a .... −17·45
V_d .... − ·27
Curvature.. .... . − ·28

Radial velocity ... . +30·6

ε HERCULIS 1062.

1907. Sept. 20.
G. M. T. 14h 37m

Observed by W. E. Harper.
Measured by J. N. Tribble.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·0379	....	....	....	2	45 2630	....	....	....
1	53·9738	·9647	·0051	− 5·86	1	45 2412	2512	·0125	−13.04

Weighted mean.. . ..... + 3·59
V_a .... − 5 90
V_d ... . − ·28
Curvature...... .. − ·28

Radial velocity..... ... ... − 2·9

ε HERCULIS 1391.

1908. March 9.
G. M. T. 20h 50m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7533	....	....	....	½	27·3570	·3650	·0566	49·13
2	53·9358	·9253	·0445	−51·22	2	27·2385	....	....	....
2	53·1215	....	....	....	½	11·7667	·7897	·0617	−46·21
2	45·2735	....	....	....	2	11·4840	....	....	....
1	45 2060	·2061	·0326	34·03					

Weighted mean... ... . −46·03
V_a .... +17·56
V_d .... − ·14
Curvature.. .. .... − .28

Radial velocity.......... ..... −28·6

ε HERCULIS 1463.

1908. March 16.
G. M. T. 21ʰ 42ᵐ

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7088	....	....	....	1	27·4090	·3380	·0746	[−64·75]†
1	53·8238	·8561	·1137	−129·87	1	27·3376	·2666	·1460	−126·73‡
2	53·0835	....	....	....	2	27·3180	....	....	....
3	45·2754	....	....	....	½	11·8287	·7037	·1477	−110·63
2	45·1363	·1345	·1042	−108·78	2	11·6327	....	....	....
1	27·4961	·4251	·0125	[+10·85]*					

Weighted mean 4 lines		−117·66
V_a	+16·96	
V_d	+ ·05	
Curvature		− ·28
Radial velocity		−100·9

* Red. † Centre. ‡ Violet.

ε HERCULIS 1483.

1908. April 13.
G. M. T. 21ʰ 35ᵐ

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	55·0591	·0413	·0839	−97·83	½	45·2031	·1830	·0557	−58·15
2	54·7597	....	....	....	2	73·0290	....	....	....
3	53·8897	·8728	·0970	−111·65	2	66·3185	·2998	·1119	+145·09
2	53·1281	....	....	....	1	41·4857	·4625	·1653	+165·30
2	45·2936	....	....	....	2	41·3097	....	....	....

Weighted mean neg. lines		−102·63
V_a	+12·31	
V_d		− ·09
Curvature		− ·28
Radial velocity		− 90·7

ε HERCULIS 1494.

1908. April 15.
G. M. T. 20h 40m

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7571	......	......	......	1	27·5470	·4416	·0290	25·17
1	54·0087	·9910	·0212	– 24·40	2	27·3528	......	......	......
2	53·1325	......	......	......	1½	12·0567	·8947	·0433	– 32·43
2	45·3117	......	......	......	2	11·6701	......	......	......
1½	45·2995	·2614	·0227	23·70					

Weighted mean	....	– 26·75
V_a	....	– 11·87
V_d	– ·04	
Curvature	– ·28	
Radial velocity	...	– 38·3

ε HERCULIS 1511.

1908. April 22.
G. M. T. 20h 33m

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7537	......	......	......	1½	27·4398	·3576	·0550	47·74
1	53·9496	·9343	·0355	– 40·86	2	27·3292	......	......	......
2	53·1311	......	......	......	1	11·9322	·7951	·0557	– 41·72
2	45·2841	......	......	......	2	11·6453	......	......	......
1½	45·2051	·1947	·0440	45·93					

Weighted mean	....	44·61
V_a	– 10·16	
V_d	..	·05
Curvature	–	·28
Radial velocity	.....	– 34·8

SESSIONAL PAPER No. 25a

ε HERCULIS 1511.*

1908. April 22.
G. M. T. 20h 53m

Observed by J. S. Plaskett.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7475	....	....	....	1	27·4466	·3521	·0605	52·51
½	53·9314	·9240	·0498	57·31	2	27·3416	....	....	....
2	53·1213	....	....	....	½	11·9315	·7915	·0600	44·94
2	45·3027	....	....	....	2	11·6479	....	....	....
1	45·2245	·1995	·0393	41·02					

Weighted mean .... 48·22
V_a .... – 10·16
V_d .... – ·05
Curvature .... – ·28

Radial velocity .... 38·4

* Check measurement.

ε HERCULIS 1531.

1908. May 15.
G. M. T. 19h 29m

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0237	....	....	....	½	45·1314	·1565	·0822	85·81
½	72·8254	·8127	·0521	– 75·59	2	43·5083	....	....	....
1	72·4550	....	....	....	½	27·3377	·3301	·0825	– 71·04
1	45·2488	....	....	....	2	27·2542	....	....	....

Weighted mean .... – 77·48
V_a .... + 3·87
V_d .... – ·11
Curvature .... – ·28

Radial velocity .... – 74·0

ε HERCULIS 1531.*

1908. May 15.
G. M. T. 19h 29m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	45·2620	....	....	....	2	15·3652	....	....	....
1½	45·1435	·1651	·0736	– 76·84	1	15·3325	·3730	·1003	77·63
1	27·2702	·3206	·0920	79·86	½	11·7025	·7530	·0984	– 73·70
2	27·1935	....	....	....	2	11·4650	....	....	....

Weighted mean .... – 77·40
V_a .... + 3·87
V_d .... – ·11
Curvature .... – ·28

Radial velocity .... – 73·9

* Check measurement.

ε HERCULIS 1540.

1908. May 18.
G. M. T. 18h 25m

Observed by
Measured by } T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	72·9755	....	....	....	½	45·2462	·2547	·0160	16·70
½	72·8376	·8724	·0076	−11·02	2	43·5332	....	....	....
1	72·4074	....	....	....	2	27·2667	....	....	....
2	45·2650	....	....	....	½	27·4414	·4293	·0077	+ 6·68

Weighted mean .... +11·47
V_a .... + 3·01
V_d .... − ·04
Curvature .... ·28

Radial velocity .... +14·2

ε HERCULIS 1540.*

1908. May 18.
G. M. T. 18h 25m

Observed by T. H. Parker.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	57·8390	....	....	....	½	27·4464	·3946	·0180	15·62
½	57·8150	·8054	·0214	−25·76	2	27·2984	....	....	....
2	54·7533	....	....	....	1	11·9200	·8464	·0050	− 3·75
1	53·9750	9629	·0019	− 2·18	2	11·5812	....	....	....
1½	53·1249	....	....	....					

Weighted mean .... − 4·73
V_a .... + 3·01
V_d .... − ·04
Curvature .... − ·28

Radial velocity .... − 2·0

* Check measurement.

ε HERCULIS 1545.

1908. May 20.
G. M. T. 14h

Observed by J. S. Plaskett.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7596	....	....	....	½	27·4008	·3230	·0896	77·77
½	53·9253	·9080	·0618	−71·13	1	27·3245	....	....	....
2	53·0461	....	....	....	½	15·4875	·3780	·0953	−73·76
2	43·5702	....	....	....	1	15·5081	....	....	....

Weighted mean .... −76·10
V_a .... + 2·47
V_d .... + ·07
Curvature .... − ·28

Radial velocity .... −73·8

ε HERCULIS 1547.

1908. May 22.
G. M. T. 18h 28m

Observed by } W. F. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7307	....	....	....	2	45·2669	....	....	....
½	53·9373	·9479	·0219	−25·21	½	45·1984	·2051	·0336	−35·08
2	53·1021	....	....	....					

Weighted mean .... − 30·15
V_a .... − 1·93
V_d .... − ·04
Curvature .... − ·28

Radial velocity .... − 28·5

ε HERCULIS 1567.

1908. June 1.
G. M. T. 17h 30m

Observed by T. H. PARKER
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7282	....	....	....	2	45·2682	....	....	....
¾	53·8856	8976	·0722	−83·10	¼	45·1598	·1652	·0735	−76·73
2	53·1018	....	....	....					

Weighted mean .... − 81·51
V_a .... − 1·17
V_d .... − ·16
Curvature .... − ·28

Radial velocity .... − 83·1

ε HERCULIS 1573.

1908. June 3.
G. M. T. 17h 56m

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9922	....	....	....	2	53·1190	....	....	....
1	72·8323	·8513	·0135	−19·59	2	45·2871	....	....	....
2	72·4216	....	....	....	1½	45·2517	·2382	·0005	0·52
2	54·7443	....	....	....	1	27·4595	·4062	·0064	−5·55
½	53·9692	9645	·0053	6·10	2	27·2999	....	....	....

Weighted mean .... − 7·23
V_a .... − 1·74
V_d .... − ·06
Curvature .... − ·28

Radial velocity .... − 9·3

ε HERCULIS 1573.

1908. June 3
G. M. T. 17h 56m

Observed by } Measured by } W. E. HARPER.

Wt.	Mean of Settings	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0222	....	....	....	½	45·2750	2294	·0093	9·71
½	72·8697	8570	0078	−11·32	½	27·4850	·4000	·0126	−10·94
2	72·4536	.	....	....	2	27·3321	....	....	....
2	45·3195	....	....	....					

Weighted mean ... − 10·66
V_a ... − 1·74
V_d ... − ·06
Curvature ... ·28

* Check measurement.

Radial velocity ... − 12·7

ε HERCULIS 1582.

1908. June 5.
G. M. T 18h 40m

Observed by } Measured by } T. H. PARKER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0057	....	....	....	2	45·2847	....	....	....
½	72·8289	·8328	·0320	46·43	1	45·1877	·1766	0621	64·83
1	72·4415	....	....	....	2	43·5492	....	....	....
1	54·7435	....	....	....	1	27·3405	·3509	0617	−53·55
2	53·9113	·9085	·0613	70·55	2	27·2362	....	....	....
1	53·1160	....	....	....					

Weighted mean ... − 62·82
V_a ... − 2·34
V_d ... − 13
Curvature ... − ·28

Radial velocity ... 65·6

ε HERCULIS 1603.

1908. June 12.
G. M. T. 18h 35m

Observed by } Measured by } T. H. PARKER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0039	....	....	....	½	27·3556	·3660	·0466	40·44
½	72·8098	·8174	·0474	−68·77	2	27·2362	....	....	....
2	72·4334	....	....	....	2	54·7252	....	....	....
2	45·2849	....	....	....	1	53·9368	·9481	·0217	−24·97
1	45·1905	·1792	·0595	62·11	1	53·0175	....	....	....
3	43·5509	....	....	....					

Weighted mean ... − 47·23
V_a ... − 4·39
V_d ... ·14
Curvature ... − ·28

Radial velocity ... − 52·0

ε HERCULIS 1603.*

1908. June 12.
G. M. T. 18ʰ 35ᵐ

Observed by T. H. PARKER.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7390	......	......	......	1	45·1900	·1834	·0553	−57·73
1½	53·9468	·9515	·0183	−21·06	2	45·2802	......	......	......
1	53·1052	......	......	......					

Weighted mean	−35·73
V_a	4·39
V_d	−·14
Curvature	−·28
Radial velocity	−40·5

Check measurement.

ε HERCULIS 1625.

1908. June 22.
G. M. T. 17ʰ 27ᵐ

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7181	......	......	......	½	27·4445	·4251	·0125	+10·85
2	53·9437	·9684	·0014	−1·91	2	27·2660	......	......	......
2	53·0867	......	......	......	½	11·8797	·8502	·0012	−0·90
2	45·2605	......	......	......	2	11·5367	......	......	......
1	45·2005	·2137	·0250	26·10					

Weighted mean	−6·24
V_a	−7·15
V_d	−·11
Curvature	−·28
Radial velocity	−13·8

ε HERCULIS 1630.

1908. June 24.
G. M. T. 16ʰ 27ᵐ

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0647	......	......	......	2	45·3237	......	......	......
1	72·9033	·8481	·0167	−24·23	2	45·2575	·2074	·0313	32·68
2	72·5011	......	......	......	1½	27·4458	·3860	·0266	23·09
2	54·7925	......	......	......	2	27·3065	......	......	......
1½	53·9978	·9484	·0214	24·63	2	11·8987	·8362	·0152	−11·38
2	53·1602	......	......	......	2	11·5698	......	......	......

Weighted mean	−23·00
V_a	−7·68
V_d	·04
Curvature	·28
Radial velocity	−31·0

ε HERCULIS 1640.

1908. June 26.
G. M. T. 16h 46m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7353	....	....	......	2	53·1042	... ...	....	......
1	53·9739	9826	0128	+14 73					

V$_s$ .... + 14 73
V$_a$ .... − 8·21
V$_d$ .. .. − ·09
Curvature........ ·28

Radial velocity ... . + 6·1

ε HERCULIS 1648.

1908. June 27.
G. M. T. 17h 07m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·6613	.....	....	....	2	27·3914	·4389	·0266	22·06
1½	53·9578	·0373	0675	−77·80	3	27·2075	... .	... .	....
2	53 0325	....	....	....	1	11·8777	·9092	·0578	+43·29
2	45·2056	... .	....	.....	3	11·4693	....	....	... .
1½	45·1725	·2405	0018	1·88					

Weighted mean....... .. .. + 34·49
V$_a$ ... ... − 8·47
V$_d$.............. − ·11
Curvature .. .. − ·28

Radial velocity....... .... + 25·6

ε HERCULIS 1648.*

1908. June 27.
G. M. T. 17h 07m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0323	. . ....	.. ..	.. ...	2	45·3181	....	....	....
1	72·9046	·8746	·0098	+14·22	1½	45·2971	·2531	0144	15·05
2	72·4869	... .	. . ..	....	1½	27·5276	·4536	·0410	35·59
2	54·7837	. . ..	....	....	3	27·3309	.. ..	.. ..	.. ..
1½	54·0660	·0260	0562	64·69	1½	12·0159	·9229	·0715	+53·63
2	53·1513	....	....	. ...	3	11·5935	....	....	.. ..

Weighted mean .. .. + 42·15
V$_a$........ ..... . − 8·47
V$_d$ .... − ·11
Curvature .. .. − ·29

Radial velocity.... .... + 29·4

* Check measurement.

ε HERCULIS 1648.*

1908. June 27.
G. M. T. 17h 07m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7470	....	....	....	½	27·4466	·4322	·0196	17·01
1	54·0110	·0063	·0365	+42·01	2	27·2610	....	....	....
2	53·1164	....	....	....	1	11·9287	·9037	·0523	+39·17
2	45·2902	....	....	....	2	11·5322	....	....	....
1½	45·2737	·2571	·0184	19·21					

Weighted mean .... +29·62
V_a .... − 8·47
V_d .... − ·11
Curvature ..... − ·28

Radial velocity .... + 20·8

* Check measurement.

ε HERCULIS 1653.

1908. July 1.
G. M. T. 16h 15m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7746	....	....	....	1	27·5156	·4756	·0630	54·68
2	54·0547	·0247	·0549	+63·19	3	27·2893	....	....	....
2	53·1395	....	....	....	1½	11·9291	·8871	·0357	+26·76
2	45·3045	....	....	....	3	11·5478	....	....	....
1	45·2795	·2490	·0103	10·75					

Weighted mean .... +42·17
V_a .... − 9·48
V_d .... − ·11
Curvature ..... − ·28

Radial velocity .... +33·3

ε HERCULIS 1653.*

1908. July 1.
G. M. T. 16h 15m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7392	....	....	....	½	27·4403	·4400	·0274	23·78
1	53·9887	·9943	·0245	+28·20	2	27·2470	....	....	....
1	53·1035	....	....	....	1	11·8804	·8856	·0342	+25·61
2	45·2625	....	....	....	2	11·5020	....	....	....
½	45·2276	·2387	·0000	·00					

Weighted mean .... +21·90
V_a .... − 9·48
V_d .... − ·06
Curvature ..... − ·28

* Check measurement.

Radial velocity .... +12·1

HERCULIS 1653.*

1908. July 1
G. M. T. 16^h [illegible]

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·8447				½	45 3489	·2537	·0150	15·66
1	53·0962	9977	·0279	32 11	1	11 9904	8880	·0366	− 27·41
2	53 2062				2	11 6096			
2	45·3688								

Weighted mean		+ 26·94
V_a	9·48	
V_d	11	
Curvature	− 28	
Radial velocity		− 17 1

* Check measurement.

ε HERCULIS 1661.

1908. July 3.
G. M. T. 19^h 40^m

Observed by T. H. PARKER.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7681				2	45 2998			
2½	53·9294	·9004	·0694	79 88	1	45·2548	·2268	·0119	− 13·61
2	53 1436								

Weighted mean	49·53
V_a	− 9 97
V_d	26
Curvature	28
Radial velocity	− 60 0

ε HERCULIS 1661.*

1908. July 3.
G. M. T. 19^h 40^m

Observed by T. H. PARKER.
Measured by W. E HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7214				2	45·2530			
2	53 8761	8968	·0730	− 84·02	¾	45·1670	1877	0510	− 53·24
2	53·0911								

Weighted mean	− 75·62
V_a	− 9·97
V_d	− ·26
Curvature	− ·28
Radial velocity	− 86 1

* Check measurement.

ε HERCULIS 1666.

1908. July 6.
G. M. T. 17h 35m

Observed by J. S. PLASKETT.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity
2	54·7101	...	...	...	1½	27·3494	·3934	·0192	16 66
1	53 8800	·9180	·0518	−59·62	2	27·1962	...	...	...
2	53·0710	...	...	...	1	11·7754	8284	0230	−17·23
2	45·2333	...	...	...	2	11·4534	...	...	...
1½	45·1985	·2375	0012	1·25					

Weighted mean	20·74
V_a	10·70
V_d	− ·06
Curvature	− ·28
Radial velocity	−31·7

ε HERCULIS 1666.*

1908. July 6.
G. M. T. 17h 35m

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	57·8433	...	...	...	1½	45 2230	·2223	·0164	−17·20
½	57·8432	·8293	·0025	+ 3·01	½	27·3862	·3874	·0252	−21·87
2	54·7567	...	...	...	2	27 2454	...	...	...
2	53·9847	·9752	·0054	+ 6·21	½	11 8301	8383	·0131	− 9·81
1	53·1164	...	...	...	2	11·5190	...	...	...
2	45·2745	...	...	...					

Weighted mean	− 5·54
V_a	10·70
V_d	− ·06
Curvature	− ·28
Radial velocity	−16·6

* Check measurement.

ϵ HERCULIS 1675.

1908. July 8. G. M. T. 15h 47

Observed by J. B. CANNON.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0235	....	....	....	3	45 2741	....	....	....
1	72·8670	·8534	·0114	− 16·54	1½	45·2271	·2267	0120	− 12·53
2	72·4584	....	....	....	1	27·4307	·4076	·0050	− 4·34
2	54·7415	....	....	....	2	27·2697	....	....	....
1½	53·9786	·9803	0105	+ 12·08	1	11·8571	·8288	·0226	− 16·93
1½	53·1090	....	....	....	2	11·5355	....	....	....

Weighted mean.	−	6·41
V_a	−	11·15
V_d	−	·07
Curvature.	−	·28
Radial velocity	−	17·9

ϵ HERCULIS 1675.*

1908. July 8. G. M. T. 15h 47m

Observed by J. B. CANNON.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
½	57·7785	·8317	·0049	+ 6·02	1½	45·1881	·2350	0037	− 3·86
2	57 7762	....	....	....	2	30·8478	....	....	....
2	54·6950	....	....	....	1	27·3860	4072	0054	− 4·69
2	53·9312	·9798	·0100	+ 11·51	2	27·2254	....	....	....
2	53·0617	....	....	....	1	11·8146	·8303	·0211	− 15·80
2	45·2267	....	....	....	2	11·4915	....	....	....

Weighted mean...		0 04
V_a	−	11·15
V_d	−	·07
Curvature.	−	·28
Radial velocity........	−	11·5

* Check measurement.

ε HERCULIS 1676.

1908. July 8.
G. M. T. 16ʰ 32ᵐ

Observed by } J. B. CANNON.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·8885	......	......	......	1	27·5711	·4031	·0095	8·25
1½	54·0948	·9498	·0200	−23·02	2	27·4152	......	......	......
2	53·2536	......	......	......	1	12·0378	·8489	·0025	− 1 87
2	45·4243	......	......	......	2½	11·6959	......	......	......
1	45·3866	·2356	·0031	3·24					

Weighted mean	− 10·64
V_a	− 11·15
V_d	− ·14
Curvature	− ·28
Radial velocity	− 22·2

ε HERCULIS 1682.

1908. July 9.
G. M. T. 17ʰ 12ᵐ

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0156	......	......	......	1½	45·2675	·2565	·0178	+18·58
½	72·8768	·8714	0066	+ 9·57	2	41·2977	......	......	......
2	72·4490	......	......	......	½	27·4402	·4102	·0024	− 2·08
2	54·7490	......	......	......	2	27·2766	......	......	......
3	54·0263	·0207	·0609	+70 09	½	11·9452	·9044	·0530	+39 70
2	53·1160	......	......	......	2	11·5482	......	......	......
2	45·2846	......	......	......					

Weighted mean		+ 42·97
V_a	− 11·36	
V_d	− ·15	
Curvature	− ·28	
Radial velocity		+ 31·2

ε HERCULIS 1685.

1908. July 10.
G. M. T. 14h 37m

Observed by } Measured by } J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7810	......	......	......	1½	27·4458	·3880	0246	21 35
2	53·9982	·9602	0096	− 11·49	2	27·3042	......	......	......
2	53·1500	......	......	......	1½	11·8880	·8260	·0254	− 19·02
2	45 3197	......	......	......	2	11·5696	......	......	......
1	45·2720	·2260	·0127	13 26					

Weighted mean	− 16·13
V_a	11·58
V_d	·00
Curvature	·28
Radial velocity	− 27·9

ε HERCULIS 1686.

1908. July 10.
G. M. T. 15h 34m

Observed by } Measured by } J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7365	......	......	......	½	27·4528	......	......	......
1½	53·9495	·9535	·0163	− 18·76	2	27·2597	......	......	......
2	53·1102	......	......	......	1½	11·8304	8099	0415	− 31·07
2	45·2762	......	......	......	2	11·5280	......	......	......
1	45·2158	·2146	·0230	24·01					

Weighted mean	− 24·56
V_a	− 11·58
V_d	− ·06
Curvature	·28
Radial velocity	− 36·4

ε HERCULIS 1693.

1908. July 11.
G. M. T. 16h 58m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0160	......	......	......	1½	45·1437	·1197	·1198	125·07
1	72·7961	·7998	·0650	− 94 52	1	27·2885	·2685	1440	124 99
1	54·7200	......	......	......	2	27·2267	......	......	......
2	53·8695	·8415	·1283	147·67	1	11·7051	·6841	·1673	− 115·31
2	53·0811	......	......	......	2	11·4860	......	......	......
2	45·2396	......	......	......					

Weighted mean	− 125·81
V_a	− 11·83
V_d	·14
Curvature	·28
Radial velocity	− 138·1

ε HERCULIS 1693.*

1908. July 11.
G. M. T. 16h 58m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	54·6857	...	...	...	1½	27·2729	·3166	·0960	83·33
2	53·8389	·8908	·0790	−90·93	2	27·2031	...	...	...
1	53·0466	...	...	...	1	11·6737	·7328	·1186	88·83
2	45·2135	...	...	...	2	11·4481	...	...	...
1	45·1326	·1927	·0460	48·02					

Weighted mean	80·67
V_a	11·83
V_d	·14
Curvature	·28
Radial velocity	−92·9

* Check measurement.

ε HERCULIS 1699.

1908. July 13.
G. M. T. 16h 19m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	72·9161	...	...	...	½	27·3386	·3706	·0513	+44·53
½	72·7681	·8611	·0037	− 5·37	2	27·2138	...	...	...
½	72·3520	...	...	...	1½	11·8957	·9057	·0543	+40·67
2	45·2128	...	...	...	2	11·4945	...	...	...
1	45·1745	·2353	·0034	− 3·55					

Weighted mean	+22·00
V_a	−12·28
V_d	− ·14
Curvature	− ·28
Radial velocity	9·3

ε HERCULIS 1699.*

1908. July 13
G. M. T. 16h 19m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	72·8786	...	...	...	1	52·9980	...	...	...
½	72·7355	·8648	·0000	0·00	2	45·1721	...	...	...
½	72·3211	...	...	...	1	45·1655	·2670	·0283	+29·54
2	54·6267	...	...	...	1½	11·8675	·9317	·0803	+60·14
1	53·8710	·9856	·0158	+18·18	2	11·4430	...	...	...

Weighted mean	+34·48
V_a	12·28
V_d	− ·14
Curvature	− ·28
Radial velocity	−21·8

* Check measurement.

ε HERCULIS 1707.

1908. July 14.
G. M. T. $17^h\ 42^m$

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	72·9823	....	....	....	2	45·2751	....	....	....
1	72·8174	·8454	·0194	−28·15	2	45·2115	·2100	·0287	29.96
1	72·4157	....	....	....	2	27·4009	·3709	·0417	36 20
2	54·7221	....	....	....	2	27·2759	....	....	....
½	53 9413	·9573	·0125	14 39	2	11·8686	·8106	·0408	30·56
2	53 0976	....	....	....	2	11·5667	....	....	....

Weighted mean	−30·50
V_a	−12·58
V_d	− ·19
Curvature	− ·28
Radial velocity	−43·6

ε HERCULIS 1712.

1908. July 15.
G. M. T. 17^h

Observed by } J. B. Cannon.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7925	....	....	....	1	27·4363	·3593	·0533	46·26
½	53·9323	8803	·0795	−91·50	2	27·3102	....	....	....
2	53·1660	....	....	....	1	11·7814	·7214	1300	−97·37
2	45·3233	....	....	....	2	11·5675	....	....	....
1½	45·2363	·1863	·0524	54 71					

Weighted mean	−67·88
V_a	−12·81
V_d	− ·14
Curvature	− ·28
Radial velocity	−81·1

ε HERCULIS 1713.

1908. July 15.
G. M. T. $17^h\ 45^m$

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	72·9943	......	....	....	2	45·2700	....	....	....
½	72·8335	·8495	·0153	−22·20	1½	45·1889	·1924	·0463	48·34
1	72·4275	......	....	....	1½	27·3745	·3583	·0543	47·13
2	54·7248	......	....	....	2	27·2630	....	....	....
1	53·8913	9083	·0615	70·79	1½	11·8010	7715	·0799	−59·92
2	53·1022	......	....	....	2	11·5368	....	....	....

Weighted mean	−52·49
V_a	−12 80
V_d	− 19
Curvature	− ·28
Radial velocity.......	−65·8

ε HERCULIS 1719.

1908. July 16.
G. M. T. $17^h\ 25^m$

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7686	....	....	....	1	27·4669	4142	·0077	− 6·68
2	53·9945	·9675	·0023	− 2·65	2	27·2995	....	....	....
2	53·1399	....	....	....	2	11·9217	·8562	·0048	+ 3·59
2	45·3019	....	....	....	2	11·5731	....	....	....
1½	45·2698	·2368	0019	− 1·98					

Weighted mean.....	− 0·27
V_a	− 13·03
V_d	− ·19
Curvature.................. ...	− 28
Radial velocity	− 13·8

ε HERCULIS 1720.

1908. July 22.
G. M. T. 17h

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	57·8345	....	....	....	1	45·2245	·2114	·0173	−18·06
1	57·8370	8333	·0065	− 7·83	1½	24·1614	....	·0076	− 6·46
1	54·7533	....	....	....	2	24·1536	....	....	....
1½	53·9636	9510	·0188	−21·64	1	11·8589	·8290	·0224	−22·57
1	53·1255	....	....	....	2	11·5373	....	....	....
2	45·2867	....	....	....					

Weighted mean....	− 9·26
V_a	− 14·00
V_d	− ·19
Curvature....	·28
Radial velocity	− 23·7

ε HERCULIS 1723.

1908. July 24.
G. M. T. 14h

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9270	....	....	....	2	53·0155	....	....	....
½	72·7558	8416	·0232	33·66	2	45·1800	....	....	....
1	72·3561	....	....	....	1½	45·1312	·2248	·0139	−14·51
2	59·7270	....	....	....	2	37·8697	....	....	....
1	58·9550	·0377	·0030	− 3·66	1½	37·6784	·7674	·0127	+12·24
1	57·7351	·8188	·0080	− 9·63	1	27·3058	·3850	·0276	23·96
2	57·5079	....	....	....	2	27·1684	....	....	....
2	54·6556	....	....	....	1	11·7612	8374	·0140	10·49
1½	53·8752	·9665	0033	3·80	2	11·4310	....	....	....

Weighted mean....	8·20
V_a	14·35
V_d	·00
Curvature....	·28
Radial velocity	23·8

ε HERCULIS 1728.

1908. July 25.
G. M. T. 17h 20m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·8772	.....	.....	.....	1½	45·3992	·2740	·0353	+36·85
2	54·1331	·0021	·0323	+37·18	1	24·5975	·4648	·0522	+45·31
2	53·2387	...	.....	.....	2	24·3793	.....	.....	.....
2	45·3988	.....	.....	.....					

Weighted mean		+ 38·89
V_a	− 14·53	
V_d	− ·22	
Curvature	− ·28	
Radial velocity		+ 23·9

ε HERCULIS 1729

1908. July 26
G. M. T. 16h 58m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0485	.....	.....	.....	2	53·1465	.....	.....	.....
1	72·8867	·8482	·0166	−24·08	2	45·3092	.....	.....	.....
2	72·4827	.....	.....	.....	1½	45·2855	·2500	·0113	+11·80
1	57·8605	·8279	·0011	+ 1·32	1	27·4567	·4100	·0026	− 2·26
2	57·8620	.....	.....	.....	2	27·2950	.....	.....	.....
2	54·7767	.....	.....	.....	1½	11·8964	·8496	·0018	− 1·35
1	53·9981	·9635	·0063	− 7·25	2	11·5540	.....	.....	.....

Weighted mean	− 2·37
V_a	14·71
V_d	− ·20
Curvature	− ·28
Radial velocity	− 17·6

ε HERCULIS 1734.

1908. July 28.
G. M. T. 17h 12m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·4230				1	45·1967	·2434	·0047	+ 4·91
2	59·7721				½	27·3527	·3951	·0175	−15·19
2	54·7033				2	27·2043			
1	53·9145	·9547	·0151	−17·38	1	11·7436	·8210	·0304	−22·77
2	55·0702				2	11·4292			
2	45·2269								

Weighted mean	−12·24
V_a	−15·07
V_d	− ·22
Curvature	− ·28
Radial velocity	− 27·8

ε HERCULIS 1737.

1908. July 29.
G. M. T. 14h 22m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9830				1	29·8960	·9563	·0333	+32·10
1	72·8682	·8968	·0320	+46·45	2	29·8627			
1	72·4145				½	27·3845	·4478	·0352	+30·55
2	54·6912				2	27·1833			
1	53·9795	·0321	·0623	+71·71	1½	11·8437	·9232	·0718	+53·78
2	54·0574				1	11·6321			
2	45·2190				2	11·4277			
1	45·2345	·2891	·0504	+52·61					

Weighted mean		+49·80
V_a	−15·17	
V_d	− ·06	
Curvature	− ·28	
Radial velocity		+34·3

ε HERCULIS 1738.

1908. July 29.
G. M. T. 15^h 08^m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7011	....	....	....	1	45·2290	·2753	·0366	+38·21
1	53 9824	·0240	0542	+62.38	2	29 8783	....	....	....
2	53·0696	....	....	....	1	11·8603	·9186	0672	+50·35
2	45 2273	....	....	....	2	11 4489	....	....	....

Weighted mean .... +50·31
V_a .... −15 17
V_d .... − ·11
Curvature .... − 28

Radial velocity .... + 34·7

ε HERCULIS 1743.

1908. July 29.
G. M. T. 18^h 05^m

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73 0345	....	....	....	2	54 0317	·0317	·0619	−71·25
½	72·8884	8670	·0022	+ 3·19	2	53·1037	....	....	....
2	72·4567	....	....	....	2	45·2694	....	....	....
2	54·7492	....	....	....	1	45·2692	·2734	·0347	+36·23
3	54·0298	....	....	....					

Weighted mean .... + 55·91
V_a .... − 15·17
V_d .... − ·25
Curvature .... − ·28

Radial velocity .... + 40·2

ε HERCULIS 1746.

1908. July 30.
G. M. T. 17^h 06^m

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7460	....	....	....	2	45 2629	....	....	....
2	53·9640	·9628	·0070	− 8·06	½	45·2283	·2390	·0003	+ 0·31
2	53·1102	....	....	....					

Weighted mean .... − 6·47
V_a .... − 15·27
V_d .... − ·24
Curvature .... − ·28

Radial velocity .... − 22 3

ε HERCULIS 1751.

1908. July 31.
G. M. T. 15h 40m

Observed by T. H. Parker.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	57·8225				2	53·1145			
½	57·7790	·7859	·0410	−49·36	2	45·2711			
2	54·7461				½	45·1693	·1717	·0670	69·95
1½	53·9111	·9078	·0620	−71·36					

Weighted mean	−66·38
V_a	15·65
V_d	·15
Curvature	·28
Radial velocity	−82·5

ε HERCULIS 1757.

1908. July 31.
G. M. T. 19h 05m

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0630				2	53·1403			
1	72·8552	·8035	·0613	−88·95	2	45·2950			
2	72·4921				2	45·1940	·1726	·0661	69·00
2	54·7682				½	27·3792	·3631	·0495	−42·97
1½	53·9147	·8874	·0824	−94·84	1	27·2627			

Weighted mean	−78·14
V_a	15·65
V_d	−·28
Curvature	·28
Radial velocity	−94·3

ε HERCULIS 1760.

1908. Aug. 1.
G. M. T. 16h 49m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7274				2	45·2642			
1½	53·9500	·9643	·0055	−6·35	1	45·2251	·2345	·0043	−4·49
2	53·0979								

Weighted mean	−5·61
V_a	−16·03
V_d	−·22
Curvature	−·28
Radial velocity	−22·1

ε HERCULIS 1761.

1908. Aug. 5.
G. M. T. 14h 05m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0351				2	53·1047	. .	. .	..
1	72·8896	·8680	0032	+ 4 64	2	45·2597	.	.....	.....
2	72·4630				1½	45·2062	·2201	·0186	− 19·42
2	57 8205			..	1	27·3982	·4028	·0098	− 8 52
1½	57·8034	·8123	·0145	17·46	2	27·2420	.. ..	.	.....
2	54·7326	..	.....	....	1½	11·8337	·8494	·0020	− 1·50
1½	53·9471	·9554	·0144	16 57	2	11·4915	.....	. .	....

Weighted mean. . ... −12·04
V_a .. .. −16·25
V_d .... − ·08
Curvature. − ·28

Radial velocity. . −28·6

ε HERCULIS 1774.

1908. Aug. 7.
G. M. T. 15h 35m

Observed by T. H. Parker.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	57 8210	...	....	....	½	45 2291	·2317	·0070	− 7·31
1	57·8004	·8088	·0180	−21·67	½	27·4238	·4026	0100	− 8·68
2	54·7349	....	. ..	....	2	27·2676	.. ..	..	....
½	53·9647	·9711	·0013	+ 1·50	1½	11·8833	8514	·0000	0·00
2	53·1063	.....	.. ..	......	2	11·5393	.. . .	...	....
2	45·2710	....	....	....					

Weighted mean .. .. − 7·23
V_a .. .. −16 35
V_d .... ·17
Curvature.... . − ·28

Radial velocity. . −24 0

ε HERCULIS 1782.

1908. Aug. 15.
G. M. T. 16h 50m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9712				2	53·9308	·9566	·0132	−15·19
1	72·8162	·8545	·0103	−14·94	2	53·0801			
2	72·4052				2	45·2550			
2	57·7983				2	45·2055	·2241	·0146	−15·24
1½	57·7814	·8125	·0143	−17·21	1	27·3902	·3902	·0336	−29·16
2	54·7181				2	27·2578			

Weighted mean .... −17·44
V_a .... −17·09
V_d .... − ·24
Curvature .... − ·28

Radial velocity .... −35·0

ε HERCULIS 1793.

1908. Aug. 19.
G. M. T. 14h 41m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	71·8997				1	66·5842	·5905	·0873	−37·19
1	71·8180	·8198	·0673	−29·58	2	61·4037			
2	68·7255				½	61·1977	·2033	·0412	−16·93

Weighted mean .... −30·09
V_a .... −17·29
V_d .... − ·15
Curvature .... − ·28

Radial velocity .... −47·8

ε HERCULIS 1818.

1908 Aug. 24.
G. M. T. 14h 03m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9400				1	53·0350			
1	72·7367	·8053	·0595	−86·33	2	45·2000			
2	72·3715				1½	45·1002	·1737	·0650	−67·86
2	54·6722				1	27·2776	·3336	·0790	−68·57
2	53·9557				2	27·1906			
1	53·8285	9018	·0630	−78·27					

Weighted mean .... −74.44
V_a .... −17·55
V_d .... − ·15
Curvature .... − 28

Radial velocity .... − 92·4

ε HERCULIS 1838.

1908. Aug. 27.
G. M. T. 15h 50m

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9994	....	....	....	2	45 2716	....	....	....
1	72 8367	·8463	·0185	−26·84	1	45·2345	2365	·0022	− 2 30
2	72·4383	....	....	....	1	27·4216	·3991	·0135	−11·72
2	57·8226	....	....	....	2	27 2694	....	....	....
1	57·8302	·8344	(076	+ 9·15	1	11·8840	8453	·0061	− 4.55
2	54·0265	....	....	....	2	11·5462	....	....	....
1½	54·9656	·9679	·0019	−2·19					

Weighted mean .... − 5·82
V_a .... 17·66
V_d .... − ·24
Curvature .... − 28

Radial velocity .... −24·0

ε HERCULIS 1844.

1908. Aug. 28.
G. M. T. 14h 07m

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0320	....	....	....	2	45·1750	·1561	·0826	−86·23
½	72·8382	8158	·0490	−71·10	½	27·3755	·3441	·0685	−59 46
2	72·4677	....	....	....	2	27·2780	....	....	....
2	54·0522	....	....	....	1	11·7805	·7394	·1120	—82·79
1	53·9207	·8973	·0725	−81·45	2	11·5485	....	....	....
2	45·2925								

Weighted mean .... −80·80
V_a .... −17·63
V_d .... − ·16
Curvature .... − ·28

Radial velocity .... −98·9

ε HERCULIS 1853.

1908. Aug. 31.
G. M. T. 13h 52m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·0330	....	....	....	1	45·2510	·2530	·0143	+14·93
2	53 9830	·9788	·0100	+11·51	¼	27·4040	·4166	·0040	+ 3·47
2	45·2716	....	....	....	2	27·2340	....	....	....

Weighted mean .... + 11·94
V_a .... − 17·63
V_d .... − ·16
Curvature .... − ·28

Radial velocity .... − 6·1

ε HERCULIS 1866.

1908. Sept. 4.
G. M. T. 14h 32m

Observed by J. B. CANNON.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·0286	....	....	....	2	45·2756	....	....	....
1½	53·9682	·9684	·0014	− 2·03	¾	45·2387	·2367	·0020	− 2·09

Weighted mean		2·05
V_a	−	17·56
V_d	−	·22
Curvature	−	·28
Radial velocity	−	20·1

ε HERCULIS 1903.

1908. Oct. 1.
G. M. T. 13h 12m

Observed by W. E. HARPER.
Measured by T. H. PARKER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9627	....	....	....	2	53·0938	....	....	....
½	72·8369	·8850	·0202	−29·31	2	45·2707	....	....	....
2	72·3935	....	....	....	½	45·2698	·2727	·0340	35·96
2	54·7217	....	....	....	2	43·5385	....	....	....
½	53·9629	·9891	·0121	13·93	1	43·0812	·0811	·0308	+31·38

Weighted mean	....	+ 28·39
V_a	− 13·58	
V_d	− 23	
Curvature	− ·28	
Radial velocity		+ 14·3

ε HERCULIS 1903.*

1908. Oct. 1
G. M. T. 13h 12m

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	57·8380	....	....	....	2	54·0527	....	....	....
⅛	57·8367	·8255	·0113	−13·60	½	45·3017	·2673	·0286	−31·95
⅜	53·0120	·9881	·0183	21·06	2	45·3080	....		....

Weighted mean	....	+ 22·17
V_a	13·58	
V_d	− 23	
Curvature	− 28	
Radial velocity		+ 8·1

* Check measurement.

ε HERCULIS 1905.

1908. Oct. 2.
G. M. T. 12h 23m

Observed by | Measured by | T. H. PARKER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72 9333				½	53 9743	0083	0385	44·31
½	72 8133	8888	0240	34·82	2	53·0845			
2	72 3735				2	45 2615			
2	54 7063				½	45·2510	·2631	0244	+25·47

Weighted mean	+34·86
V_a	16·17
V_d	19
Curvature	28
Radial velocity	+18·2

ε HERCULIS 1905.*

1908. Oct. 2.
G. M. T. 12h 23m

Observed by T. H. PARKER.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0219				1	54·0557	9920	0222	+25·55
½	72·9047	·8923	·0275	+39·90	2	45·3540			
2	72·4605				1½	45·3672	·2868	·0481	+50·22
2	54 0925								

Weighted mean	+40·28
V_a	−16·17
V_d	·19
Curvature	−·28
Radial velocity	+23 6

* Check measurement.

ε HERCULIS 1906.

1908. Oct. 2.
G. M. T. 13h 18m

Observed by } Measured by } T. H. PARKER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72 9878				2	45·2706			
½	72 8491	·8716	·0068	+9·86	1	45·2536		0179	18·69
2	72·4218				½	27·4469	·3999	0127	−11·02
2	54·7350				2	27·2936			
½	53.9915	·9995	·0297	+34·18	½	15·5485	4771	·0040	+2·93
2	53·1029				2	15·4700			

Weighted mean	+12 22
V_a	−16 17
V_d	−·23
Curvature	−28
Radial velocity	4·4

ε HERCULIS 1906.*

1908. Oct. 2.
G. M. T. [illegible] 18m

Observed by T. H. Parker.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0126	....	....	....	½	45·2729	·2434	·0047	− 4·81
½	72·8790	·8759	·0111	−16·11	2	45·3031	....	....	....
2	72·4515	....	....	....	½	27·4884	·4016	·0110	− 9·55
2	54·0508	....	....	....	2	27·3237	....	....	....
¾	53·9882	9662	0036	− 4·14					

Weighted mean.......	− 1·15	
V_a.........	...	−16·17
V_d................	..	− ·23
Curvature	....	− 28
Radial velocity ...	....	−15·5

* Check measurement.

ε HERCULIS 1917.

1908. Oct. 5
G. M. T. 12h 45m

Observed by T. H. Parker.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	53·9338	.	....	....	1	53·9042	·9992	·0294	+33·84

Weighted mean.	....	−33·84
V_a...	.........−15·21	
V_d....	− ·22	
Curvature	·28	
Radial velocity....	..	−18·1

ε HERCULIS 1926.

1908. Oct. 12.
G. M. T. 14h 15m

Observed by / Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7809	....	....	....	2	45·3392	....	....	....
½	53·0112	·9684	·0014	− 1·61	½	45·2745	·2089	·0298	−31·11
2	53·1586	....	....	....					

Weighted mean....	−16·36
V_a......	−12·99
V_d........	− ·28
Curvature....	− ·28
Radial velocity .	−29·9

ε HERCULIS 1926.*

1908. Oct. 12.
G. M. T. 14h 15m

Observed by T. H. Parker.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9282	....	....	.....	1	53·9142	·9648	·0050	5·55
¼	72·7570	8283	·0265	38·47	2	45·2412	......	....	....
2	72·3640	......	....	.....	¾	45·1955	2281	·0106	– 11·06
2	53·9777	.....	....	....					

Weighted mean .... 11·73
V_a .... – 12·99
V_d .... – ·28
Curvature .... – ·28

* Check measurement.

Radial velocity .... – 25·3

ε HERCULIS 1961.

1908. Nov. 13.
G. M. T. 10h 33m

Observed by }
Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9540	....	....	....	1½	45·1868	·1763	·0725	75·91
½	72·7900	·7980	·0207	– 30·08	1	27·4609	·4488	·0394	34·36
2	72·3992	....	....	....	2	27·3340	....	....	....
2	54·0249	....	....	....	½	11·8665	·8626	·1378	– 103·76
1	54·9106	·9010	·0556	64·16	2	11·6620	....	....	....
2	45·2941	....	....	....					

Weighted mean.......... – 62·07
V_a .... 4·70
V_d .... ·23
Curvature .... ·28

Radial velocity .... – 67·3

ε HERCULIS 1961.*

1908. Nov. 13.
G. M. T. 10h 33m

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9915	....	....	....	2	48·8173	....	....	....
½	72·8067	·8233	·0415	– 60·22	½	48·1143	·0670	....	....
2	72·4317	....	....	....	2	45·3301	....	....	....
2	54·7682	....	....	....	1	45·2254	·1689	·0698	72·87
1	53·9192	8912	·0603	62·42	1	27·4192	·3334	·0792	– 67·74
2	53·1417	......	....	....	2	27·3324	....	....	....

Weighted mean.......... – 66·75
V_a .... – 4·69
V_d .... – ·25
Curvature .... – ·28

* Check measurement.

Radial velocity .... – 71·8

ε HERCULIS 1961.*

1908. Nov. 13.
G. M. T. 10h 33m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9300				2	53·0847			
½	72·7524	7849	·0338	−48·11	2	45·2672			
2	72·3700				1	45·1730	·1894	·0593	62·09
2	54·7057				½	11·8557	8791	·1213	−91·95
¼	53·8622	·8807	0759	87·59	2	11·6345			

Weighted mean	−68·24
V_a	−4·70
V_d	−·23
Curvature	−·28
Radial velocity	−73·4

* Check measurement.

ε HERCULIS 1983.

1908. Nov. 26.
G. M. T. 10h 07m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9887				2	53·1422			
2	72·4267				2	45·3295			
2	57·8410				½	45·2686	·2237	0250	−26·17
¼	57·8284	·7837	·0210	−25·32	2	27·3610			
2	54·7670				2	11·6692			
1	53·9637	·9227	·0339	39·12					

Weighted mean	−29·54
V_a	−·79
V_d	−·25
Curvature	−28
Radial velocity	−30·9

ε HERCULIS 1993.

1908. Dec. 2.
G. M. T. 11h 05m

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0015				2	54·0327	·9273	·0159	18·28
½	72·8197	·7353	·0368	−53·51	2	45·3945			
2	72·4371				1	45·3182	·2173	·0416	−43·68
2	54·1072								

Weighted mean	−30·57
V_a	+1·12
V_d	−28
Curvature	−·28
Radial velocity	−30·0

ε HERCULIS 2263.

1909. Feb. 8.
G. M. T. 22h 08m

Observed by, Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·8987	.		. . . .	1	45·2382	·1897	0692	79·51
½	72·7145	7305	·0416	−60·49	½	27·5582	·5058	0560	49·56
2	72·3414	. . .	. . . .	. . . . .	2	27·4495	. . . . . .	. . . .	. . . .
2	54·0360	. . . . . .	. . . .	. . .	½	12·1170	·1096	0391	−29·56
1	53·9233	8891	·0541	62·57	2	11·8145	. . . . . .	. . . .	. . . . . .
2	45·3421	. . . . .	. . . .	. . . .					

Weighted mean		− 60·54
V_a.	+ 17·19	
V_d.	− ·16	
Curvature.		− 28
Radial velocity		− 43·5

ε HERCULIS 2264.

1909. Feb. 8.
G. M. T. 23h

Observed by, Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·8680	. . . .	. . . .	. . . .	1	45·2202	·2118	·0471	−54·12
½	72·6942	·7400	·0321	−46·67	1	27·5152	·5061	·0551	−49·29
1	72·3157	. . . . . .	. . . .	. . . .	2	27·4062	. . . . . .	. . . .	. . . .
2	54·0053	. . . .	. . . .	. . . .	1	12·0368	·0711	·0776	−58·66
1½	53·8918	·8878	·0554	−64·07	2	11·7743	. . . .	. . . .	. . . .
2	45·3020	. . . .	. . . .	. . . .					

Weighted mean		− 56·30
V_a.	+ 17·19	
V_d.	+ ·12	
Curvature		− ·28
Radial velocity		− 39·3

ε HERCULIS 2305.

1909. Feb. 22.
G. M. T. 21h 34m

Observed by J. B. Cannon.
Measured by W. E. Harper

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9872	...	...	...	½	53·9658	·9111	·0321	– 37·13
½	72·8275	·7571	·0150	– 21·81	2	45·3275	...	...	...
2	72·4233	...	...	...	1	45·2636	·2295	·0294	– 30·87
2	57·8428	...	...	...	½	27·4794	·4953	·0665	– 58·22
1½	57·8125	·7522	·0303	– 36·63	2	27·3812	...	...	...
2	54·0565	...	...	...					

Weighted mean		– 36·09
V_a	– 17·95	
V_d	– ·15	
Curvature		– ·28
Radial velocity		– 18·2

ε HERCULIS 2306.

1909. Feb. 22.
G. M. T. 22h 36m

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9687	...	...	...	2	45·3155	...	...	...
½	72·8071	·7544	·0177	– 25·74	1	45·2637	·2415	·0174	– 18·27
1	72·4092	...	...	...	½	27·5020	·5276	0342	– 29·93
1	57·7942	...	...	...	2	27·3725	...	...	...
2	57·8290	·7477	·0348	– 42·05	1	11·9835	·0905	·0582	– 44·00
2	54·0450	...	...	...	2	11·7002	...	...	...
1	53·9530	·9100	·0332	– 38·40					

Weighted mean		– 34·12
V_a	+ 17·95	
V_d	+ ·09	
Curvature		– ·28
Radial velocity		– 16·4

ε HERCULIS 2327.

1909. March 2.
G. M. T. 21h 12m

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9387	....	....	......	2	45·2988	....	....	....
½	72·8030	·7800	·0079	11·49	1¼	45·3043	·2991	·0402	+42·21
2	72·3801	....	....	......	½	12·0685	·1891	·0404	+30·54
2	54·0227	....	....	......	2	11·6875	....	....	....
¾	53·9890	9681	·0249	+28·70					

Weighted mean.... .. .. +31·76
V_a.. ... . +17·90
V_d........... .... + ·14
Curvature .. .. . – ·28

Radial velocity .... – 49·5

ε HERCULIS 2328.

1909. March 2.
G. M. T. 22h 26m

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	53·9935	....	....	....	2	45·2644	....	....	....
1	53·9260	·9343	·0091	–10·52	½	45·2350	·2642	·0053	+ 5·56

Weighted mean .. .. 5·16
V_a. ... . +17·90
V_d....... . . .. . + ·05
Curvature.... . – ·28

Radial velocity..... . – 12·5

ε HERCULIS 2370*.

1909. March 13.
G. M. T, 18h 35m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	50·9370	....	....	....	½	34·7430	34·7193	·1038	100·00
1	50·8242	·8081	·0804	–93·05	2	34·6975	....	....	....

Weighted mean .. .. –95·36
V_a.... .... +17·44
V_d.. . ... – ·19
Curvature....... .... – ·30

Radial velocity . . .. –78·0

* This plate and all following were taken by the new single-prism Spectroscope.

ε HERCULIS 2371.

1909. March 13.
G. M. T. 19h 23m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	58·8462	....	....	....	1	50·8549	·8347	·0538	−62·27
½	58·7184	·6911	·0741	−94·51	½	34·7589	·7401	.0820	−79·00
2	50·9411	....	....	....	2	34·6926	....	....	....

Weighted mean	−71·66
V_a	+17·44
V_d	+ ·19
Curvature	− ·30
Radial velocity	−54·3

ε HERCULIS 2384.

1909. March 15.
G. M. T. 19h 32m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	58·8228	....	....	....	2	50·9196	....	....	....
½	58·7768	·7729	·0077	+ 9·82	½	50·9081	·9094	·0209	−24·19

Weighted mean	−19·40
V_a	+17·16
V_d	+ ·18
Curvature	− ·30
Radial velocity	−36·4

ε HERCULIS 2385.

1909. March 15.
G. M. T. 20h 30m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	58·8349	....	....	....	1	50·9261	·9091	·0206	+23·84
½	58·7924	·7764	·0112	+14·29	½	34·8678	·8413	0192	+18·50
2	50·9379	....	....	....	2	34·7003	....	....	....

Weighted mean	+21·36
V_a	+17·16
V_d	+ ·18
Curvature	− ·30
Radial velocity	+38·4

ε HERCULIS 2454.

1909. March 21.
G. M. T. 20h 05m

Observed by, Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	58·8306	....	....	....	1	50·9084	·9091	·0206	+23·84
½	58·7836	·7720	·0068	+ 8·67	½	34·7992	·8274	·0053	+ 5·11
2	50·9202	....	....	....	2	34·6456	....	....	....

Weighted mean	+15·34
V_a	+14·93
V_d	− ·06
Curvature ·30	
Radial velocity	−30·0

ε HERCULIS 2455.

1909. March 31.
G. M. T. 20h 39m

Observed by, Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	58·8294	....	....	....	1	50·9111	·9091	·0206	+23·84
½	58·8022	·7917	·0265	+33·80	½	34·7789	·8005	·0216	−20·90
2	50·9229	....	....	....	2	34·6522	....	....	....

Weighted mean	+15·15
V_a	+14·93
V_d	+ ·06
Curvature − ·30	
Radial velocity	+29·8

OBSERVING RECORD AND DETAILED MEASURES OF η BOÖTIS.

P.—Plaskett.
P[1].—Parker.
H.—Harper.
C.—Cannon.
T.—Tribble.

RECORD OF SPECTROGRAMS.

Star.	No. of Negative.	Camera.	Plate.	Date.	Middle of Exposure. G. M. T.	Duration.	Hour Angle at end.	Temperature. Room. Beg.	Room. End.	Prism Box. Beg.	Prism Box. End.	Slit Width.	Seeing.	Observer.
				1906.	h. m.	m.	h. m.	Fahrenheit.		Centigrade.				
η Boötis.	308	IL	Seed 27.	June 25	15 55	35	3 30W.	65·0	64·0	22·7	22·8	·001	Poor ...	P
" ..	313	"	" ..	" 27	14 35	35	2 15W.	75·6	74·0	27·1	27·0	·001	Fair....	P
" ..	318c	"	" ..	" 29	14 21	18	2 10W.	77·4	76·2	27·0	27·0	·0009	" ..	P
" ..	326	"	" ..	July 4	14 50	60	3 15W.	62·5	60·9	21·3	21·4	·001	Fair to good ..	P
" ..	333	"	"	" 6	15 00	70	3 40W.	71·5	68·0	25·3	25·4	·001	Fair....	P
" ..	366	"	" ..	Aug. 6	14 05	70	4 45W.	78·0	74·0	28·8	28·8	·001	Good...	P
"	372	"	"	" 8	14 15	75	5 10W.	80·8	77·5	29·5	29·3	·001	Fair....	P
				1907.										
" ..	657	"	" ..	Mar. 8	18 45	30	50E.	26·5	25·6	1·3	1·5	·0013	Fair....	P
" .	670	"	" .	" 20	18 32	45	10E.	28·6	28·3	2·8	2·9	·0013	Good...	P
" .	691	"	" .	Apr. 3	18 02	35	15W.	44·0	40·2	9·8	10·1	·001	Poor ...	P
" ..	731	"	" .	" 19	18 35	10	1 37W.	34·8	34·5	10·4	10·4	·0013	Clouds .	P
" ..	739	"	" .	" 26	17 30	30	1 07W.	42·0	40·4	9·0	9·0	·0013	Fair....	P
" .	752	"	" .	May 7	14 20	20	1 30E.	50·5	50·0	16·1	16·1	·0013	" ..	H
								Centigrade.						
" ..	760	IIIL	" ..	" 14	17 55	34	2 05W.	11·7	11·7	15·0	15·0	·0012	Very poor..	H
" .	764	"	" .	" 20	16 25	55	1 45W.	6·0	5·3	9·2	9·2	·0012	Unst'dy	H
" ..	769	"	" ..	" 22	16 51	47	2 20W.	10·5	10·5	13·2	13·2	·0012	Cloudy.	P
" .	774	IL	" .	" 23	14 08	16	37E.	15·5	15·0	17·3	17·3	·0012	Fair....	H
" ..	779	"	" .	" 24	15 01	12	20W.	11·8	12·0	16·4	16·4	·001	Good...	P
"	793	"	" ..	" 29	16 46	27	2 30W.	8·0	8·0	14·5	14·5	·001	Cloudy.	P
" .	797	"	" ..	" 31	14 54	12	45W.	15·2	15·2	19·0	19·0	·001	Good...	P
" .	812	"	" ..	June 10	13 35	35	1 48W.	16·6	15·6	18·2	18·0	·0009	" ..	P
" ..	868	"	"	" 21	14 27	25	1 40W.	25·4	24·6	28·9	28·9	·001	Hazy ..	P
" ..	891	"	"	" 27	14 55	30	2 35W.	22·0	22·0	24·5	24·5	·0012	Fair ...	H
" ..	918	"	" ..	July 8	15 09	18	3 30W.	21·5	21·1	22·4	22·4	·0012	" ...	P
" .	950	"	"	" 18	13 57	26	3 00W.	27·0	26·0	28·5	28·5	·0012	Very hazy..	T
" ..	972	"	"	Aug. 1	13 39	25	3 37W.	22·2	21·0	25·2	25·2	·001	Hazy ..	H
" ..	990	IIIL	" .	" 7	13 58	50	4 30W.	23·1	22·0	24·1	24·1	·0015	Poor ...	P
				1908.										
" ..	1231	IL	" ..	Jan. 14	22 00	26	1 10E.	−16·5	−18·0	− 5·2	− 5·5	·001	Hazy...	H
" .	1294	IIIL	" .	" 27	20 12	50	1 52E.	−20·0	−18·0	−15·3	−15·3	·0013	Good...	H
" .	1307	"	" ..	" 29	21 14	62	1 07E.	−25·3	−25·5	−13·7	−13·7	·0013	Unst'dy	P
" .	1332	"	" ..	Feb. 17	22 30	40	1 45W.	−17·5	−18·0	−10·5	−10·5	·0015	Good...	P
" ..	1357	"	" ..	" 24	19 06	47	1 20E.	−16·5	−15·5	−19·0	−18·6	·0013	Unst'dy	H
" .	1446	"	" ..	Mar. 30	20 52	40	3 50W.	0·5	0·5	6·0	6·0	·002	Fair....	H
" .	1513	"	" ..	May 4	18 13	55	2 40W.	8·0	7·0	13·4	13·3	·0017	Good ..	P[1]H
" .	1553	"	" .	" 25	15 58	64	1 50W.	21·3	20·5	25·6	25·4	·0016	" ...	P[1]
" .	1557	"	" ..	" 23	16 00	50	1 45W.	21·5	20·7	25·7	25·6	·0015	Fair....	P
" ..	1621	"	" .	June 22.	14 10	30	2 35W.	20·0	19·6	24·0	23·8	·0015	" ..	P
" ..	1663	"	" ..	July 6	14 40	80	3 25W.	25·3	24·8	26·8	26·3	·0015	Good...	P
" ..	1710	"	" ..	" 15	14 41	102	4 11W.	19·5	18·0	21·8	21·6	·0015	Cloudy.	C
"	1792	"	" ..	Aug. 19	13 18	60	4 47W.	18·8	16·5	24·3	23·8	·0018	Good...	H
" ..	1867	"	" ..	Sept. 7	12 57	65	5 40W.	18·2	17·6	21·4	21·2	·0015	Fair....	P
				1909.										
" .	2115	"	"	Jan. 7	23 23	60	10W.	−20·0	−20·5	−13·6	−13·6	·0016	Fair....	P
" .	2209	"	" ..	" 30	18 37	45	3 20E.	− 8·3	− 8·5	− 2·8	− 2·9	·0016	Unst'dy	P
" ..	2283	"	" ..	Feb. 17	20 30	62	00	−12·0	−12·0	− 1·3	− 1·3	·0015	Good...	C
" ..	2396	"	" ..	Mar. 20	17 00	60	1 30E.	− 2·3	− 3·3	4·6	4·6	·0015	Fair ...	P

η BOÖTIS 308.

1906. June 25.
G. M. T. 15h 55m

Observed by J. S. Plaskett.
Measured by J. N. Tribble.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.
3	65·1413	4583·661	....	....	....	....	1½	46 0370	4376·165	....	....	....	....
2	62·3546	4550·101	·165	·766	·399	+26·28	1½	45·4280	4370·332	·276	·856	420	30·61
1	60·7590	4531·441	·473	·201	272	17·99	1½	41·8841	4337·216	....	....	....	....
1	60·5605	4529·147	·171	·807	·364	24·10	1	39·8944	4319·219	·191	·817	·374	38·64
1½	60·0525	4523·302	·318	·055	·263	17·43	¾	39·7049	4317·527	·503	·068	·435	30·21
2	57·5179	4494·721	....	....	....	....	1⅓	39·4547	4315·298	....	....	....	....
1½	54·9606	4466·816	....	....	....	....	¾	39·4909	4315·620	·600	·178	422	29·33
¾	54·2971	4459·723	·651	·304	·347	23·32	2	37·0639	4294·322	....	....	....	....
1¾	54.2635	4459·366	....	....	....	....	¾	33·1023	4260·796	·820	·503	·317	22·30
1⅓	53·8823	4455 320	·240	·962	·278	18·71	1	29·7582	4233 629	·685	·462	·223	15·79
¾	51·2524	4427·927	·855	·420	·435	29·45	1	31·9013	4250·924	·972	·643	·329	+23·21
1½	49·0104	4405·271	199	·951	·320	21·78	2	22·9884	4181·569	....	....	....	....

Weighted mean	+23·08	
V_a		−24·87
V_d		− ·25
Curvature		− ·28
Radial velocity		− 2·3

η BOÖTIS 313.

1906. June 27.
G. M. T. 14h 35m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.
2	70·0228	4549·704	....	....	....	....	1	58 7715	4425·974	·982	·608	·374	25·31
2	70·0646	4550·199	·143	·766	·377	+24.84	2	57·7472	4415·579	·571	·244	·327	22·20
2	68·8922	4536·420	·408	·965	·443	29·28	2	56·7110	4405·198	·194	·951	·243	16·80
1	68·4773	4531·556	·552	·202	·350	23·13	3S	56·6837	....	....	....	....	....
1	68·3445	4530·057	·057	·784	·273	18·04	2	55·7498	4395·689	696	·286	·410	27·96
2	68·2790	4529·300	·297	·807	·490	32·38	1	54·5449	4383·928	·970	·720	·250	17·07
3S	68 2356	....	....	....	....	....	1	54 5162	4383·650	....	....	....	....
1	67·7616	4523·337	·345	·855	·490	32·38	1	53·1281	4370·320	·356	·856	·500	31·30
3	65·2295	4494·746	....	....	....	....	1	52·9142	4368·285	·320	·840	·480	32·92
1	64·1575	4482·928	·924	·434	·490	32·88	2	51·2105	4352·272	·312	·006	·366	21·08
1	63·5802	4476·631	·631	·214	·420	28·09	3	48·3264	4325·902	....	....	....	....
2	63·5399	4476·193	....	....	....	....	2	47·8181	1321·348	·368	·992	·376	26·05
1	63·2805	4473·381	·377	·*57	420	28·10	2	47·1641	4315·529	·545	·178	·367	25·46
2	62·6605	4466·698	....	....	....	....	3S	46·3197	....	....	....	....	....
2	59·7122	4435·639	·654	·184	470	31·77	1	46·3442	4308·296	·296	·023	·273	18 97
1	58·9422	4427·719	·730	·420	·310	20·98	2	46·1418	4306·521	·513	·153	·360	25·02

Weighted mean		+25·87
V_a	−25·19	
V_d	− ·14	
Curvature	·50	
Radial velocity		0·0

η BOÖTIS 318c.

1906. June 29.
G. M. T. 14h 21m

Observed by J. S. Plaskett.
Measured by J. N. Tribble.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.
2½	65·1913	4584 018	...	...	...	...	1½	46·8204	4383·596	...	...	...	...
2	62·3803	4550·121	·205	·766	·439	+28·93	1½	45·5865	4371·738	·806	·312	·494	29·78
2	62·3321	4549·552	...	...	...	...	1	45·4158	4370·111	·177	·856	·321	22 03
½	60·7998	4531·584	·664	·202	·462	30·59	1	45·2187	4368·238	·302	·840	·462	31·84
1½	60·5480	4528·712	...	...	...	...	¾	42·2886	4340·901	·941	·634	·307	21·20
¾	60·0766	4523·289	·377	·855	·522	34·61	1½	39·4436	4315·255	...	...	...	...
1½	57·5359	4494·635	...	...	...	...	1	38·6660	4308 394	390	023	·367	25·53
1½	54 2713	4459·185	...	...	...	...	3	37·0462	4294·299	...	...	...	...
1½	53·9012	4455·264	·384	·962	·422	28·40	1	35·7398	4283·122	·106	·721	·385	26·95
1	51·5610	4430·869	·985	·678	·307	20·78	1½	33·0517	4260·643		...	...	...
2	50·0623	4415·601	·709	·293	·416	28·25	1	28·9306	4227·475	463	·010	453	32·12
1½	50·0089	4415·084	...	...	...	...	1	25·2131	4198·823	·819	·403	...	+28 78
2	49·0242	4405·227	·331	·951	·380	25·87	2	22·9474	4181·919	...		...	...
1	46·8536	4383·917	·001	·720	·281	20·02							

Weighted mean		+ 27·55
V_a	− 25·31	
V_d	− ·14	
Curvature...........	− ·28	
Radial velocity		+ 1·8

η BOÖTIS 326.

1906. July 4.
G. M. T. 14h 50m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.
2	47·9535	4321·280	·292	·992	·300	+20·97	1	62·1243	4459·686	·724	·304	·420	28·22
2	72·9821	4584·067	...	...	...	...	2	61 7085	4455·266	·300	·962	·338	22·74
1	72·0410	4572·552	·528	·156	·372	24·32	1	61·3025	4450·975	·097	·654	443	29·81
2	70·1726	4550 127	·126	·766	·360	23 68	2	59·0672	4427·735	·743	·420	·323	21·86
2S	70·1316	...	...	...	...	...	2	57·8787	4415·645	·638	·293	·345	23·42
2	68·9985	4536·325	·325	·965	·360	23·79	2	56·8425	4405·249	·251	·951	·300	20·43
1	68·3839	4529·186	·187	·807	·380	25·15	3S	56·8102	...	...	...	...	...
3	68·3512	4528·807	...	...	...	...	2	55·8790	4395·702	·710	·286	·424	28·91
1	67·8624	4523·173	·165	·855	·310	20·55	3	54 6865	4384·041	·060	·720	·340	23·25
2	65·9783	4501·798	·786	·448	·338	22·47	2	54·6501	4383·688	...	...	...	...
3	65·3427	4494·706	...	...	...	...	2	53·4072	4371·721	·752	·312	·440	30·18
2	63·6949	4476·593	·584	·214	·370	24·75	1	53·0457	4368·273	·300	·840	·460	31·55
2	63·6582	4476·195	...	...	...	...	2	51·3477	4352·284	·308	·006	·302	20·80
2	63·3995	4473·387	·407	·957	·450	30·15	3	50·1222	4340·944	·960	·634	·326	22·49
2	62·7750	4466·648	...	...	...	...	3	48·4705	4325·922	...	...	...	...
1	62·8070	4466·982	·061	·771	·290	19·45	3	47·3080	4315·523	·523	1·78	·345	+23·94
2	62 6324	4465·118	·158	·712	·446	29·92	3S	46·4662	...	...	...	...	...

Weighted mean	+ 24·70	
V_a		− 25·68
V_d		− ·21
Curvature...........		− ·50
Radial velocity		− 1·7

η BOÖTIS 333.

1906. July 6.
G. M. T. 15h 0m

Observed by J. S. Plaskett.
Measured by J. N. Tribble.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.
3	65·1677	4584 687					2	49·0105	4405·903	·327	·951	·376	25·60
1	64.2090	4572·978	·370	·156	·214	+14·03	2	49·9783	4415·602				
2	62·3521	4550·733	·149	·766	·383	25·23	1½	46·8362	4384·534	·958	·720	.238	16·28
2	62·3108	4550·244					1	46·0199	4376·656				
1½	60 7739	4532·258	·690	·202	·488	32 27	2	45·2045	4368·866	·298	840	458	31 43
1½	60·5228	4529·354					2	42 2765	4341·509	·949	·634	·315	21·66
2	57·5196	4495·363					1¾	39·4279	4315·792				
1½	54·8062	4465·776	·200	·972	228	15 31	2	38·6559	4308·969	425	·023	402	29·97
1	54·5412	4462·942	·366	·977	.389	26 15	2	37·6252	4299·954				
1	54·2551	4459·893					1	37·0706	4295·148	·620	·273	·347	24·22
2	53·8852	4455·966	·390	·962	428	22·07	2	33·0446	4261·155				
1	53·4774	4451·659	·079	·597	·482	32·45	2	33·0766	4261 419	·923	·523	.400	28·14
2	51·5374	4431·472	·888	·678	·210	14·21	1¾	28·9090	4227·803	·371	·010	.361	25·59
2	51·2451	4428 473	.893	·420	·473	32·02	2	24·3115	4192·463	·103	·678	.425	+30·37
1½	51·0727	4426 719	·135	·805	·330	22·37	2	22·9368	4182·232				
2	50·0457	4416·282	·702	·293	·409	27·76							

Weighted mean.................. +24 60
V_a .... −25·76
V_d .... − ·21
Curvature .... − ·28

Radial velocity.......................... − 1·7

η BOÖTIS 366.

1906. Aug. 6.
G. M. T. 14h 5m

Observed by W. E. Harper.
Measured by J. N. Tribble.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.
2½	65·2314	4584·018					1½	46·8746	4383·831	871	·720	·151	10·42
1	64·2565	4572·121					1½	46·8483	4383·577				
2	62·4060	4549·971	.039	·766	·273	+18·00	1	45.6093	4371·677	·707	·312	·395	27·11
2	62·3706	4549·552					1½	45 2419	4368·182	·210	·840	·370	25·38
1½	60·8339	4531·583	.495	·202	.293	19·38	1	46·0709	4376·090				
1½	60·5846	4528·704					1½	42 3186	4340·924	·936	·634	·302	20·85
½	60·1077	4523·221	·307	·855	·452	29·97	1½	39·4696	4315·255				
2	57·5747	4494·670					1½	38·6818	4308·308	·296	·023	·273	18·99
1	53·9251	4455·161	·247	·962	.285	20·18	2	37·0702	4294·292				
1	53·5350	4451·047	·131	·597	·534	35·98	2	33·0764	4260·658				
1½	54 3107	4459·249					1½	28·9385	4227·371	·349	·010	·339	24·03
1½	51·5845	4430·779	·859	678	·181	12·25	1½	25·2344	4198·838	·830	·403	·427	28·48
2	50.0855	4415·538	·602	·293	·309	21·09	1	24 3315	4192·055	·047	·678	·369	+26·37
1½	50·0371	4415·051					2	22·9657	4181·919				
2	49 0520	4405·195	·251	·951	·300	20·42							

Weighted mean.................. +23·28
V_a .... −23·23
V_d .... − ·21
Curvature .... − ·28

Radial velocity.......................... − 0·4

η BOÖTIS 372.

1906. Aug. 8.
G. M. T. 14h 1[illegible]

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.
2	72·9730	4584·279	.....	.....	.....	.....	2	59·0301	4427·683	·683	·420	·263	17 80
2	71·4967	4566·264	·114	·726	·388	+25·33	3	57·8275	4415·472	·456	·244	·212	14 43
1	71·3535	4564·535	.....	.....	.....	.....	3	56·7962	4405·149	·149	·951	·198	13·48
2	70·6887	4556 559	·539	202	·337	22 14	3S	56·7738	.....	.....	.....	.....	.....
3	70·1445	4550·083	·083	·766	·317	20·85	2	55·8252	4395·551	·567	·286	·291	19 84
3S	70·1072	.....	.....	.....	.....	.....	2	54 6369	4383·963	·995	·720	·275	18 81
2	68·9701	4536·273	·233	·965	·268	17·71	1	54·6080	4383 683	.....	.....	.....	.....
2	68·3516	4529·077	·017	·807	·210	13·90	1	53·3464	4371·570	·602	·312	·290	19.89
3	68·3336	4528 881	.....	.....	.....	.....	1	53·1912	4370·093	·125	·856	·269	18·45
1	68 0462	4525 563	·505	·295	·210	13 95	1	52·9897	4368·180	·210	·840	·370	25·38
2	67·8440	4523·237	·177	·855	·322	21·24	2	52·1188	4359·963	·979	·784	·195	13·41
2	65·9487	4501·743	·743	·431	·312	20·74	2	52·0196	4359·033	·050	·732	318	21 87
3	65·3170	4494·693	.....	.....	.....	.....	2	51·2852	4352·180	·180	·006	·174	11 98
2	64·1450	4481 782	·806	·591	215	14 38	3	48·4145	4325·973	.....	.....	.....	.....
3	63·6316	4476·186	.....	.....	.....	.....	2	47·1450	4314·668	·660	·353	·307	21·30
1	63·0377	4470·518	·558	·300	·258	17·28	2	48 4512	4326·302	·270	·939	331	22·93
2	62·7485	4466·650	.....	.....	.....	.....	3S	46·3963	.....	.....	.....	.....	.....
2	62·7757	4466·943	·983	·771	·212	14·22	2	44·8470	4294·632	·552	·273	·279	19·50
2	62·0833	4459·540	·588	·304	·284	19·08	2	44·8210	4294·409	.....	.....	.....	.....
1	62·0545	4459·233	.....	.....	.....	.....	2	44·1405	4288·580	·500	·134	·366	25·58
2	61·2637	4450·865	·913	·596	·317	21·33	1	42·5767	4275·360	·280	·922	·358	−25 09
2	59·7795	4435·386	406	·184	·222	15·00							

Weighted mean.... .... +18·89
V_a .... −22 83
V_d .... − ·28
Curvature.......... − 50

Radial velocity.............. −4 7

η BOÖTIS 657.

1907. March 8.
G. M. T. 18h 45m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.
2	70·1436	4550·186	...	.....	......	....	1	58·8587	4425·560	·385	·805	·420	28·43
3	70·1197	4549·902	·356	·766	·410	−27·02	3	57 8397	4415·172	·033	·293	·260	17·65
2	68·9542	4536·160	·665	·965	·300	19·86	3	56·8292	4405 001	.....	.....	.....	....
2	68 5475	4531·415	·982	·202	·220	14·58	3	56·7987	4404·697	601	·951	·350	23·83
1½	68·4181	4529·911	·489	·849	·360	23·86	2	55·8360	4395·127	·056	286	·230	16·00
2	68 3585	4529 219	.....	.....	.....	....	2	54·6789	4383 776	.....	....	.....	....
2	68·3380	4528 981	·557	·807	·250	16·57	2	54·6412	4383·409	·370	·720	·350	23·94
2	67 8226	4523·022	·625	·855	·230	15·25	2	53·3717	4371·145	·152	·312	·160	10·96
2	65·3575	4495·078	....	.....	......	....	2	53·2120	4369·615	·636	·856	·220	15·07
2	65 3175	4494 631	·270	·550	280	18·67	2	51·3172	4351·693	786	·006	·220	15·14
1½	62·8052	4467 078	....	......	......	....	2	50·0839	4340·245	·364	·634	·270	18·63
2	62 6047	4464·920	·562	·772	·210	14·07	3	48·4987	4325·775	.....	.....	.....	....
2	61·6695	4454·916	·642	·962	·320	21·54	2	47·9197	4320·558	·752	·992	·240	16 63
2	61·2555	4450·527	·257	·597	·340	22 88	3	46·4945	4307·864	.....	.....	.....	....
2	59 0292	4427·311	·130	·420	·290	19·63	3	46·4645	4307·596	·793	·023	·230	−15 98

Weighted mean		−18·92
V_a	+13·75	
V_d	+ ·09	
Curvature		− ·50
Radial velocity		− 5·6

η BOÖTIS 670.

1907. March 20
G. M. T. 18h 32m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.
2	72·9506	4583·964	......	....	.....	....	3	56·7806	4404·929	.....	....	.....	.....
2	71·9460	4571·690	·762	·112	·350	−22·92	3	56·7601	4404·724	·721	951	·230	15 68
1½	70·0986	4549·552	....	....	......	....	2	55·7993	4395·209	.....	....	.....	....
3	70·0827	4549·365	·436	·766	·330	21·74	2	54·6290	4383·769	.....	......	.....	....
2	68·9205	4535·721	·775	·965	·190	12·58	2	54 5986	4383·548	·520	·720	·200	13·68
1	68 5150	4531·010	·062	·202	·140	9·28	1	53·1621	4369·660	·626	·856	·230	15·78
2	68 3215	4528·772	....	....	....,	....	2	51·2715	4351·839	·796	·006	.216	14·86
1	68 3066	4528·600	·647	·807	.160	10 61	1	50·0474	4340·514	·474	·634	·150	11·04
1	67·7847	4522·590	·635	·855	·220	14·60	3	48·4494	4325·976	.....	.....	.....	......
1	65·3175	4494·740	.....	.....	.....	....	2	48·4195	4325·707	·659	·939	·280	19 38
1	65·2786	4494·308	·320	·550	·230	15·34	2	47·8720	4320·790	·732	·992	·260	18·00
1	62·7505	4466·699	·551	·771	·220	14·74	3	46·4482	4308·150	.....	...	.....	....
1	62·7368	4466·540	592	·772	·180	12·08	3	46·4205	4307·906	·843	·023	·180	12·50
1½	62·5533	4464 583	.....	......	.....	......	1½	48·2000	4271·650	·570	·865	·295	20·56
2	61·6272	4454·717	·725	·962	·237	15·93	2	40 8897	4260·744	.....	.....	.....	....
1	58·0902	4427·252	·260	·420	·160	10·83	2	40·8547	4260·455	·370	·640	·270	18·87
3	57·7921	4415·071	·083	·293	·210	14·26							

Weighted mean		−15·25
V_a	+ 8.78	
V_d	+ ·04	
Curvature		− ·50
Radial velocity		− 6·9

η BOÖTIS 691.

1907. April 5.
G. M. T. 18h 02m.

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.
2	72·9612	4584 046	....	....	....	....	3	56·7745	4404·984	....	....	....	....
1	71 9513	4571·717	·730	·900	·170	−11·13	3	56·7572	4404·812	·761	·951	190	13·62
1	70·6445	4556 013	·022	·202	·180	11·80	2	55·7889	4395·232	·176	·286	·110	7·50
3	70·0995	4549·546	·556	·766	·210	13·84	2	54·6189	4383 808	....	....	....	....
2	70·1085	4549·612	....	....	....	....	2	54 5876	4383 504	·440	·720	280	19·83
1½	68·9195	4535 705	·695	965	·270	17·87	1	53·3159	4371·275	·202	·312	·110	7·55
1	68 5217	4531·088	·072	·202	·130	8·62	1	53·1540	4369·732	666	856	·190	13·03
2	68·3245	4528·809	....	....	....	....	2	51·2648	4351·942	·876	·006	·130	8·96
2	67·7992	4522 765	·735	.855	·120	7·96	1½	50·0325	4340·553	·489	·634	·145	10 00
2	65·3230	4494 834	....	....	....	....	2	48·4305	4325·995	....	....	....	....
1	65·2775	4494·329	·270	550	·280	18 67	1	47·8566	4320·846	792	·992	·200	13·88
1	63·3106	4472 793	·737	·957	·220	14 76	2	47·2100	4315·086	·038	·178	·140	9·73
2½	62·7485	4466·737	·612	·772	·160	10·74	3	46·4200	4308·108	....	....	....	....
1½	62·5545	4464·657	....	....	....	....	2	46 4001	4307·932	·883	·023	·140	9 74
2	62·0287	4459·047	·004	304	·300	20·16	2	40·8496	4260·662	....	....	....	....
1	61·6241	4454 755	712	·962	·250	16·80	2	40·8220	4260·434	·420	·640	·220	15·48
2	61·2216	4450·507	467	·597	·130	8·76	1	37·8036	4235·956	962	·112	150	10·62
2	58·9911	4427 357	·320	·420	·100	6·77	1	37·0112	4229·664	·676	826	·150	−10·65
1½	58·8230	4425·639	·605	·805	·200	13·54	1	36·7472	4227·580	....	....	....	....
3	57·7905	4415·163	·113	·293	180	12·22							

Weighted mean .. .. −12 29
V_a .. .. + 2·59
V_d .... ·00
Curvature.... . ... ·50

Radial velocity........... .... −10·2

η BOÖTIS 731.

1907. April 19.
G. M. T. 18h 35m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.
1½	72 9712	4584·004	....	....	....	....	2	56·7843	4405·001	.001	·951	·050	+ 3 40
1	71·9874	4571·996	·106	·116	·010	− 0·65	3	56·7769	4404 927	....	....	....	....
2	70·1315	4549·777	·776	·776	·010	+ 0·66	1	55·8147	4395·409	·386	·286	·100	+ 6·83
1½	70·1200	4549 641	....	....	....	....	2	54·6220	4383·766	....	....	....	....
1½	68·9540	4535·965	·965	·965	·000	·00	1½	54 6211	4383·757	720	·720	·000	·00
1	68·3433	4528·888	·887	·807	·080	+ 5·28	1½	53·1719	4369·837	·806	·856	·050	− 3·43
1	68·3355	4528·798	....	....	....	....	2	48·4312	4325·956	....	....	....	....
1	63·3442	4473·043	·007	·957	·050	+ 3·35	1	48·4336	4325·977	·959	·939	·020	+ 1·38
1½	62·7670	4466·826	....	....	....	....	3	46·4205	4308·075	....	....	....	....
1	62 5922	4464·952	·902	·772	·130	+ 8·74	1½	46·4160	4308·036	·033	023	·010	+ 0·69
1	61·6492	4454·916	892	·962	·070	− 4·72	2	40 8494	4260·646	....	....	....	....
1½	58·8439	4425·761	·755	·805	·050	− 3·38	1½	40 8433	4260·595	·590	·640	·050	− 3·50
2	57·8224	4415·399	·393	·293	·100	+ 6·80							

Weighted mean .... + 1·34
V_a .. .. − 4·57
V_d . ... − ·11
Curvature....... .... − ·50

Radial velocity...... .... − 3·8

η BOÖTIS 739.

1907. April 26.
G. M. T. $17^h 30^m$

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.
3	70 0827	4549·755	·796	766	030	+ 1·98	2	57·7755	4415 358	·373	·293	080	+ 5·43
2	70·0699	4549·604	....	....	....	....	3	56·7328	4404 911	....	....	....	....
1½	68 9152	4536·057	·105	965	040	+ 2·65	3	56·7360	4404·943	·961	·951	·010	+ 0·68
1	68·4980	4531 213	252	·202	·050	+ 3·31	2	55·7610	4395·296	326	·286	·040	+ 2·73
2	68·2387	4528·736	....	....	....	....	2	54 5687	4383·616	....	....	....	....
1	67·7681	4522 804	845	855	010	− 0·66	2	54 5705	4383·670	·750	·720	·030	+ 2·05
1	65·8880	4501 514	548	·508	040	. 2·66	1	53·1335	4369·862	926	·856	070	+ 4·80
2	65·2791	4494·730	....	....	....	....	2	51·2440	4352·066	·126	·006	·120	+ 8·26
1	65·2665	4494·590	·620	550	·070	+ 4·66	2	50 0165	4340 719	·774	634	·140	+ 9·66
1	63 6012	4476·313	·334	·214	·120	+ 8·04	2	48 3872	4325·910	....	....	....	....
1½	63·5860	4476·149	....	....	....	....	2	48·3885	4325·922	969	·939	030	+ 2·07
1	63 2975	4473·023	·037	·957	·080	+ 5·37	1	47·8422	4321·020	·042	·992	·050	+ 3·46
2	62·7133	4466·729	....	....	....	....	3	46·3798	4308·051	....	....	....	....
2½	61·6094	4454 963	·972	962	010	+ 0·67	2	46·3865	4308·110	133	·023	·110	+ 7·63
2	61·2057	4450·702	·707	·597	·110	+ 7 41	2	40 8133	4260·641	....	....	....	....
1½	58·9633	4427 425	·430	·420	010	+ 0 67	2	40 8102	4260·612	·610	·640	·031	− 2·11

Weighted mean .... + 3·70
V_a .... − 7·58
V_d .. .. − ·09
Curvature... .. .. − ·50

Radial velocity.... ... . − 4·5

η BOÖTIS 752.

1907. May 7.
G. M. T. $14^h 20^m$

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.
1	73·0097	4584·071	....	....	....	....	1	61·2811	4450·747	·807	·597	·210	14·13
1½	72·0492	4572·350	·392	·112	·280	+18·31	1½	59·0410	4427·514	·570	·420	·150	10·15
2	70·1677	4549·830	·866	·776	·100	6·60	3	57·8548	4415·473	·533	·293	·240	16·30
1	70·1520	4549·640	....	....	....	....	3	56·8036	4404·951	·021	·951	·070	4·77
2	69·0077	4536·228	·286	·965	·320	21·18	3	56 7947	4404·863	....	....	....	....
1½	68·5945	4531·433	·492	·202	290	19·20	2	55·8355	4395·380	·456	·286	·170	11·62
3	68 3596	4528·720	....	....	....	....	2	54·6312	4383·633	·720	·720	·000	·00
1	68 3767	4528·917	·987	·807	180	11·92	2	54·6284	4383·606	....	....	....	....
1½	67·8727	4523 121	·195	·855	·340	22·54	2	53·2125	4370·014	116	·856	·260	17 84
1	65·7679	4499·332	·399	·129	·270	17·98	1	51·3040	4352·057	·166	·006	160	11·00
1	65·3486	4494 672	....	....	....	....	1	50·0865	4340 815	·934	·634	·300	20·70
½	65·3500	4494·679	·750	·550	200	13·34	3	48·4356	4325·827	....	....	....	....
1½	63·3679	4472·994	·057	·957	100	6·70	1½	47·8955	4320·987	.122	·992	·130	9·00
1	62·7800	4466·663	....	....	....	....	3	46·4197	4307·917	....	....	....	....
1	62·6280	4465·038	·102	·772	·330	22·11	2	46·4370	4308·068	·223	·023	·200	+13·88
2	61·6907	4455·067	·132	·962	·170	11 44	2	40·8503	....	....	....	....	....

Weighted mean .... +13·07
V_a .... −12·01
V_d .. .. + ·11
Curvature........ . . − ·50

Radial velocity .. .. + 0·7

η BOÖTIS 760.

1907. May 14.
G. M. T. 17h 55m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.
2	77·0138	4586 749	....	.....	......	......	1½	60·3522	4476·077	...	...	......	.....
1½	75·0110	4572·563	·402	·112	·290	−18·96	1	60·3978	4476·358	438	·214	·224	14 03
1	74·0961	4566·168	·006	·726	·280	18 30	½	59·8743	4473·133	·223	·957	·266	17·84
1	72·7052	4556·546	426	·202	·224	14·72	1½	51·9075	4425·754	·924	·608	·316	21·39
½	71·7530	4550·028	·906	·766	140	9·22	1	48·7471	4407·805	·995	·851	·144	9·80
1½	71·7146	4549·767	..	...	.....	......	3	48·1928	4404·704	.....	.....	....	......
2	68·5907	4528·772	..	...	.....	....	1	42·0610	4371·304	·632	·312	·320	+21·95
1½	68·0928	4525·481	441	·295	·146	9·66	1½	38 5042	4352 659	......	.....	.....	......
1½	67·7272	4523·072	·035	·855	·180	11·92							

Weighted mean .... +15·25
V_a .... −14 70
V_d .... − ·14
Curvature .... − ·50

Radial velocity .... − 0·1

η BOÖTIS 764.

1907. May 20.
G. M. T. 16h 25m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.
2	76 8697	4586·673	·521	·191	·330	+21·52	1	57·5027	4459·583	·604	·304	·300	20 22
1½	76·8647	4586·638	·208	·018	·190	12·39	1	56·0608	4450 947	·967	·597	·370	24 93
1	76·5408	4584·329	·018	·618	·400	26·08	2	53·4276	4435·427	·444	184	·260	17 57
1	76·2327	4582·137	... ..	.....	.....	....	2	52·0857	4427·650	666	·420	·246	16·65
2	76·0296	4580·696	....	.....	.....	....	1½	51·8037	4426·026	·038	608	·430	29·11
1	73·6800	4564·218	·149	·939	·210	13.75	2½	49·9630	4415·519	·523	·293	·230	15·62
1½	72·5669	4556·532	472	·202	·270	17·76	2	49 9173	4415 260	.....	.....	.....	......
1	72·2842	4554·592	·537	·257	280	18·42	2	48·1222	4405 168	·171	·951	·220	15·60
1	72·0388	4552·913	·864	·594	·270	17 76	2	46·3847	4395 539	·539	·286	·253	17·25
2½	71 6337	4550·080	·046	·766	·280	18·42	1½	44·2712	4384·005	·005	·720	·285	20·14
½	71·5812	4549·791	..	...	......	....	2	43·4159	4379·392	.....	....	......	....
1	69 5846	4536·314	·295	·965	·330	21·81	1½	41·9670	4371·648	·652	·312	·340	23·30
2	68·4979	4529·079	·077	·807	·270	17·87	2	39·7680	4360·064	·074	·784	·290	19·90
2	67 5990	4522·147	·155	·855	·300	19·89	1½	39·5791	4359·078	·086	·732	·354	24·28
2	65·3760	4508·673	·685	·455	·230	15·30	1	38·4112	4353·015	... .	......	......	....
1½	64·3050	4501 799	·818	·448	·370	24·64	2	38 2760	4352·317	·336	·006	·330	22·70
2	63·2326	4494·979	·994	·664	·330	22 01	2	36·0640	4340·994	·004	·634	·370	25·53
1	63·1922	4494·724	.. ..	.....	......	....	2	33·0691	4325·962	.....	.....	......	....
1½	61·1145	4481·693	·710	·400	·310	20·74	1½	33 1252	4326·247	·239	·939	·300	20·76
2	60·2770	4476·506	·524	·214	·310	20·74	2	32·1120	4321·238	·226	·992	·234	16·20
1½	59 7526	4473·277	·297	·957	·340	22·78	1½	30·9360	4315·473	·458	·178	·280	19·40
1	59·1947	4469·856	·876	·520	·356	23·85	2	29·4608	4308·313	·293	·023	·270	18·72
1	58·6782	4466·704	....	.....	.....	....	2	29·4193	4308·113	......	......	...,..	....
½	58·4205	4465·137	·162	·772	390	26·13	2	25·2745	4288·450	·424	·134	·290	+20·27

Weighted mean .... +20·26
V_a .... −16·77
V_d .... − ·10
Curvature .... − ·50

Radial velocity .... + 2·91

η BOÖTIS 769.

1907. May 22.
G. M. T. 16h 51m

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.
2	72·3751	4554·627	·507	·257	·250	+16 47	2	57·5897	4459·591	·644	·304	·340	22·91
1½	72·1497	4553·084	·964	·594	·370	24 38	1	56·8622	4455·219	·272	·962	·310	20·89
3	71·7156	4550·122	·006	·766	·240	16 00	1½	52·1741	4427 666	·720	420	·300	20·31
1½	71·6651	4549 777	......	....	....	....	2	50·0535	4415·548	·598	·293	·305	20·70
2	6: ·6739	4536·338	·255	·965	·290	19·20	2	49·9998	4415 244	....	....	....	....
2	68 5989	4529·180	·107	807	·300	19·86	1½	48·2070	4405 164	·211	·951	260	17·73
2	68·5477	4528·841	.....	.....	.....	....	2	48 1555	4404·877	.....	....	...	....
2	67·6870	4523·161	·105	·855	·250	16·55	3	43 4978	4379·372	....	....	....	......
1	66·5626	4515·805	·768	·508	·260	17·10	1½	42·0517	4371·654	·702	·312	·390	26·75
1	66·4065	4514 789	·736	·476	·260	17·26	1	41·7560	4370·074	·116	856	·260	17·85
2	63·3054	4494·898	·894	·664	·230	15·34	1	41·3860	4368 116	·160	·840	·320	21·95
1½	63·2838	4494·762	......	....	......	....	2	38 4841	4352 949	....	....	.....	....
1	60·3530	4476 447	484	214	270	18 09	1½	38 3357	4352·182	·246	·006	240	16.54
2	59 8426	4473 304	·337	957	.380	25 46	1	32·1922	4321·209	·292	992	·300	20·76
1½	59·2733	4469 814	..	....	.....	....	2	30·9890	4315 312	·408	·178	230	+15·92
2	58 4874	4465·024	062	·772	·290	19·48	2	30·9043	4315·192		..	.....	....

Weighted mean... ... ... +19·46
V_a.... ... . −17·43
V_d.. .... ·14
Curvature.. .. .. . ·50

Radial velocity..... .... + 1·4

η BOÖTIS 774.

1907. May 23.
G. M. T. 14h 08m

Observed by W. E. HARPER.
Measured by J. N. TRIBBLE.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.
1	73 3722	4871·911	. .	.....	......	....	¾	42·5701	4299·750	·726	·277	·247	17 23
2S	73 5307	4875·673	......	......	....	......	1½	40·6425	4272·077	·053	·760	·293	20·56
1½	72 9489	4861·911	·803	·527	·276	+17·03	1¼	40 4252	4269·004	......	..	......	....
2	56·7439	4528·932	....	......	......	....	¾	39·8399	4260·771	·747	·640	107	7 53
1	57 9013	4549·900	......	......	......	....	2	36·5802	4216 114	·102	·897	·105	7·47
1	57·9293	4550·311	·119	·766	·353	23 26	2½	36·1574	4210·469	..	......	.....	....
1	52·5304	4455·601	·565	962	·603	40·65	1½	35 5747	4202·733	·733	·161	·272	17·51
2S	48·8521	4395·386	....	.. ..	......	....	1	35·2917	4198·999	·999	·494	·505	36·07
2½	49 1726	4400·502	....	....	......	....	1½	S35·5345	4202·202	......	......	.....	....
1	49·4586	4405·090	·982	·908	·074	5·04	1	30·0803	4132·687	·767	·212	·555	40·29
1	49 2138	4401·162	·162	·138	·424	28·87	1	29·3427	4123·660	.. .	...	....	... ...
1½	45·3618	4341·187	....	......	.....	.... ..	¾	28·9702	4119·134	·234	·844	·390	28·38
1	45·3471	4340 964	·948	·634	·314	21·82	1	27·5532	4102 114	·218	·000	·218	15·94
1	43·1330	4307·974	·950	·932	·018	1·25	¾	26·7817	4092·974	078	·626	·452	33·13
2	42·5531	4299 503	......	......	......	....							

Weighted mean....... .... +21·29
V_a ... . −17·73
V_d .. .. − ·03
Curvature... .... − ·28

Radial velocity. . ... + 3·2

η BOÖTIS 779.

1907. May 24.
G. M. T. 15h 01m

Observed by J. S. Plaskett.
Measured by J. N. Tribble.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.
2	58 0640	4549·549					1½	40·8102	4271·728	872	760	·112	7·85
1	58·0817	4549 873	·001	·766	·235	+15 46	2	37·6159	4227·429				
2	50·2577	4415·039					1½	37·5998	4227·211	·331	·904	427	30·27
1	50·2836	4415·459	·595	·293	302	20·54	1	36·7625	4215·917	·021	·897	·124	8·82
2½	49·6247	4404 812					1	35·4747	4198 795	·907	·403	·505	35·99
1	49·6384	4405 032	216	·951	·265	18·05	1	33·0716	4167·618	·706	438	·268	19·27
1½	46·3206	4352·943					2	31·1734	4143 682				
1	46·2767	4352·270	·454	·006	·448	30·86	1	31·1972	4143·979	051	·914	137	9·91
1	45·5212	4340 763	·939	634	305	20·95	1	29·9036	4127·997	·053	·862	·191	+13·88
2½	40·8015	4271·605					2	28·0030	4104·992				

Weighted mean.............. −18·15
V_a .... −18·04
V_d .... − ·21
Curvature..................... − ·28

Radial velocity..................... − 0·3

η BOÖTIS 793.

1907. May 29.
G. M. T. 16h 46m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in Revolutions.	Velocity.
1	61·2267	4613 852					2	47·7600	4379·416				
2	61 2151	4613·629	755	465	·290	+18·76	1½	47·0501	4368 323	·307	840	·467	32 04
2	60·7801	4605·266	437	997	·440	28·51	1	45·2664	4340 948	·954	·634	320	22·08
2	60·5522	4600 908	076	·524	552	35·76	2	44·2835	4326·157	·174	·694	·480	33·22
2	59·7843	4586·340					1	43·0857	4308 409	·443	·023	·420	29·15
1	59·6576	4583·954	·150	796	·354	23·08	2	43·0609	4308·044				
2	57·8364	4550·173	·308	766	·542	35·72	1½	40·5687	4272·055	·090	·760	·330	23·20
2	56·6522	4528 720					2	39·7598	4260·611				
2	52·7172	4460·183					2	39·7727	4260·835	861	·546	·315	22·14
2	50·0340	4415 682	·783	·293	·490	33·37	1	37·8163	4233·751	·768	·328	·440	31·15
2	49·3967	4405 432	·471	·951	·520	35·46	1½	36·5183	4216·158	·167	·897	·270	+19 17
3	48·7702	4395·409					2	35·4705	4202·202				
2	48·8021	4395·909	·896	·286	610	41·66							

Weighted mean........................ +29·03
V_a .... − 19·56
V_d .... − ·15
Curvature .... − ·50

Radial velocity.................. + 8·8

η BOÖTIS 797.

1907. May 31.
G. M. T. 14h 54m

Observed by J. S. Plaskett.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9660	...	...	...	2	43·0819	·0711	·0208	21·20
2	72·8399	·8829	·0181	+26·26	2	40·5728	·5560	·0301	29·86
2	72·4047	...	...	...	2	39·7707	·7517	·0249	24·50
2	57·8365	·8410	·0142	17·10	2	39·7551	...	...	...
2	57·8055	...	...	...	1½	37·3501	·3227	·0339	32·51
2	50·0029	...	...	...	2	36·5196	·4893	·0271	25·77
1½	49·3909	3937	·0263	28·72	1½	35·4969	·4631	·0355	33·40
1	48·7877	·7855	·0215	23·53	2	35·4641	...	...	...
2	48·7722	...	...	...	1½	31·6032	·5560	·0151	13·65
1	47·0514	·0483	·0352	37·45	2	30·1736	...	...	...
2	45·2777	...	...	...	2	27·3086	...	...	...
1½	45·2658	·2617	·0230	23·56	1½	26·7220	·6579	·0296	+25·48
2	43·5481	...	...	...	2	26·7084	...	...	...

Weighted mean		+25·50
V_a	−20·10	
V_d	− ·05	
Curvature	− ·28	
Radial velocity		+ 5·1

η BOÖTIS 812.

1907. June 10.
G. M. T. 14h 10m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement.	Velocity.
2	72·8854	4864·874	...	...	...	...	2	43·0742	4308·544	·560	·023	·537	37·37
2	72·7643	4862·010	·047	·527	·520	+32·08	2	42·0980	4294·278	...	...	...	...
1½	57·8020	4550·549	·386	·766	·620	40·85	1	41·3355	4283·269	·285	·722	·563	39·00
2	57·7617	4549·811	...	...	...	...	2	40·5595	4272·188	·204	·760	·444	31·12
2	53·0646	4466·768	...	...	...	...	1½	39·7652	4260·968	·987	·527	·460	32·34
1½	52·9887	4465·474	·412	·772	·640	42·94	2	39·7401	4260·615	...	...	...	...
2	52·4071	4455·617	·562	·962	·600	40·32	2	39·0561	4251·055	·067	·643	·424	29·89
2	52·2073	4452·249	...	...	...	...	1½	37·8028	4233·770	·778	·462	·316	22·37
2	49·3623	4405·394	·391	·908	·483	32·84	2	37·3322	4227·356	·364	·010	·354	25·06
2	48·7661	4395·825	·826	·426	400	27·28	1½	35·2093	4198·927	·924	·494	·430	30·70
2	45·9963	4352·404	·412	·957	·455	31·44	2	34·6878	4192·067	·068	·678	·390	27·70
2	45·2575	4341·177	...	...	...	...	2	31·9631	4156·989	·989	·623	·366	26·35
2	45·2518	4341·089	·099	·634	·465	32·08	2	30·9498	4144·262	·262	·928	·334	+24·11
1½	44·2697	4326·286	·299	·939	·360	24·91	2	27·3112	4099·919	...	...	...	...

Weighted mean		+30·09
V_a	−22.52	
V_d	− ·04	
Curvature	− ·28	
Radial velocity		+ 7·2

η BOÖTIS 868.

1907. June 21.
G. M. T. 14h 27m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement.	Velocity.
3	59·4917	4580·498	...	...	...	...	2	45 2755	4341 084	...	...	...	...
2	59·0511	4572 262	·308	·758	·550	+35·91	2	44·2785	4326·119	199	939	·260	18·00
3	57·8496	4550·094	156	·766	·390	25 70	2	43·5520	4315·347	·448	·178	270	18·71
1½	57·8233	4549·613	...	...	...	...	2	42·1004	4294 152	...	...	...	...
3	56·6631	4528·612	...	...	...	...	1	40·5592	4272 120	·270	·760	·510	35·70
1½	56·3594	4523·178	·345	·985	·360	23·80	2	39·7555	4260·816	·947	·527	·420	29·53
1½	53·1004	4466·545	...	...	...	...	2	39 7351	4260·530	...	...	...	...
2	50·9767	4430·966	·138	·678	460	31·14	1	36·4997	4216·283	·323	897	426	30·12
2	50·0392	4415·661	·824	·354	·470	31·96	1½	35·4821	4202·764	·768	·198	·570	40·58
2	50·0050	4415·107	...	...	...	...	2	35·4386	4202·190	...	...	...	...
2	49·4000	4405·349	·498	·908	·590	40.18	1	34·6655	4192·048	·038	·678	360	25·74
2	48·7697	4395·275	...	...	...	...	1	32·7961	4167·952	·902	·617	285	20·49
2	47·2771	4371·789	·893	·343	550	37·62	2	30 1393	4134·712	...	...	...	...
1½	47·1802	4370 281	·387	·867	·520	35·56	1	29·9750	4132 694	·592	·212	·380	+27·40

Weighted mean		+29·89
V_a	−24 46	
V_d	·11	
Curvature	− 28	
Radial velocity		− 5·0

η BOÖTIS 891.

1907. June 27.
G. M. T. 14h 55m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	57 7980	·8200	·0173	+20·87	2	40·5817	·5833	·0324	32·24
1	57·7762	...	...	...	2	39·7320	·7845	·0300	29·61
2	49·9624	...	...	...	2	39·7102	...	...	...
1	49·3500	·3936	·0279	30 55	1	37·3052	·3613	.0363	35·57
½	48 7547	·7987	·0160	17·41	1	36·4711	·5275	.0262	25·41
2	48 7277	...	...	...	1	35·4539	·5119	.0414	39·54
1½	47·0142	0602	·0391	41·25	2	35·4170	...	...	...
2	45·2395	...	...	...	1	31 5636	·6300	·0313	28 17
1½	45·2339	·2809	·0322	33 71	2	30·1178	...	...	...
2	43·5028	...	...	...	2	27·2449	...	...	...
2	43·0515	·1009	·0377	38 52	1½	26·6595	·7335	·0272	−24·13
2	42 0723	...	...	...	2	26·6400	...	...	...

Weighted mean		+30·53
V_a	24 37	
V_d	− 17	
Curvature	− ·28	
Radial velocity		+ 5·7

η BOÖTIS 918.

1907. July 8.
G. M. T. 15ʰ 09ᵐ

Observed by J. S. Plaskett.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	59·8099				1	44 2898	·2798	·0206	21.27
1	57·8572	·8620	·0352	+42·38	1	43·5460			
1	56 6611				1	43·0888	·0758	·0255	25·98
1	55·1526	·1576	0324	37·77	1	41·3060			
1½	54·7393				1	40·5805	·5615	·0356	35·31
1	50·0034				1	39 7823	·7613	·0264	25·97
1	50·0306	·6296	·0205	22 55	1	37·9860			
1	49·4064	·4034	0360	39·31	1	37·3568	3308	·0180	46·04
1	49·1127				1½	36·5317	·5047	·0425	40·41
1	48·8040	·8020	·0292	31·68	1	35 4581			
1½	48 7675				1	35 2228	·1928	·0438	41·08
1	46·0327	·0257	0385	40·40	1	31·8048	·7713	·0232	+21·01
1	45·2824	·2744	·0437	45·62	1	30·9164			
1	45·2825								

Weighted mean		+34·45
V_a	−25·79	
V_d	− ·24	
Curvature	− ·28	
Radial velocity		+ 8 1

η BOÖTIS 918.*

1907. July 8.
G. M. T. 15ʰ 09ᵐ

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1½	59·0510				2	44·3211	2820	·0228	23·55
1	59 0784	·0634	·0227	+27·74	2	43·5749			
2	57 8689	·8520	0252	30·34	2	43·1211	·0790	·0327	33 32
2	57 8388				2	41·8827	·8380		
1	56·8542	8352	·0244	29·04	2	41·3385			
2	56 6862				2	40·6093	·5590	·0331	32 83
1	55·1704	·1464	·0212	24·72	2	39·8204	·1694	·0345	33 95
2	54·0562				1½	39·7879			
1½	52·8790	·8510	0206	23 40	2	39·1058	·0533	·0370	36·11
2	52·4827	·4547	·0399	45·13	2	38·0112			
2	52·2770				2	37·3845	·3295	·0407	39·03
2	50 0586	·0280	0179	19·69	2	36·5511	·4940	·0318	30·24
2	49·4332	·4012	·0350	38·22	2	35·4884			
2	48·8006				1	35·5290	·4706	·0430	40·46
2	45·3140				1½	35·2561	·1973	·0483	+45·06.
2	45·3180	·2800	·0413	43·12					

Weighted mean		+33·11
V_a	−25 80	
V_d	− ·24	
Curvature.	− ·28	
Radial velocity		+ 6·8

*Check measurement.

η BOÖTIS 950.

1907. July 18.
G. M. T. 13h 57m

Observed by J. N. Tribble.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	59·7949	...	...	...	1½	43·5484	·5524	·0192	19.68
1	59·0552	·0672	·0265	+32·36	2	43·0820	·0852	·0451	45·95
1½	57·8347	·8427	·0160	19·26	1½	42·1019	...	...	...
1½	57·8138	...	...	...	2	40·5663	·5655	·0396	39·28
2	53·0966	...	...	...	2	39·7395	...	...	...
1½	52·8357	·8490	·0186	[illegible]	1	39·7719	·7700	·0351	34.54
2	52·4416	·4546	·0398	45·01	1	39·0430	·0385	·0222	21·67
1½	50·0253	·0343	·0241	26·51	2	37·3630	...	...	...
1	49·3917	·3997	0331	36·14	1	37·3251	·3195	·0307	29·44
1½	48·7944	·8010	·0282	30·79	1	36·5090	·5020	·0398	37·85
2	48·7650	...	...	...	3	35·4418	...	...	...
2	45·2671	...	...	...	1	35·4710	·4595	·0319	30·02
½	45·2590	·2654	·0267	27·87	1	35·1990	·1875	·0385	+35·92

Weighted mean		+31·38
V_a	−25·61	
V_d	− ·20	
Curvature	− ·28	
Radial velocity		+ 5·3

η BOÖTIS 950.*

1907. July 18.
G. M. T. 13h 57m

Observed by J. N. Tribble.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	59·8053	...	...	...	1	43·0955	·0835	·0332	33·82
1	59·0690	·0730	·0323	+39·43	1	42·1179	...	...	...
1	57·8528	·8563	·0295	35·51	1½	40·5776	·5621	·0362	35.91
1	57·0777	·0807	·0139	16·58	1	39·7823	·7653	·0304	29·91
1½	56·6654	...	...	...	1	38·0089	·9889	·0278	26·93
1	53·1105	...	...	...	1	37·9769	...	...	...
1	52·8502	·8512	0·208	23·62	1	37·8012	·7822	·0177	17·06
1	52·4460	·4470	0·322	36·41	1	36·5180	4960	·0338	32·04
1	45·2830	...	...	...	1	35·4775	·4535	·0259	+24·37
1	43·5729	·5619	·0287	29·43	1	35·4548	...	...	...

Weighted mean		+29·23
V_a	−25·61	
V_d	− ·20	
Curvature	− ·28	
Radial velocity		+ 3·1

*Check measurement.

η BOÖTIS 972

1907. Aug. 1
G. M. T. 13h 39m

Observed by, Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	59·8125	....	....	....	1	47·2717	·2733	·0315	33·55
1	59·0699	·0660	·0253	+30 89	1	47·1677	·1693	·0225	23·96
2	57·8529	·8497	·0229	27·57	1	47·0555	0571	·0409	43·56
2	57·8249	....	....	....	2	45·2721	....	....	....
2	56 6666	....	....	....	1½	45·2731	·2751	0364	38·00
1	56 3701	·3709	·0347	41 05	2	43·5334	....	....	....
1	55·1626	·1642	·0390	45·47	1	43·0770	·0795	0332	33·90
2	54·0291	....	....	....	2	40·5588	·5580	·0321	31·84
1½	52·8504	·8494	·0190	21·58	1½	39·7640	·7620	·0352	34·64
1	52·4609	4600	·0452	51·12	2	39·7388	....	....	....
2	52·2516	....	....	....	2	37·9622	....	....	....
1	50·0488	·0488	·0387	42·57	2	37·3332	3284	0396	37·97
1½	49·4090	4048	0386	42·57	2	36·5021	·4960	0338	+32·14
2	48·7684	....	....	....	2	35·4334	....	....	....

Weighted mean............		-36·02
V_a....................	-24·14	
V_d....................	-·24	
Curvature................	-·28	
Radial velocity..........		+11·4

η BOOTIS 990.

1907. Aug. 7.
G. M. T. 13h 58m

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions	Velocity.
1	77·5311	·3820	·0765	+34·73	2	68·8751	....	....	....
2	77·5065	....	....	....	1½	68·0457	·9557	0875	37·45
1	77·2249	·0775	·0838	37·88	2	67 6516	·5636	·0768	32·87
1½	75·4840	·3450	·0687	30·91	2	64·6597	·5717	·0641	26·92
2	75·3861	....	....	....	2	61·4950	....	....	....
1½	74·5448	·4108	·0755	33·75	1½	60·5500	·5045	0777	31·62
2	73·1143	·9873	·0597	26·45	2	58·9771	·9411	·0833	33·57
2	72·8337	·7101	·0719	31·71	1	58·6538	·6200	·0878	35·38
3	72·1565	·0350	·0677	29·79	2	56·4377	....	....	....
2	72·0721	....	....	....	1	50·0635	·0820	·0726	27·66
2	70·0758	·9700	·0879	38·15	1½	48·1930	·2266	·0853	+32·07
2	69·3246	·2233	·0691	29·78	2	46·3541	....	....	....
2	68·9702	·8732	·0867	37·37					

Weighted mean............		+32·66
V_a....................	-23·09	
V_d....................	-·28	
Curvature................	-·28	
Radial velocity..........		-9.0

η BOÖTIS 1231.

1908. Jan. 14.
G. M. T. 22h 00m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	57·8434	....	....	....	1½	44·2401	·2266	·0326	33·67
2	57·8277	·8047	·0221	−26·61	2	41·3012	....	....	....
1½	54·7647	....	....	....	2	40·5147	·5000	0259	25·69
2	53·1290	....	....	....	2	39·7496	....	....	....
1	52·8248	·8048	0256	29·08	2	39·7099	·6959	0309	30·40
2	52·3986	·3790	·0358	40·49	1½	39·0059	·9925	0238	23·23
2	52·2705	....	....	....	2	37·9716	....	....	....
2	49·9963	·9788	·0313	34·43	2	37·2765	2630	0258	24·74
1½	49·3502	·3340	·0334	36·47	1½	36·4496	·4350	·0272	25·87
2	48·7851	....	....	....	2	35·4474	....	....	....
1½	48·7630	7470	·0258	28·00	1½	35·4212	4043	·0233	21·92
2	45·2867	....	....	....	1½	35·1325	·1150	·0340	−31·72
1½	45·2195	2060	·0327	34·14					

Weighted mean	−29·76
V_a	−26·58
V_d	− ·12
Curvature	− ·28
Radial velocity	− 3·3

η BOÖTIS 1231.*

1908. Jan. 14.
G. M. T. 22h 00m

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	59·8174	....	....	....	1	44·2521	....	....	....
1	57·8144	8084	·0182	−21·91	1	41·2816	....	....	....
1	56·6735	....	....	....	1	40·4982	5032	·0227	22·51
1	53·1182	....	....	....	1	39·7312	....	....	....
1	52·8153	8133	·0171	19·42	2	39·6870	·6915	·0353	34·73
1½	52·3882	·3872	·0276	31·21	1½	37·9558	....	....	....
2	52·2605	....	....	....	1	37·2517	2567	·0321	33·66
1	50·0076	....	....	....	1	36·4308	.4358	·0264	25·00
2	49·9827	9847	·0254	27·94	2	35·4251	....	....	....
1	49·3633	....	....	....	1	35·3991	·4041	·0264	24·84
1	49·3360	3390	·0272	29·70	1	30·8692	....	....	....
1	49·1028	....	....	....	1	30.8499	·8543	·0213	−19·12
1	48·7675	....	....	....	1	29·9064	....	....	....
1	48·7445	·7485	·0155	16·81					

Weighted mean	−25·62	
V_a		+26·58
V_d		∓ ·12
Curvature	− ·28	
Radial velocity		+ 0·6

*Check measurement.

η BOÖTIS 1294.

1908. Jan. 27.
G. M. T. 20ʰ 12ᵐ

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	76·7049	....	....	....	2	60 2453	·2668	·0714	29.34
2	76·3139	·3760	·0487	−22·25	2	59·7232	·7437	·0627	25·11
2	74·9780	....	....	....	2	58·3645	3830	·0767	31·14
2	74·9412	·9966	·0686	31 07	2	57·4642	·4818	0701	28·32
2	74·0085	·0615	·0691	31·16	2	56·3435	....	....	....
2	73 3760	....	....	....	2	56 7436	·7596	0669	26·90
2	72·6176	6656	0690	30·77	2	56·0215	·0370	·0559	22·36
1½	71·7327	....	....	....	1	50·9975	....	....	....
3	71 6719	·7194	·0628	27 88	2	49·9284	9324	·0677	26·00
2	69·6070	·6495	0647	28·27	2	48·0797	0787	·0806	30·63
2	68·8730	·9130	·0794	34·46	2	46·4398	....	....	....
2	68·5172	·5572	·0705	30·60	2	46 3377	·3310	·0839	31·46
2	68·5312	....	....	....	2	38 2531	·2267	·0794	28.34
2	67·6069	·6434	·0735	31·75	2	36·2270	....	....	....
2	64·2811	·3091	·0754	31·82	2	36·0357	0027	·0878	30·90
2	61·3235	....	....	....	2	33·1311	·0940	·0779	−26·87

Weighted mean........		−29.00
V_a........	+25·27	
V_d........	+ ·16	
Curvature........		− ·28
Radial velocity........		3·8

η BOÖTIS 1307.

1908. Jan. 29.
G. M. T. 21ʰ 14ᵐ

Observed by J. S. Plaskett.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	76 7556	....	....	....	2	59·7720	·7402	·0662	27·12
1½	76·3539	·3649	·0598	−27·37	2	58·4380	4030	0567	23·02
2	75·0276	....	....	....	2	57·5179	4802	·0715	28 86
2	74·9901	·9980	·0660	29·92	2	56·8023	·7628	0637	25·59
2	74·0588	·0640	·0666	30 02	2	56·3977	....	....	....
2	73·4219	....	....	....	1	56·0711	·0300	0629	25·15
2	72·6605	·6620	·0726	32·41	2	50·0571	....	....	....
3	71·7218	·7208	·0614	27·24	2	49·9803	·9258	·0851	32·70
2	69·6614	·6552	·0590	25·81	2	48·1479	·0864	·0685	26·01
2	68·9241	·9159	·0765	33·31	2	46·4998	....	....	....
3	68·5710	·5620	·0657	28·53	2	46·4076	·3415	0734	27·56
2	68·6280	....	....	....	2	38·3121	·2251	·0810	28·88
2	67·6542	·6427	·0742	32·03	2	36·2864	....	....	....
2	64·3451	·3251	·0594	25 08	2	36·1037	0107	·0798	28·06
2	61·3704	....	....	....	2	33·1978	·0938	·0781	−26·96
1½	60·2939	·2634	·0748	30·75	2	33·2792	....	....	....

Weighted mean........		−28 32
V_a........	+24·95	
V_d........	+ ·13	
Curvature........		− ·28
Radial velocity........		− 3·5

η BOÖTIS 1332.

Feb. 17. 1908.
G. M. T. 22h 30m

Observed by J. S. Plaskett.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	76·7212	......	......	......	2	58 3842	·3982	·0615	24·97
2	76·3188	·3628	·0619	−28·33	2	57·4824	·4954	·0565	22·80
2	74·9946	......	......	......	2	56·7485	·7600	·0665	26·71
2	74·9565	·9982	·0658	29·83	2	56·3452	......	......	......
2	74·0249	·0649	·0657	29 61	1	56·0291	·0393	·0536	21·43
2	73·3885	......	......	......	2	53·4001	·4061	·0624	24·52
2	72·6378	·6756	0590	26·34	2	49·0003	......	......	......
3	71·6874	·7236	·0586	26·00	2	49·9357	·9359	·0750	28 82
2	69·6200	·6528	0614	26·86	2	48·0881	·0853	·0696	26·43
2	68·8936	·9251	·0673	29·30	2	46·4381	......	......	......
3	68·5431	·5741	0536	23·18	2	46·3480	·3422	·0727	27·30
2	68·5930	......	......	......	2	38 2430	·2240	·0821	29·28
3	67·6210	·6505	·0664	28·66	2	36·2164	......	......	......
2	64·2952	·3192	·0653	27·57	2	36·0427	·0202	·0703	24·72
2	61·3281	......	......	......	2	33·1294	·1019	·0700	−24·16
2	60·2510	·2682	·0700	28·78	2	33·2010	......	......	......
2	59·7464	·7629	·0435	17·82					

Weighted mean		−25 21
V_a	+20·45	
V_d	+ ·12	
Curvature		− ·28
Radial velocity		− 5·2

η BOÖTIS 1357.

1908. Feb. 24.
G. M. T. 19h 06m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity
2	76·7176	......	......	......	½	67 6130	·6450	·0719	30·99
1	76·3250	·3710	·0537	−24 59	½	63·2135	·2395	·0700	29·33
½	74·9671	0101	·0539	24 42	2	61·3207	......	......	......
2	73·3845	......	......	......	1	60·2534	·2750	·0632	25·97
½	72·1053	·1450	·0562	25·06	½	58·3903	·4073	·0524	21·27
1	71·6970	·7365	·0457	20·34	2	56·3395	......	......	......
2	71·1225	......	......	......	½	56·0048	·0208	·0721	28·84
2	68·5883	......	......	......	½	52 0625	·0730	·0528	−20 59
½	68·5422	·5762	0515	22 35	2	49·9913	......	......	......
½	67·9892	·0212	·0683	29·44					

Weighted mean		−25·27
V_a	+18·26	
V_d	+ ·16	
Curvature		− ·28
Radial velocity		− 7 1

η BOÖTIS 1446.

1908. March 30.
G. M. T. 21ʰ 52ᵐ

Observed by } W. E. Harper.
Measured by }

Region.	Settings I. Star.	Settings I. Comparison.	Difference in Revolutions.	Settings II. Star.	Settings II. Comparison.	Difference in Revolutions.	Mean Difference	Velocity.
4	395	424	·029	·350	·324	·026	·275	−12·88
5	·410	435	·025	·336	·314	·022	·235	10·57
6	411	437	·026	·346	306	·040	·280	12·29
7	417	·446	·029	·330	·321	009	·190	8·15
8	·441	465	·024	317	·296	·021	·225	9·43
9	450	·471	·021	·320	·290	030	255	10·45
10	·435	·475	·040	·304	·276	·028	·340	−13·60

Standard...	− 33	
Weighted mean		−10 72
V_a	− 3·98	
V_d		− ·25
Radial velocity...		− 7·0

η BOÖTIS 1446.*

1908. Mar. 30.
G. M. T. 21ʰ 52ᵐ

Observed by W. E. Harper.
Measured by C. R. Westland.

W	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	75·0031	....	....	....	2	58·3770	4406	·0191	7·75
2	75·0052	·0377	·0263	−11·92	2	57·4580	·5231	·0288	11·62
2	74·0795	·1152	·0154	6 94	2	56·7254	7917	0348	13·98
2	73·3860	....	....	....	2	56·2921	....	....	....
2	72·6643	·7044	·0302	13·48	1	56·0050	0732	·6197	7·88
3	71·7097	·7522	·0300	13·31	2	49·9236	....	....	....
2	68·9128	·9623	·0301	13·10	1	49·8982	·9763	·0346	13·20
2	68·5557	·6061	·0216	9 38	2	48·0465	·1272	·0321	12·19
2	68·5760	....	....	....	2	46·3500	....	....	....
2	67·6457	·6970	·0199	9·32	2	46·3083	·3908	0241	9 05
2	61·2856	....	....	....	3	38·1702	·2679	·0382	−13·62
2	60·2494	·3100	·0282	11·59	2	36·0923			....
2	59·7264	·7878	·0186	7·62					

Weighted mean...		−10 94
V_a	− 3·98	
V_d		− ·25
Curvature		− ·28
Radial velocity..		− 7 5

*Check measurement.

η BOÖTIS 1446.*

1908. March 30.
G. M. T. $21^h 52^m$

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	76·7922				1	59·7825	·7820	·0244	10.00
1	76·4392	4142	·0105	−4·80	1	58·4374	·4384	·0213	8·64
1	75·0585				1	57·5302	·5322	.0197	7·95
1	75·0715	·0465	0175	7·92	1	56·7981	·8011	·0154	6·19
2	73·4509				1	56·3536			
1	72·7325	·7074	·0272	12·13	2	49·9915			
2	71·7755	7505	·0317	14·07	1	49·9582	·9712	·0289	11·09
1	68·9752	·9542	0382	16·62	1	48·1122	·1272	·0321	12·19
1	68·6257	6047	0230	9·98	2	46·4180			
2	68·6416				1	46·3655	·3845	·0304	11·43
1	67·7025	·6945	0224	9·67	1	38·2275	·2595	·0466	−16·63
1	61·3480				1	36·1572			
1	60·3231	·3211	·0171	7·02					

Weighted mean . . . . −10·39
V_a . . . . +3·98
V_d . . . . − ·25
Curvature . . . . − ·28

Radial velocity . . . . − 6·9

*Check measurement.

η BOÖTIS 1513.

1908. May 4.
G. M. T. $18^h 13^m$

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	75·1160				2	63·3747			
2	74·2116	·2076	0087	+ 3·91	1	63·3747	·3635	0061	2·55
2	73·4946				1	60·3917	·3785	·0109	4·47
2	72·8120	8070	·0080	3·55	1	59·8668	·8533	·0189	7·71
1	72·5446	·5394			2	58·8243			
2	72·2822	·2770	0131	5·82	2	58.5330	·5188	·0112	4·54
2	71·8622	8567	·0128	5·68	1	56·8700	·8540	·0081	3·24
1½	69·7922	·7857	·0155	6·76	2	56·3934			
1	69·0562	·0492			2	53·9788			
1	68·7040	·6967	·0159	6·92	1	52·1672	·1482	·0164	6·36
2	68·6835				1	48·1835	1620	0087	+ 3·30
1	67·7903	·7823	·0150	6·46	2	46·4436			
1	65·5445	·5350	0056	2.37					

Weighted mean . . . . + 4·91
V_a . . . . −11·19
V_d . . . . − ·17
Curvature . . . . − ·28

Radial velocity . . . . − 6·7

η BOÖTIS 1557.

1908. May 23.
G. M. T. 16h 00m

Observed by J. S. PLASKETT.
Measured by T. H. PARKER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	76·9548	......	......	...	1	68·2353	·2063	·0138	5·93
1	76·9700	·9334	·0152	6·93	2	67·4948	·4461	·0085	3·63
1	76·6302	·5937	·0200	9·10	1	63·4283	......	......	......
1	75·2687	·2326	·0273	12·31	1	59·9277	·8962	·0339	13·79
2	75·2128	......	......	......	1	59·3672	·3358	·0362	14·69
2	73·5876	......	......	......	2	56·4245	......	......	......
1	72·9026	·8696	·0064	2·84	1	52·7616	·7366	·0308	11·98
1½	71·9679	·9359	·0303	13·36	1	50·0213	......	......	......
1	71·9354	......	......	......	1½	48·1823	·1643	·0168	6·35
2	69·1577	·1285	·0283	12·25	2	46·4392	·4238	·0315	+11·74
1	68·7609	......	......	......	2	46·4258	......	......	......

Weighted mean	9·6	
V_a		−17·97
V_d		− ·10
Curvature		− ·28
Radial velocity		− 8·7

η BOÖTIS 1558.

1908. May 25.
G. M. T. 15h 58m

Observed by }
Measured by } T. H. PARKER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	76·9679	......	......	......	2	68·7945	·8090	·0225	9·69
1	77·3242	·3499	·0444	−20·24	2	68·7714	......	......	......
1	76·6597	·6853	·0371	16·84	2	67·8874	·9004	·0322	13·78
½	76·4693	·4923	·0189	8·58	2	64·5208	·5278	·0202	8·46
1	75·2271	......	......	......	1	63·4552	·4606	·0371	15·43
2	74·3368	·3568	·0215	9·61	2	63·4326	......	......	......
2	73·6031	......	......	......	1	61·4657	·4657	·0300	12·30
2	72·3932	·4112	·0210	9·26	2	60·4492	·4482	·0214	8·73
1	71·9847	·0027	·0354	15·57	2	59·9312	·9297	·0394	15·99
2	71·3184	......	......	......	2	59·3758	·3723	·0464	18·83
2	69·8968	·9123	·0302	13·10	2	58·8903	·8853	·0275	−11·08
1	69·1583	·1728	·0186	8·03	2	56·4272	......	......	......

Weighted mean	12·38	
V_a		−18·59
V_d		− ·10
Curvature		− ·28
Radial velocity		− 6·6

η BOÖTIS 1553.*

1908. May 23.
G. M. T. 15ʰ 58ᵐ

Observed by T. H. Parker.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	76·8899	......	......	......	2	68·7225	8120	·0255	10·99
1	77·2379	·3419	·0364	+16·60	2	68·6957	......	......	......
2	76·5803	6833	·0351	15·93	2	67·8170	·9050	·0368	15·73
1	76·3967	4997	·0263	11·91	2	64·4485	·5294	0219	9·24
2	75·1498	......	......	......	2	63·3766	·4560	·0325	13·52
3	74·2572	·3557	·0202	9·03	2	63·3594	......	......	......
2	73·5255	......	......	......	1	61·3866	·4610	·0253	10·37
2	72·3153	·4103	·0201	8·84	2	60·3764	·4489	·0221	9·02
2	71·9030	·9973	·0300	13·20	2	59·8471	·9186	·0283	11·49
2	71·8607	......	......	......	1	59·2900	·3600	·0341	13·78
2	71·2438	......	......	......	2	58·8184	8874	·0296	+11·96
2	69·8265	·9175	·0354	15·36	2	56·3496	......	......	......
2	69·0868	1768	0226	9·76					

Weighted mean ...... −12·16
V_a ...... −18·59
V_d ...... − ·10
Curvature ...... − ·28

Radial velocity ...... − 6·8

*Different standard.

η BOÖTIS 1621.

1908. June 22.
G. M. T. 14ʰ 10ᵐ

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity
2	76·8898	......	......	......	2	67·8377	·8610	·0432	18·53
2	76·5947	·6227	·0450	+20·47	2	65·5907	·6127	0392	16·58
2	74·2843	·3110	·0440	19·71	2	64·4965	5180	0514	21·59
2	74·0261	·0526	·0477	21·32	2	63·3773	......	......	......
2	73·5353	......	......	......	2	60·4210	4413	0439	17·91
2	72·8694	·8954	·0322	14·30	2	59·8945	9145	0522	21·24
2	72·5840	·6100	0353	15·64	2	58·8142	......	......	......
2	72·3438	3693	·0418	18·47	2	58·8748	·8948	·0620	25·04
3	71·9275	·9528	·0472	20·81	2	58·5401	·5601	·0521	20·37
2	71·2520	......	......	......	2	53·9551	......	......	......
2	69·8502	·8744	0483	21·01	2	52·1673	·1880	0505	−19·54
3	68·7500	·7735	·0400	17·28	2	49·9791	......	......	......
2	68·7025	......	......	......					

Weighted mean ...... +19·40
V_a ...... −24·75
V_d ...... − ·17
Curvature ...... − 28

Radial velocity ...... − 5·8

η BOÖTIS 1621.*

1908. June 22.
G. M. T. 14h 10m

Observed by J. S. PLASKETT.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	76·9515	......	......	......	3	67 8975	8633	·0455	20·88
2	76·6545	·6195	·0458	+20 84	2	65·6520	·6150	0415	17·55
2	74·3483	·3118	0448	20·07	2	64·5563	·5168	0502	21·08
2	74·0780	·0418	0369	16·50	2	63·4410	......	......	......
2	73·5981	......	......	......	2	60·4858	·4438	·0464	18·93
2	72·9294	8934	·0302	13 40	2	59·9466	9046	·0423	17·22
2	72 6463	·6103	·0356	15·77	2	58 8764	......	......	......
2	72·4084	·3722	0347	15·34	2	58·9274	·8859	·0531	21·45
2	71·9888	·9527	0471	20·77	2	58·5948	·5533	0453	17·71
2	71·3110	......	......	......	2	54·0116	......	......	......
2	69·9688	·8748	0487	21·18	2	52 2260	·1960	·0585	+22·64
2	68·8137	·7802	·0467	20·17	2	50·0224	......	......	......
2	68·7675	......	......	......					

Weighted mean	−18·91	
V_a		−24 75
V_d		− 17
Curvature		− ·28
Radial velocity		− 6·3

*Check measurement.

η BOÖTIS 1663.*

1908. July 6.
G. M. T. 14h 40m

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Region.	Settings I. Star.	Settings I. Comparison.	Difference in Revolutions.	Settings II. Star.	Settings II. Comparison.	Difference in Revolutions.	Mean Difference	Velocity.
6	·325	·359	·034	·688	·643	045	·040	+19·04
7	·334	·363	029	·686	·641	045	·037	16 98
8	·341	·378	037	·668	·632	·036	·036	15·95
9	·334	·378	·044	·676	·632	·044	·044	18·92
10	·347	·387	040	·672	619	·053	·046	19·14
11	·350	·403	053	·660	·603	·057	055	22·11
12	372	·411	·039	·650	·603	·047	·043	16·65
13	368	414	·046	·650	605	·045	·046	17·30
14	378	·425	047	·650	·600	·050	·048	17·47
15	·397	445	·048	·634	·579	·055	052	18·30
16	·407	458	·051	·628	564	·064	·057	19·49
17	·430	467	037	·604	·554	·050	·044	+14·56

Weighted mean	+17·99	
*1519 Standard	+ ·41	
V_s	+18·40	
V_a		−25·77
V_d		− ·17
Radial velocity		− 7·6

η BOÖTIS 1663.*

1908. July 8.
G. M. T. 14h 40m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Region.	Settings I. Star.	Settings I. Comparison.	Difference in Revolutions.	Settings II. Star.	Settings II. Comparison.	Difference in Revolutions.	Mean Difference	Velocity.
5	·021	·970	·051	205	·246	·041	·046	+22·72
6	·009	·975	·034	·201	·250	049	·042	20·00
7	·021	·966	·056	·206	·254	·048	·052	23·87
8	·021	·965	·056	·212	·251	·039	·047	20·82
9	·009	·967	·042	·213	·253	·040	·041	17·63
10	·995	·958	·037	·220	·266	·046	·041	17·06
11	·008	·955	·053	·229	·270	·041	·047	18·89
12	·984	·949	·035	·219	·284	·065	·050	19·41
13	·973	·944	·029	·241	·283	·042	·036	13·54
14	·989	·927	062	·240	·284	·044	·053	19·29
15	·970	·914	·056	·250	·301	·051	·053	18·66
16	·967	·917	·050	·255	·311	056	·053	18·13
17	·950	·905	·045	·265	319	·054	·048	15·89
18	·931	·890	·041	·285	·324	·039	·040	12·82
19	·942	877	·065	·291	·335	·044	·054	+16·74

Weighted mean	+18·36	
*1520 Standard	−·38	
V_s	−18·74	
V_a		−25·77
V_d		−·17
Radial velocity		−7·2

η BOÖTIS 1710.

1908. July 15.
G. M. T. 14h 11m

Observed by J. B. Cannon.
Measured by W. E. Harper.

Region.	Settings I. Star.	Settings I. Comparison.	Difference in Revolutions.	Settings II. Star.	Settings II. Comparsion.	Difference in Revolutions.	Mean Difference	Velocity.
6	·435	·396	·039	·456	·405	·051	·045	+21·42
7	·426	·386	040	·445	·407	·038	·039	17·90
8	426	·386	·040	·442	391	·051	·045	19·93
9	448	·395	·053	·439	·392	·047	·050	21·50
10	·448	·400	·048	·434	·395	·039	·043	17·89
11	·454	·391	·063	·426	·383	·043	·053	21·31
12	436	·399	·037	·444	·400	·044	·040	15·53
13	·448	·400	·048	·444	·375	·069	·058	21·81
14	·455	·405	·050	·439	·400	·039	·045	16·38
15	451	·396	·055	·450	·390	·060	·057	20·06
16	·461	·391	·070	·451	·395	·056	·063	21·55
17	·425	390	·035	·452	·398	·054	·044	+14·56

Weighted mean	+19·15	
1520 Standard	+·38	
V_s	+19·53	
V_a		−25·71
V_d		−·24
Radial velocity		−6·4

η BOÖTIS 1792

1908, Aug. 19.
G. M. T. 13h 18m

Observed by W. E. Harper.
Measured by T. H. Parker.

Region.	Settings I. Star	Settings I. Comparison.	Difference in Revolutions	Settings II. Star	Settings II. Comparison	Difference in Revolutions.	Mean Difference	Velocity.
5	·802	817	·015	·718	·690	·028	·022	+10 86
6	·812	·824	·012	·697	·673	·024	·018	8·56
7	·815	·834	·019	·710	·671	·039	·029	13·31
8	·829	·846	·017	·693	·670	·023	·026	11·51
9	·828	·841	·013	·681	·660	·021	·025	10·72
10	·831	·860	.029	·685	·654	·031	·030	12·45
11	·837	·865	·028	·682	·644	·038	·033	13·23
12	·842	·868	·026	·687	·654	·033	029	11·25
13	·853	·885	·042	·668	·640	·028	·035	13·16
14	·865	895	·030	·660	·619	·041	·036	13·10
15	·864	·902	·039	·636	·600	·036	·037	13·02
16	·876	·909	·033	·637	·591	·046	·039	+13·29

Weighted mean .... +12·04
1519 Standerd.... ...... + ·41
V_a .... −20 04
V_d ... . − 28

Radial velocity......... .... − 7·9

η BOÖTIS 1867.

1908. Sept. 7.
G. M. T. 12h 57m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	76 9031	....	....	......	2	71·8856	....	....	....
1½	77·2356	·2508	·0215	+ 9.80	1	68·7611	·7763	·0428	18·49
1½	76·6039	·6189	·0452	20·61	2	68 7171	....	....	....
1	75·8642	·8777	·0405	18·35	1	67·8216	·8366	·0188	8·06
1½	72·8696	·8798	·0166	7·37	2	63·3916	....	....	....
1½	72 5992	·6116	·0369	16·35	1	60·4216	·4276	·0302	12·35
2	71·9211	.9371	·0315	13·89	½	59·3391	·3441	·0545	22·13

Weighted mean..... .... +14·18
V_a .... −13·88
V_d .... − ·30
Curvature..................... − ·28

Radial velocity.................... ..... − 0·3

η BOÖTIS 2115.

1909. Jan. 7.
G. M. T. 23h 23m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	76 6775	......	......	......	2	69·3445	·3612	0260	11 39
2	76 6430	·6575	·0344	−15·82	2	68·8810	9002	0381	16·65
2	76·3060	·3200	0301	13·79	2	68·5537	......	......	......
2	74·9547	......	......	......	2	68·5247	5245	·0502	21·80
1	74 .9365	·9467	0464	21·11	2	67·6056	6244	0421	18 24
1	74·0052	·0152	0471	21·29	2	67·2315	·2501	0393	17·02
2	73·7510	·7610	·0413	18·63	2	65·3890	4052	0359	15·30
2	73·3481	......	......	......	1	64·2927	3075	·0360	15·30
2	72·6167	·6277	0425	19 08	2	63·2724	......	......	......
2	72·3162	3279	·0560	25 09	2	63·2091	·2230	·0486	20 41
2	71·6667	·6810	0394	17·53	2	58·7025	·7188	·0387	−15·79
2	71 0812	......	......	......	2	58 7427	......	......	......
2	69·6012	·6173	0409	17·91					

Weighted mean .. .. −17·88
V_a .... +26·69
V_d .... + ·04
Curvature 28

Radial velocity.... ...... + 8·6

η BOÖTIS 2209.

1909. Jan. 30.
G. M. T. 18h 37m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	81·7544	......	......	..	1	67·6626	6721	·0448	19 35
1	80·5548	5772	0398	−18·75	½	66·5389	5481	·0351	15·02
2	76·7524	......	......	......	½	64·3381	3469	·0376	15·87
1	76·7084	·7234	0440	20·20	2	61·3366	......	......	......
1	76·3728	·3878	0369	16·90	½	61·1268	·1347	·0458	18·92
½	75·0031	·0159	·0481	21·79	½	59·7626	7719	·0355	14·55
½	74·0754	0862	·0444	20 02	1	58·4051	·4151	·0446	18·11
2	73·4156	......	......	......	½	52·0778	0920	0338	13·18
1	72·6808	·6896	0450	20·07	2	49·9854	......	......	......
2	71·7318	·7410	·0412	18·29	1	48 0966	·1130	·0463	−17·59
2	68·6164	......	......	......					

Weighted mean...... .... −19·76
V_a .... +25·02
V_d .... + ·20
Curvature.. . . − ·28

Radial velocity........ ...... + 5·2

η BOÖTIS 2283.

1909. Feb 17.
G. M. T. 20h 30m

Observed by } Measured by } J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	76·7061	....	....	....	1	61·0771	·1522	·0283	11·70
½	76·6704	·7317	·0357	-16·38	1	59·6981	·7740	0324	13·27
1	74·9769	·0382	·0258	11·70	1	56·7141	·7913	·0342	13·74
½	74·0486	·1100	·0206	9·28	2	56·2824	....	....	....
1	73·0121	·0736	·0474	21·21	½	52·9986	0808	0450	17·53
2	73·3628	....	....	....	½	51·6967	·7801	0303	11·78
1	72·1104	·1739	·0272	12·10	1½	49·8821	·9680	0321	12·34
2	71·6891	·7546	·0276	12·24	1½	48·0301	·1171	0378	14·35
1	69·6231	·6925	·0217	9·49	2	46·3428	....	....	....
2	68·5548	....	....	....	1	46·2721	·3617	·0532	19·97
1	68·5298	·6012	0265	11·51	2	33·0633	....	....	....
½	67·6224	·6945	·0224	9·67	½	31·5776	·6899	·0444	15·19
2	63·2498	....	....	....	1	30·8284	9422	·0517	17·61
1	63·1931	·2674	·0421	17·65	½	26·4908	6107	0496	-16·44

Weighted mean	-13·98	
V_a		+20·25
V_d		+ ·04
Curvature.......	- 28	
Radial velocity..................		+ 6·0

η BOÖTIS 2396.

1909. March 20.
G. M. T. 17h 00m

Observed by J. S. PLASKETT.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	77·1341	....	....	....	1	68·6049	·6109	·0168	7·29
1	76·7516	·7465	·0209	-9·59	1	67·6992	·7072	0097	4·19
½	76·4234	·4178	·0060	2·75	2	61·3222	....	....	....
1	75·0522	·0491	·0149	6·75	1	60·3016	·3269	·0113	4·64
1	74·1209	·1191	·0115	5·19	1	59·7754	·8027	·0037	1·51
2	73·4249	....	....	....	1	58·4149	·4462	·0135	5·48
1	72·7076	·7079	0267	11·91	2	49·9442	....	....	....
½	72·4306	·4318	·0157	7·00	1	49·9466	0041	·0068	2·61
2	71·7664	·7688	·0134	5·95	2	30·9059	....	....	....
2	71·1534	....	....	....	1	30·8756	·9795	·0144	-4·91
1	69·7034	·7074	·0068	2·97					

Weighted mean	- 5·59	
V_a		+ 8·52
V_d		+ ·14
Curvature.......	- ·28	
Radial velocity..................		+ 2.8

OBSERVING RECORD AND DETAILED MEASURES OF α CORONÆ BOREALIS.

P.—Plaskett.
Pl.—Parker.
H.—Harper.
C.—Cannon.
T.—Tribble.

RECORD OF SPECTROGRAMS.

Star.	No. of Negative.	Camera.	Plate.	Date.	Middle of Exposure G. M. T.	Duration.	Hour Angle at end.	Temperature. Centigrade. Room. Beg.	Room. End.	Prism Box. Beg.	Prism Box. End.	Slit Width.	Seeing.	Observer.
				1907.	h. m.	m.	h. m.							
α Coronæ Borealis :	784	IL	Seed 27.	May 24	17 43	10	1 20W.	9·0	9.4	16·4	16·4	·001	Fair.. ..	P
" ..	790	"	" ..	" 29	15 14	12	50W.	8·9	·9·0	14 5	14·5	·001	" ...	P
" ..	800	"	" .	" 31	17 18	8	1 20W.	13·0	12·8	18·8	18·8	·001	Good...	P
" ..	808	"	" ..	June 8	16 28	10	1 05W.	15·4	15·2	17·2	17·2	·001	....	P
" ..	813	"	" ..	" 10	15 23	10	0 00	14·8	14·6	18·1	18·1	001	....	P
" ..	830	"	" ..	" 11	17 40	10	2 15W.	14 0	14·0	18·9	18·9	·001	Fair....	H
" ..	837a	"	" ..	" 12	17 36	12	2 30W.	17·0	16·3	19·0	19·0	·001	" ...	P
" ..	837b	"	" ..	" 12	17 52	12	2 42W.	16·0	15 6	19·0	19·0	·001	" ...	P
" ..	845	"	" ..	" 13	16 32	15	1 30W.	19·8	19·4	25·8	25·8	·0012	" ...	H
" ..	850a	"	" .	" 14	16 39	12	1 40W.	21·6	21·4	23·3	23·3	·0012	" ...	P
" ..	850b	"	" .	" 14	16 52	5	1 50W.	21·4	21·1	23·3	23·3	·0012	Good. .	P
" ..	869a	"	" .	" 21	15 10	15	50W.	24 8	24 8	28 9	28·9	·001	Hazy...	P
" ..	869b	"	" .	" 21	15 42	15	1 20W.	24·8	24 6	28 9	29·0	·001	" ...	P
" ..	892a	"	" .	" 27	15 25	10	1 17W.	21·2	20 9	24·5	24·5	·0012	Fair....	H
"	892b	"	" ..	" 27	15 37	5	1 25W.	20·9	20·9	24·5	24·5	·0012	Cloudy.	T
" ..	903a	"	"	" 28	14 36	13	33W.	23·8	23·6	26·4	26·3	·0012	Fair ...	P
"	903b	"	" ..	" 28	14 57	25	1 00W.	23·5	22 8	26·3	26·2	·0012	" ...	P
" ..	912a	"	" ..	July 4	15 38	10	2 00W.	21·0	20·5	29·0	28·8	·0012	Good. .	H
"	912b	"	" ..	" 4	15 47	5	2 17W.	21·0	20·0	28 8	28·6	·0012	" ..	H
"	917	"	" ..	" 5	15 20	10	1 45W.	21·0	20 8	26·4	26·4	0011	....	P
"	919	"	"	" 8	15 36	22	2 05W.	21·2	21·2	22·4	22·4	·0012	Fair....	P
"	927	"	" ..	" 9	14 32	15	1 14W.	23 1	23·1	24·5	24·5	·0012	Good..	H
"	939a	"	" ..	" 12	16 25	10	4 15W.	22·6	22·4	26·0	26·0	0012	" ...	P
"	939b	"	" ..	" 12	16 33	2½	4 20W.	22 6	22·4	26·0	26·0	·0012	"	P
"	941a	"	" ..	– 13	15 25	10	3 15W.	18 2	18·0	25·2	25 0	·0012	....	T
"	941b	"	" ..	" 13	15 32	3	3 20W.	18·0	17·8	25·0	25·0	·0012	....	T
"	944a	"	"	" 16	14 37	13	1 42W.	25·5	25·5	26·8	26·8	·0012	Unst'dy	T
"	944b	"	" ..	" 16	14 49	6	1 53W.	25·5	25·5	26·8	26 8	·0012	"	T
"	951a	"	" ..	" 18	14 50	60	2 32W.	26·0	25·0	28·5	28·5	0012	Very hazy..	T
" ..	951b	"	" .	" 18	15 32	5	2 45W.	22·5	22 5	28·5	28·5	·0012	"	H
"	956a	"	" .	" 20	16 07	14	3 30W.	19·2	18 6	21·6	21·6	·0012	Good...	P
"	956b	"	" .	" 20	16 17	2	3 32W.	19·2	18·6	21·6	21·6	·0012	" ...	P
"	963a	"	"	" 23	14 32	6	2 05W.	23·2	23·2	26·4	26·4	·0012	" ..	T
"	963b	"	" ..	" 23	14 41	3	2 15W.	22·6	22·6	26·4	26·4	0012	....	T
"	973a	"	"	Aug. 1	14 06	12	2 15W.	21·3	21·0	25·2	25·2	·0008	....	H
" .	973b	"	" ..	" 1	14 18	8	2 26W.	21·0	19·5	25 2	25·2	·0008	. . . .	H
"	978	"	" .	" 3	13 02	8	1 15W.	21·6	20·8	24·1	24·1	·0012	....	P
"	986	"	" ..	" 6	16 38	23	5 15W.	19·5	19·4	23·3	23·3	·0012	Poor...	H
"	1006	"	" ..	" 12	16 36	12	5 31W.	23·0	22·5	29·0	29·0	·0014	Unst'dy	H
"	1014	"	" ..	" 15	15 09	7	4 20W.	22·3	19·5	26·3	26 3	·0014	Very poor..	H
" ..	1017	"	" ..	" 22	15 11	11	4 47W.	18·7	18·5	24·1	24·2	·0014	Fair....	H
"	1022	"	" ..	" 23	14 46	62	4 46W.	22·5	21·4	27·0	27·0	·0014	Light clouds.	T
" ..	1026	"	" ..	" 27	12 06	13	2 57W.	18·5	18·5	20·6	20·6	·0014	Fair....	H
" ..	1032	"	" .	Sept. 6	13 43	17	4 15W.	19·0	18·5	21·0	21·0	·0012	Good..	T
" ..	1037	"	" ..	" 12	14 39	18	5 37W.	17·0	16·8	20·9	20·9	·0012	" ...	T
"	1047	"	" .	" 18	12 50	30	4 17W.	15·0	15·0	17·1	17·1	·0012	Cloudy.	T
"	1048	"	" ..	" 18	13 16	16	4 36W.	15·0	14·2	17·1	17·1	·0012	Fair....	T
" ..	1060	"	" ..	" 20	13 35	20	5 05W.	22·0	22·0	22·9	22·9	·0012	Poor....	H
" ..	1061	"	" ..	" 20	13 58	24	5 30W.	22 0	22·3	22·9	22·9	·0012	" ...	H
" ..	1083	"	" .	Oct. 1	13 44	16	5 55W.	10·5	10·4	14 2	14·2	·0014	....	H
" ..	1084	"	" ..	" 1	14 06	27	6 23W.	10·4	10·2	14 2	14·1	·0014	Hazy...	H

RECORD OF SPECTROGRAMS.—(*Concluded*).

Star.	No. of Negative.	Camera.	Plate.	Date.	Middle of Exposure. G. M. T.	Duration.	Hour Angle at end.	Temperature. Centigrade. Room. Beg.	Room. End.	Prism Box. Beg.	Prism Box. End.	Slit Width.	Seeing.	Observer.
				1908.	h. m.	m.	h. m.							
α Coronæ Borealis:	1393	IL	Seed 27.	Mar. 9	22 08	24	55W.	−15·0	−15·0	1·0	1·0	....	Hazy..	H
" ..	1402	"	" ..	" 16	21 02	10	9W.	−12·5	−13·0	2 3	2 3	....	Good...	H
" ..	1493	"	" ..	Apr. 15	19 18	8	28W.	− 3·0	− 2·3	7·8	7·7	....	" ...	P
" .	1565	"	Seed Process	June 1	18 00	30	2 50W.	15·7	14 6	21·4	21·3	....	" ...	P-P[1]
" ..	1566	"	Seed 27.	" 1	18 42	15	3 13W.	14 5	14·0	21 3	21·2	....	Fair....	P[1]
" .	1571	"	" ..	" 3	16 32	15	57W.	14·9	15·0	18·4	18·4	....	" ...	P
" ..	1572	"	" ..	" 3	16 52	15	1 20W.	15·0	14 8	18·4	18 4	....	" ...	P
" .	1581	"	" .	" 5	17 31	18	2 04W.	17·5	17·0	24·6	24·6	·0016	Good...	H
" ..	1601	"	" ..	" 12	16 56	12	1 54W.	19·5	19·0	25·0	25·0	·0017	" ...	H
" ..	1608	"	"	" 17	13 53	14	50E.	19·0	18·5	23·4	23·3	·0016	" ...	H
" ..	1623	"	" ..	" 22	16 27	14	2 10W.	18·3	18·0	23·7	23·8	·0015	Fair....	P
" ..	1624	"	" ..	" 22	16 43	13	2 25W.	18·0	18·0	23·8	23·8	·0015	Good...	P
" ..	1628	"	" ..	" 24	15 26	18	1 15W.	21·5	21·5	27·5	27·5	·0015	" ...	P
" ..	1629	"	" .	" 24	15 49	15	1 35W.	21·5	21·5	27·5	27·5	·0015	" ...	P
" .	1638	"	" ..	" 26	15 51	15	1 48W.	21·0	20 5	30·0	30·0	·0016	" ...	H
" ..	1639	"	" .	" 26	16 04	8	1 57W.	20·5	21·0	30·0	30·0	·0016	" ...	H
" ..	1646	"	" ..	" 27	16 20	10	2 20W.	20·8	20·5	23·8	23·8	·0014	" ...	P
" ..	1647	"	" ..	" 27	16 30	10	2 30W.	20·5	....	....	....	....	Fair....	P
" .	1652	"	" ..	July 1	15 15	30	1 30W.	23·6	23·6	25·8	25·8	·0015	Cloudy..	P
" .	1656	"	" ..	" 3	15 17	13	1 38W.	23·0	21 9	25·5	25·5	·001	Good...	H
" ..	1665	"	" ..	" 6	16 50	10	3 20W.	24·0	23·8	26 4	26·4	·0015	" ...	P
"	1674	"	" ..	" 8	15 11	10	1 50W.	19 0	19·3	21·8	21·8	·0015	Fair....	C
" .	1683	"	" ..	" 10	13 34	20	26W.	25·0	24·5	27·5	27·5	·0012	Good...	H
" ..	1684	"	"	" 10	13 51	13	40W.	24·5	24·5	27·5	27·5	·0012	" ...	H
" .	1692	"	" .	" 11	16 20	10	3 12W.	27·7	27·5	30·1	30·1	·0015	Fair....	P
" .	1697	"	"	" 13	15 26	13	2 25W.	20·0	19·9	23·1	23·1	·0015	" ...	P
" ..	1698	"	" .	" 13	15 42	16	2 50W.	19·9	19 6	23·1	23 1	·0015	" ...	P
" .	1711	"	" ..	" 15	16 24	12	3 30W.	17·5	17·0	21·6	21·6	·0015	Good..	C
" ..	1721	"	" .	" 24	13 05	15	48W.	24·0	24 0	26 4	26·4	·0012	" ...	H
" ..	1722	"	" ..	" 24	13 21	14	1 03W.	24·0	24·0	26·4	26·4	·0012	" ...	H
" ..	1739	"	" ..	" 29	15 34	12	3 37W.	26·6	26·3	30·2	30·2	·0015	Fair....	P
" .	1748	"	" .	" 31	13 38	17	2 00W.	23·3	23·1	26·0	26·0	0015	" ...	P[1]
"	1749	"	" ..	" 31	14 00	20	2 20W.	23·0	22·6	26·0	26·0	·0015	" ...	P[1]
" .	1764	"	" ..	Aug. 5	15 37	15	4 10W.	22 0	21·6	26·9	26 9	·0015	" ...	P
" ..	1773	"	" ..	" 7	14 25	20	3 05W.	21·5	20·6	23·6	23·6	·0015	Hazy...	P[1]
" ..	1775	"	" ..	" 7	16 25	10	5 05W.	19 1	19·0	23·6	23·6	·0015	Good...	P[1]
" ..	1797	"	" ..	" 20	12 51	16	2 21W.	19·2	19·0	23·1	23·1	·0015	Fair.....	H
" ..	1798	"	" ..	" 20	13 05	10	2 32W.	19·0	18·8	23·1	23·0	·0015	Good...	H
" ..	1805	"	" ..	" 21	12 54	11	2 22W.	21·1	20 6	25·8	25·8	·0015	" ...	C
" ..	1809	"	" ..	" 21	15 01	12	4 30W.	18·8	18·4	25·0	25·4	·0015	" ...	C
" ..	1816	"	" ..	" 24	13 17	15	3 03W.	18·5	18·2	23·4	23·4	·0015	" ...	H
" ..	1817	"	" .	" 24	13 32	14	3 17W.	18·2	17·5	23·4	23·3	·0015	" ...	H
" ..	1827	"	" ..	" 25	13 00	14	2 49W.	20·6	19·3	26·0	26·0	·0015	Hazy...	C
" ..	1836	"	" ..	" 27	14 34	12	4 30W.	18·3	18·0	23·2	23·2	·0015	Good...	C
" ..	1842	"	" ..	" 28	13 14	12	3 16W.	18·5	18·2	23·3	23·3	·0015	" . .	C
" ..	1852	"	"	" 31	13 17	15	3 30W.	24·0	24·0	28·0	28·0	·0015	" ..	H
" ..	1861	"	" ..	Sept. 3	12 50	13	3 15W.	18 6	18·8	21·2	21·1	·0015	" ...	P
" ..	1865	"	" ..	" 4	13 27	26	4 05W.	20·5	20·3	23·4	23·4	·0015	Poor....	P[1]
" ..	1882	"	" ..	" 14	12 51	13	4 00W.	18·6	18·4	21·7	21·7	·0015	Fair....	P
" ..	1894	"	" ..	" 19	12 02	13	3 30W.	17·5	17·3	21·2	21·2	·0015	" ..	P
" ..	1895	"	" ..	" 19	12 17	15	3 45W.	17·3	17·2	21·2	21·2	·0015	" ...	P
" ..	1896	"	" ..	" 19	12 32	15	4 00W.	17·2	16·8	21·1	21·1	·0015	" ...	P
" ..	1897	"	" .	" 19	12 50	16	4 20W.	16·8	16·5	21·1	21·0	·0015	" ...	P
" ..	1949	"	" ..	Nov. 1	10 41	17	5 00W.	2·0	0·6	3·8	3·8	·0015	Good...	C
" ..	1991	"	" ..	Dec. 2	10 10	10	6 19W.	− 7·5	− 8·2	−2·0	−2·0	·0015	Windy	C
" .	1992	"	" ..	" 2	10 21	13	6 30W.	− 8·2	− 8·2	−2·0	−2·0	·0015	" .	C

α CORONÆ BOREALIS, 784.

1907. May 24.
G. M. T. 17h 43m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected wave length.	Normal wave length.	Displacement in revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected wave length.	Normal wave length.	Displacement in revolutions.	Velocity.
2	72·9951	4891·192	....	....	.....	.....	1½	27·6301	4105·162	....		.....	.....
2	72·7321	4861·180	·187	·527	·340	−21 00	1	27·3080	4101·318	·440	·890	·450	−32·90
½	72·3165	4851·453	.....	.....	.....	....	1½	27·1825	4099·824	.	..	.....	....
2	47·6461	4379·418	.....	...	.....	....	½	15·4180	3969 627	·807	·177	·670	−50·77
2	45·0940	4340·085	·054	·634	·580	−40·02	2	15·3605	3969·034	.....	.....	.....	....
2	44·1555	4325·981	...	..	.....	....	3	28·1875	4111·853	......	..	.....	....

Weighted mean	−32 78
V_a	− 7·63
V_d	− ·07
Curvature	− ·28
Radial velocity	−39 8

α CORONÆ BOREALIS, 790.

1907. May 29.
G. M. T. 15h 14m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected wave length.	Normal wave length.	Displacement in revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected wave length.	Normal wave length.	Displacement in revolutions.	Velocity.
2	73·2093	4870·229	.....	.....	..	....	2	27·7347	4105·312	....	..	.....	......
2	72·8135	4800·908	2·107	1·527	·580	+35·78	1½	27·5259	4102·815	·700	1 890	·810	+59·21
2	63·6051	4661·138	....	.	.....	......	3	27 2873	4099·970	......	.....	....	....
3	48·7335	4395·316	...	...	......	....	½	15·64—	3970·820	·797	·177	·620	+47·00
1	45·2535	4341·252	....	....	.....	....	3	15·4860	3969·232	....	.....	....	......
2	45·2502	4341·201	·114	0·634	480	+33·12							

Weighted mean		+41·68
V_a	− 9·22	
V_d		+ ·10
Curvature	− ·28	
Radial velocity		+32·3

α CORONÆ BOREALIS, 794.

1907. May 29.
G. M. T. 18h 05m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in revolutions.	Velocity.
2	72·8775	4862·407	·407	1·527	880	+59·30	1	27 5506	4102·369	·360	1 890	·470	+34·36
1½	63 6559	4661 600	...	...	...	...	½	12 111–	3934·713	·795	3·825	.970	+74·01
2	45·3234	4341·403	·388	0·634	754	+52·02	3	11·6613	3930·276	...	...	...	...
	45·3085	4341·177	...	...	...	...							
	27·7905	4105·235	...	...	...	...							

Weighted mean		+53 45
V_a	− 9·22	
V_d	− ·14	
Curvature	− ·28	
Radial velocity		+43·8

α CORONÆ BOREALIS, 800.

1907. May 31.
G. M. T. 17h 18m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length	Corrected Wave Length	Normal Wave Length.	Displacement in revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in revolutions	Velocity.
	73·2965	4871·490	...	...	...	...	1½	45·3314	4341 634	1·000	0·634	366	+25·25
	72·8966	4862·058	2·021	1·527	·494	+30 48	2	45·3203	4341 463	...	...	...	...
1½	63·6950	4662·143	...	...	...	...							

Weighted mean		+28·24
V_a	− 9 87	
V_d	·09	
Curvature	− ·28	
Radial velocity		−18·00

α CORONÆ BOREALIS, 800*.

1907. May 31.
G. M. T. 17h 18m

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected wave length.	Normal wave length.	Displacement in revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected wave length.	Normal wave length.	Displacement in revolutions.	Velocity.
2	73·1662	4870·711	......	....	.....	....	½	53·9228	4482 746	·156	·400	·756	+[50·57]
2	72·7643	4861·253	·993	·527	·366	+22 58	1½	45·1975	4341·903	..	.....	......	....
1	53·9370	4482·990	....	..	.....	....	2	45·1921	4341·822	084	·634	·450	+31·05

Weighted mean. .... +26·82
V_a .... − 9·87
V_d .... − ·09
Curvature.. ..... − ·28

Radial velocity... .... +16·6

*Check measurement.

α CORONÆ BOREALIS, 808.

1907. June 8.
G. M. T. 16h 28m

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected wave length.	Normal wave length.	Displacement in revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected wave length.	Normal wave length.	Displacement in revolutions.	Velocity.
2	73·6301	4880·622	.....	.....	...	....	1½	53·2825	4459·560	.....	...	.....	....
1½	73·2099	4870·635	......	......	.....	....	1½	45·2977	4341·340	......	......	.....	....
2	72·7779	4860·446	·117	·527	·410	−25·30	1½	45·2356	4340·399	·224	·634	·410	−28 29
1½	54·7247	4494 835	.....	.....	.....	....	½	27·4985	4101·465	·740	·890	·150	−10·97
1	53·9597	4481·558	·400	·400	·000	[0·00]	2	27·3464	4099·648	....	...	.....	....

Weighted mean.. .... −24·63
V_a .... −12 26
V_d .... − ·07
Curvature ... . − ·28

Radial velocity .. .. −37 2

α CORONÆ BOREALIS, 813.

1907. June 10.
G. M. T. 15^h 23^m

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected wave length.	Normal wave length.	Displacement in revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected wave length.	Normal wave length.	Displacement in revolutions.	Velocity.
1	72·9500	4864·729		....	.....	....	1½	45·2570	4340 581	·584	·634	·050	− 3·45
2	72·7916	4860·995	·047	·527	·480	− 29·62	1	27·4836	4101·565	565	·890	·325	− 23·76
·1	54·0328	4482·605	.....	.....	......	....	½	11·9745	3933·225	·505	·825	·320	− 23·52
½	53·9933	4481·933	720	·400	·320	+ [21·40]	3	11·6547	3930·072	.... .	.. ..	......	....

Weighted mean................... ...	− 19·99
V_a.....................	12·82
V_d	·00
Curvature....	− ·28
Radial velocity......	− 33·1

α CORONÆ BOREALIS, 813*.

1907 June 10.
G. M. T. 15^h 23^m

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0019	....	....	.. ..	1	27·4611	·3746	·0380	− 33·00
1	72·8452	·8543	·0105	− 15·23	2	27·3334	....	....	....
1	72·4360	....	... .	....	½	11·9831	·8494	·0020	− 1·50
2	45·2832	....	....	....	2	11·6415	... .	....	....
1½	45·2550	2404	·0017	+ 1·77					

Weighted mean....	− 11·33
V_a..............	− 12·82
V_d.........	·00
Curvature......	− ·28
Radial velocity....	− 23·4

Check measurement.

α CORONÆ BOREALIS, 830.

1907. June 11.
G. M. T. $17^h\ 40^m$

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0400	....	....	....	1	27·5388	·4018	·0108	− 9·37
½	72·9005	·8714	·0066	+ 9·57	2	27·3838	....	....	....
2	72·4707	....	....	....	½	15·6378	·4462	·0271	− 20·97
2	45·3505	....	....	....	2	15·5903	....	....	....
1½	45·2971	·2202	·0177	− 19·31					

Weighted mean	− 12·59
V_a	− 13·12
V_d	− ·14
Curvature	− ·28
Radial velocity	− 26·1

α CORONÆ BOREALIS, 837 (*a*).

1907. June 12.
G. M. T. $17^h\ 36^m$

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in revolutions.	Velocity.
2	73·2575	4871·377	.....	.....	.....	....	1½	53·2836	4469·109	·260	1·400	·140	− 9·37
2	72·9590	4864·316	.....	.....	.....	....	2	45·2743	4341·034	.....	.....	.....	....
1	72·7939	4860·427	·027	·527	·500	− 30·85	2	45·2468	4340·618	·744	·634	·110	+ 7·59
1½	54·7243	4494·565	.....	.....	.....	....	1	27·4500	4101·723	·700	·890	·190	− 13·40
1	54·0416	4482·729	·880	1·400	·1480	+ [99·01]	2	27·2997	4099·937	.....	.....	.....	....
1½	53·9476	4484·109	.....	.....	.....	....							

Weighted mean	− 7·84
V_a	− 13·39
V_d	− ·15
Curvature	− ·28
Radial velocity	− 21·7

α CORONÆ BOREALIS, 837 (*b*).

1907. June 12.
G. M. T. 17h 48m

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in revolutions.	Velocity.
2	73·3641	4871·496	...	...	...	...	1½	45·3637	4340·923	·834	·634	·200	+13·80
1½	73·0748	4864·652	...	...	...	...	1	27·5769	4102·126	·780	890	·110	− 8·74
1	72·9262	4861·152	·417	·527	·080	− 4·90	2	27·4205	4100·265	...	...	...	...
2	45·3955	4341 251	...	...	...	...							

Weighted mean	+ 2·22	
V_a		− 13·39
V_d		·15
Curvature		− ·28
Radial velocity		− 11·6

α CORONÆ BOREALIS, 845.

1907. June 13.
G. M. T. 16h 32m

Observed by / Measured by } W. E. HARPER.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected wave length.	Normal wave length.	Displacement in revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected wave length.	Normal wave length.	Displacement in revolutions.	Velocity.
2	73·5911	4875 434	...	...	...	...	½	30·3756	4135·609	·374	...	...	...
2	73·1412	4864·776	...	...	...	...	3	30·3142	4134·852	...	...	...	...
1	73·0219	4861·964	·817	·527	·290	+17·89	1	27·6096	4102·126	1·921	890	·031	+ 2·27
2	45·4418	4341·360	...	...	...	...	2	27·4418	4100·132	...	...	...	...
1½	45·4224	4341·068	0·868	·634	·23.4	+16·14							

Weighted mean	+12·68	
V_a		− 13·65
V_d		− ·10
Curvature		·28
Radial velocity		− 1·4

α CORONÆ BOREALIS, 850 (a).

1907. June 14.
G. M. T. 16ʰ 39ᵐ

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected wave length.	Normal wave length.	Displacement in revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected wave length.	Normal wave length.	Displacement in revolutions.	Velocity.
2	73·4113	4875·633	....	..	......	....	1½	53·9875	4482·586	1·046	·400	·646	+[43·22]
2	72·9635	4865·037	......	...	......	....	1½	53·2781	4470·405	......	...	......	......
1	72·8279	4861·845	·747	·527	·220	+13·57	2	45·2668	4341·590	...	.....	......	....
1½	54·3973	4489·656	.	.....	.....	....	2	45·2482	4341·307	0·879	·634	·245	+16·90

Weighted mean ...... +15·79
V_a .... −13 92
V_d .... − ·12
Curvature .... − ·28

Radial velocity .. .. + 1·5

α CORONÆ BOREALIS, 850 (b).

1907. June 14.
G. M. T. 16ʰ 52ᵐ

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected wave length.	Normal wave length.	Displacement in revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected wave length.	Normal wave length.	Displacement in revolutions.	Velocity.
1½	73 4199	4875·835	. ...	......	......	......	2	45·2684	4341·613	·188	·634	·554	+38·23
1½	72 9691	4865·169	......	... .	.....	....	1	27·4757	4102·322	2·290	1·890	·400	+29·24
1	72·8446	4862·238	1·997	·527	·470	+29·00	2	27·2770	4099·954	. ..	.....	......	....
2	45·2666	4341·587	......	... ..	......	....							

Weighted mean .. .. +33·68
V_a .... −13·92
V_d .... − ·12
Curvature. ...... − ·28

Radial velocity .... +19·4

α CORONÆ BOREALIS. 861 (a).

1907. June 20.
G. M. T. 16h 05m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in revolutions.	Velocity.	Wt.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement in revolutions.	Velocity.
1	73·2760	4871·450	.....	.....	.....	.....	1½	45·2526	4341·493	....	.....	.....	.....
1½	72 9905	4864·720	.....	.....	.....	.....	1½	45·2364	4341·249	0·918	0·634	·284	+19·60
1	72·8861	4862·267	2·467	1·527	·940	+58·00	1	27·4436	4102·363	2·320	1·890	·430	+31·43
¼	54·0070	4482 788	2 495	1·400	1·095	+[73.25]	1½	27·2416	4099·960	.....	.....	.....	.....
½	53·2695	4470·164	....	.....	.....	.....							

Weighted mean........		+33.95
V_a	−15·42	
V_d	− ·11	
Curvature.........	− ·28	
Radial velocity........		+ 17·1

α CORONÆ BOREALIS, 869 (a).

1907. June 21.
G. M. T. 15h 10m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·4558	.....	.....	.....	1	53·1220	.....	.....	.....
1½	72.9987	.....	.....	.....	2	45·2828	.....	.....	.....
1	72·8723	·8833	·0185	+26·84	2	45·2626	·2574	·0187	+19·52
1	72 4343	.....	.....	.....	1	27·4687	·4329	·0203	+17·62
1½	54·7447	.....	.....	.....	2	27·2824	.....	.....	.....
½	54·0017	·9962	·0264	+[30·39]					

Weighted mean........		+20·88
V_a	−15·65	
V_d	− ·05	
Curvature.........	− ·28	
Radial velocity........		+ 4·9

α CORONÆ BOREALIS, 869 (*b*).

1907. June 21.
G. M. T. 15h 42m

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·4265	....	....	....	1½	53·0887	....	....	....
1½	72·9753	....	....	....	2	45·2563	....	....	....
1	72·8572	·8940	·0292	+42·37	2	45·2497	·2670	·0283	+29·53
1	72·4075	....	....	....	½	27·4248	·4145	·0019	+ 1·65
2	54·7245	....	....	....	2	27·2569	....	....	....
1	54·0007	·0197	·0499	+[57·42]					

Weighted mean	+29·22
V_a	−15·66
V_d	− ·07
Curvature	− ·28
Radial velocity	+13·2

α CORONÆ BOREALIS, 880.

1907. June 25.
G. M. T. 15h 43m

Observed by }
Measured by } W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	49·3450	....	....	....	½	27·4294	·4144	·0018	+ 1·50
2	45·1892	·2092	·0295	−30·80	1	27·2616	....	....	....
2	44·2398	....	....	....					

Weighted mean	−24·34
V_a	−16·56
V_d	− ·10
Curvature	− ·28
Radial velocity	−41·3

α CORONÆ BOREALIS, 888.

1907. June 26.
G. M. T. 15^h 01^m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	48·7894	....	....	....	½	27·5130	5033	·0168	+13·57
2	45·2958	·2794	·0307	+32·14	1	27·3316	....	....	....
2	45·2880	....	....	....					

Weighted mean ... ... −28 42
V_a ... ... −18·76
V_d ... ... − ·05
Curvature ... − ·28

Radial velocity ... ... +11·3

α CORONÆ BOREALIS, 892 (a).

1907. June 27.
G. M. T. 15^h 25^m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·9825	....	....	....	2	45·2750	....	....	....
1	72 8545	·8822	·0174	+25·20	½	45·2277	·2363	·0124	−12·98
2	72·4160	....	....	....	2	57·8430	8237	·0190	+(22·91)*
½	54 0205	....	....	....	1½	57·8172	....	....	....
¼	53·9655	·9603	·0037	+[4·27]					

Weighted mean ... ... +12·47
V_a ... ... −16·98
V_d ... ... − ·09
Curvature ... ... − ·28

Radial velocity ... ... − 4·9

*Not used.

α CORONÆ BOREALIS, 892 (b).

1907. June 27.
G. M. T. 15ʰ 25ᵐ

Observed by W. E. HARPER.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0205	......	....	....	2	54·7740	......	....	....
½	72·8582	·8479	·0169	−24·52	1	54·0162	·9814	·0116	+[13·35]
2	72·4540	......	....	....	2	53·1495	......	....	....
2	57·8550	......	....	....	2	45·3208	......	....	....
½	57·8570	8288	·0020	+(2·41)*	1	45·2668	2196	·0191	−19·94

Weighted mean .... −21·47
V_a .... −16·98
V_d .... − ·09
Curvature .... − ·28

Radial velocity .... −38·8

*Not used.

α CORONÆ BOREALIS, 912 (a).

1907. July 4.
G. M. T. 15ʰ 38ᵐ

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·4621	......	....	....	3	54·0285	·0243	·0545	+[62·73]
1	73·0125	......	....	....	2	53·1130	......	....	....
½	72·8823	·8823	·0175	−25·39	2	45·2818	......	....	....
½	72·4506	......	....	....	1½	45·2930	·2848	·0461	+48·13
1½	54·7496	......	....	....					

Weighted mean .... +43·58
V_a .... −18·30
V_d .... − ·14
Curvature .... − ·28

Radial velocity .... +24·9 α CORONÆ BOREALIS, 917 (a).

1907. July 5.
G. M. T. 15ʰ 20ᵐ

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9847	....	....	....	2	53·1159	....	....	....
1	72·8795	·9040	·0392	+56·38	2	45·2826	....	....	....
1½	72·4219	....	....	....	2	45·2955	·2865	·0478	+49·90
2	54·7410	....	....	....	½	27·4935	·4460	·0334	+28·99
¼	54·022-	·0210	·0512	+[58·93]	2	27·2942	....	....	....

Weighted mean		+48·77
V_a	−18·45	
V_d	− ·10	
Curvature	− ·28	
Radial velocity		+29·9

α CORONÆ BOREALIS, 919.

1907. July 8.
G. M. T. 15ʰ 36ᵐ

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings,	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9772	....	....	....	1½	45·2712	·2697	·0210	+21·98
1	72·8492	·8372	·0185	+26·88	1	27·5298	·5265	·0300	+34·16
2	72·4058	....	....	....	1	30·9330	....	....	....
2	45·2852	....	....	....	2	27·3256	....	....	....

Weighted mean		+26·86
V_a	−18·95	
V_d	− ·14	
Curvature	− ·28	
Radial velocity		+ 7·5

α CORONÆ BOREALIS, 927.

1907. July 9.
G. M. T. 14h 32m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9662	....	....	....	2	45·2862	....	....	....
1	72·8618	·8562	·0375	−54·48	1½	45·2380	2354	0133	−13·92
2	72·4106	....	....	....	½	27·4734	4889	·0076	+ 1·40
2	54·7306	....	....	....	2	27 3064	....	....	....
1	53·9888	·9833	·0267	+[30.81]	½	57·8628	·8428	·0428	+(51·62)*
2	53·1078	....	....	....	2	57·8178	....	....	....

Weighted mean	−11·43
V_a	−19·09
V_d	− ·08
Curvature	·28
Radial velocity	− 8·0

*Not used.

α CORONÆ BOREALIS, 927.**

1907. July 9.
G. M. T. 14h 32m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9680	....	....	....	1	53·9622	9697	·0131	+[15·12]
1	72·8569	·8503	·0316	+45·91	1½	53·0917	....	....	....
1½	72·4102	....	....	....	2	45·2603	....	....	....
½	57·8736	·8675	·0675	+(81·27)*	1½	45·2267	2500	0013	+ 1·36
1½	57·8040	....	....	....	½	27·4465	4910	·0055	+ 3·20
2	54·7205	....	....	....	3	27·2774	....	....	....

Weighted mean	+16·52
V_a	−19·09
V_d	− ·08
Curvature	− ·28
Radial velocity	− 2·9

**Check measurement.
*Not used.

α CORONÆ BOREALIS, 936.

1907. July 10.
G. M. T. 14h 06m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity
2	73·4385	......	....	...	2	45·3045	·2916	mean .0317	+33 18
2	72·9873	......	....	....	2	45·2722	·2693		
1	72·8610	8370	·0183	+26 58	1	27·4904	·5206	0241	+28·99
2	45 2865	......	......	......	2	27·2917	......	......	......

Weighted mean........ +30·48
V_a .. 19 23
V_d...... ·05
Curvature 28

Radial velocity...... + 10·9

α CORONÆ BOREALIS, 936*

1907. July 10.
G. M. T. 14h 06m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings	Displacement in Revolutions.	Velocity.
2	73·0197	......	......	......	½	27·5361	4419	·0293	+25·43
½	72·8963	·8854	·0206	+29·89	2	27·3413	......	......	......
2	72·4588	......	......	......	½	12·0294	·9169	0655	+49·06
2	45·3296	......	......	......	2	11·6198	......	......	......
1	45 3064	·2504	·0117	+12·21					

Weighted mean...... +25·76
V_a.... −19·23
V_d.. − ·05
Curvature...... − ·28

Radial velocity.... + 6·2

*Check measurement.

α CORONÆ BOREALIS, 939 (a).

1907. July 12.
G. M. T. 16h 25m

Observed by J. S Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9412	......	......	......	1½	45·2344	·2304	·0183	−19·16
1	72·7980	8200	0013	+ 1·89	1	27·4394	·4837	·0035	− 3·16
2	72·3774	...	......	......	2	27·2776	......	......	......
2	45 2876	...	......	...					

Weighted mean........ − 8·58
V_a ..... 19·52
V_d........ ·23
Curvature ...... − ·28

Radial velocity..... − 28·6

α CORONÆ BOREALIS, 941 (*a*).

1907 July 13.
G. M. T. 15h 25m

Observed by J. N. Tribble.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9571				1	53·9164	·9216	·0350	−[36·57]
1	72·7891	·7967	·0220	−31·94	2	45·2737			
2	72·3883				2	45·2395	·2494	·0010	+ 1·05
1	54·0101								

Weighted mean ... − 9·95
V_a ... −19·64
V_d ... − ·20
Curvature ... − ·28

Radial velocity ... − 30.1

α CORONÆ BOREALIS, 944 (*a*).

1907. July 16.
G. M. T. 14h 37m

Observed by J. N. Tribble.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9844				2	45·2506	·2292	0095	− 9·94
1	72·8686	·8938	·0290	+42·08	½	27·4712	·4048	·0078	− 6·57
1½	72·4200				2	27·3130			
2	45·2950								

Weighted mean ... − ·20
V_a ... −19·98
V_d ... − ·11
Curvature ... − ·28

Radial velocity ... −20·6

α CORONÆ BOREALIS, 944 (*a*)*.

1907. July 16.
G. M. T. 14h 37m

Observed by J. N. Tribble.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·6086				2	53·1311			
½	72·8748	·8752	·0104	+15·09	2	45·3033			
2	72·4466				1	45·2588	·2290	·0097	−10·12
2	54·7631				½	27·5206	·4520	·0394	+54·20
¼	54·0116	·9915	·0217	+[21·98]	2	27·3153			

Weighted mean ... + 7·26
V_a ... −19·98
V_d ... − ·11
Curvature ... − ·28

Radial velocity ... −13·1

*Check measurement.

α CORONÆ BOREALIS, 951 (*a*).

1907. July 18.
G. M. T. 14h 50m

Observed by J. N. Tribble.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0275				¼	53·9282	0274	·0576	+[66·30]
⅛	72 8907	8738	0090	+13·06	2	53 0075			
2	72·4593				2	45 1272			
2	54·6480				½	45 0922	·2386	0001	−18·0

Weighted mean .... − 2 53
V_a .... − 20·16
V_d .... ·14
Curvature .... − ·28

Radial velocity .... − 18·0

α CORONÆ BOREALIS, 951 (*b*).

1907 July 18.
G. M. T. 15h

Observed by J. N. Tribble.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0220				1	53·8272	0264	0264	−[30 38]
½	72·8730	8616	·0032	− 4 64	2	52 9927			
2	72 4539				2	45·1147			
2	54 6277				¼	45·0804	2395	0008	+ 8·35

Weighted mean .... − 0·31
V_a .... − 20·16
V_d .... − 14
Curvature .... − ·28

Radial velocity .... − 20·9

α CORONÆ BOREALIS, 956 (*a*).

1907. July 20.
G. M. T. 16h 07m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9731				2	45 3021	2932	·0445	+46 59
1	72 8743	8653	·0418	+65·09	1	27·5473	·5493	0621	+54·03
1½	72·4128				3	27·3199			
2	45·2925								

Weighted mean .... +53·08
V_a .... −20·37
V_d .... − ·22
Curvature .... − ·28

Radial velocity .... +32·2

σ CORONÆ BOREALIS, 963 (a).

1907. July 23.
G. M. T. 14h 32m

Observed by J. N. Tribble.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
½	73·4670				½	54·0566	·0256	·0558	[+64·22]
1	72·8900	·8860	·0212	−30·76	2	50·0472			
2	56·6944								

V_s	+30·76
V_a	−20·59
V_d	− ·14
Curvature	− ·28
Radial velocity	+ 9·8

α CORONÆ BOREALIS, 973 (a).

1907. Aug. 1.
G. M. T. 14h 06m

Observed by, Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Lines.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Lines.	Displacement in Revolutions.	Velocity.
2	72·9868				2	45·2780			
½	72·8440	·8210	·0023	+ 3·34	1	45·2568	2624	·0137	+14·34
2	72·4220								

Weighted mean	+10·67
V_a	−20·98
V_d	− ·14
Curvature	− ·28
Radial velocity	−10·7

α CORONÆ BOREALIS, 973 (a)*.

1907. Aug. 1.
G. M. T. 14h 06m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0088				½	53·9750	·9619	0079	− 9·09
½	72·8800	·8807	·0159	+23·07	2	53·1240			
2	72·4485				2	45·2885			
2	54·7562				½	45·2552	·2402	·0015	+ 1·57

Weighted mean	+ 5·85
V_a	20·98
V_d	− ·14
Curvature	− ·28
Radial velocity	−15·5

* Check measurement.

α CORONÆ BOREALIS, 973 (*b*).

1907. Aug. 1.
G. M. T. 14h 20m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0342	..	..	..	½	45·2752	·2335	0052	− 5·43
2	45·3153	..	..	..					

V_s	− 5·43
V_a	20 98
V_d	− ·14
Curvature	− ·28
Radial velocity	− 26 8

α CORONÆ BOREALIS, 978.

1907. Aug. 3.
G. M. T. 13h 02m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9938	..	..	..	2	45·2426	·2434	·0054	− 5·65
1	72·8526	·8224	·0037	+ 5·37	1	27·4524	·4800	·0165	− 6·40
2	72 4294	..	..	..	2	27·2940	..	..	..
2	45·2828	..	..	..					

Weighted mean	− 3·08
V_a	−20·98
V_d	− 08
Curvature	− ·28
Radial velocity	−24·4

α CORONÆ BOREALIS, 986.

1907. Aug. 6.
G. M. T. 16h 38m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9297	..	..	..	2	54·6972	..	..	..
1	72·8025	·8363	·0176	+25·57	1½	53 0647	..	..	..
1½	72·3657	..	..	..	2	45·2377	..	..	..
1	53·9672	·0000	0434	+[50·08]	1	45·2437	·2877	0390	+34·00

Weighted mean		+29·78
V_a	−20·96	
V_d	− ·27	
Curvature	− ·28	
Radial velocity		+ 8·3

α CORONÆ BOREALIS, 986.*

1907. Aug. 6. G. M. T. 16h 38m — Observed by / Measured by: W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9624				1	54·0154	54·0019	·0553	+[63·93]
1	72·8494	72·8504	·0317	+46·06	2	45·2934			
2	72·3988				1½	45·2948	45·2850	·0363	+38·00
1	54·0288								

Weighted mean		+41·22
V_a	−20·96	
V_d	− ·27	
Curvature	− ·28	
Radial velocity		+19·7

*Check measurement.

α CORONÆ BOREALIS, 1006.

1907. Aug. 12. G. M. T. 16h 36m — Observed by / Measured by: W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·8216				1	53·9092	53·9903	·0205	+[23·66]
½	72·6801	72·8664	·0016	+ 2·32	2	45·2372			
2	72·2641				½	45·2140	45·2504	·0117	+12·25
2	53·9477								

Weighted mean	+ 7·28	
V_a		−20·76
V_d		− ·28
Curvature		− ·28
Radial velocity		−14·0

α CORONÆ BOREALIS, 1014.

1907. Aug. 15. G. M. T. 15h 09m — Observed by / Measured by: W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9915				2	53·9737	53·9813	·0115	+[13·24]
½	72·8396	72·8573	·0075	−10·88	2	53·1065			
2	72·4290				2	45·2707			
2	54·7321				½	45·2197	45·2226	·0161	+16·81

Weighted mean	+13·84	
V_a		−20·58
V_d		− ·24
Curvature		− ·28
Radial velocity		− 7·3

α CORONÆ BOREALIS, 1017.

1907. Aug. 22.
G. M. T. 15h

Observed by / Measured by W. E. HARPER.

Wt.	Mean of Settings	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1½	45·7844	....	....	...	¼	45·7576	45·2448	·0061	+ 6·37

V_s		+ 6·37
V_a		−19·90
V_d		− ·20
Curvature		− ·28
Radial velocity		−14·0

α CORONÆ BOREALIS, 1022.

1907. Aug. 23.
G. M. T. 14h 46m

Observed by J. N. TRIBBLE.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	56·6754	......	....	......	2	45·2730	....	....	......
1	54·0042	53·9960	·0262	+[30·16]	½	45·2628	45·2634	·0247	+25·78
2	53·1214	....	....	....					

V_s		+25·78
V_a	−19·80	
V_d	·24	
Curvature	− ·28	
Radial velocity		+ 5·5

α CORONÆ BOREALIS, 1026.

1907. Aug. 27.
G. M. T. 12h 06m

Observed by / Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0220	......	....	....	2	45·2880	......	....	....
⅛	72·9344	72·9232	·0584	+84·74	⅛	27·4870	27·4500	·0281	+32·50
2	72·4630	....	....	....	2	27·2840	......	....	....
2	54·0444	....	....	......	⅛	45·2840	45·2696	·0310	+32·36
⅛	54·0000	53·9844	·0146	+[16·80]					

Weighted mean		+49·87
V_a	−19·35	
V_d	− ·19	
Curvature	− ·28	
Radial velocity		+30·0

α CORONÆ BOREALIS, 1032.

1907. Sept. 6.
G. M. T. 13ʰ 43ᵐ

Observed by J. N. Tribble.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0155				2	45·2322			
¼	72·8710	72·8631	·0017	− 2·46	1	45·1848	45·2273	·0114	−13·05
2	72·4595				½	27·3558	27·4204	·0078	− 6·77
2	54·7134				2	27·1818			
½	53·9360	53·9634	·0064	− [7·36]	¼	11·7425	11·8493	·0021	− 1·57
2	53·0852				2	11·4098			

Weighted mean	− 4·50
V_a	−17·34
V_d	− ·25
Curvature	− ·28
Radial velocity	− 22·4

α CORONÆ BOREALIS, 1037.

1907. Sept. 12.
G. M. T. 14ʰ 40ᵐ

Observed by J. N. Tribble.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9383				1	45·1575	45·2878	·0491	+51·20
1½	72·8230	72·8950	·0302	+43·82	½	27·3467	27·5090	·0964	+83·52
2	72·3715				2	27·0843			
2	45·1433								

Weighted mean		+52·93
V_a	−16·20	
V_d	− ·28	
Curvature	− ·28	
Radial velocity		+36·2

α CORONÆ BOREALIS, 1047.

1907. Sept. 18.
G. M. T. 12ʰ 50ᵐ

Observed by J. N. Tribble.
Measured by W. E. Harper.

Wt.	Mean of Settings	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·1431				2	45·3762			
1	72·9930	72·8596	·0052	− 7·55	1	45·3585	45·2560	·0173	+18 06
1½	72·5787								

Weighted mean	+ 5·25	
V_a		−14·94
V_d		− ·25
Curvature		− ·28
Radial velocity		−10·2

α CORONÆ BOREALIS, 1048.

1907. Sept. 18.
G. M. T. 13h 16m

Observed by J. N. TRIBBLE.
Measured by W. E. HARPER and J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0030	....	....	......	½	53·9418	53·9718	·0020	+ [2·30]
½	72·8640	72·8695	0047	+ 6·82	2	53·0866	....	....	......
2	72·4433	....	....	......	2	45·1702	....	....	......
2	57·8023	....	....	......	1	45·1457	45·2339	·0048	− 5·00
1	57·7850	57·7895	·0373	− (44·91)	¼	27·3310	27·3870	·0256	− 22·22
2	54·7113	....	....	......	2	27·1905	....	....	......

Weighted mean	− 4·09
V_a	− 14·94
V_d	− ·28
Curvature	− ·28
Radial velocity	− 19·6

α CORONÆ BOREALIS, 1060.

1907. Sept. 20.
G. M. T. 13h 35m

Observed by W. E. HARPER.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0090	....	....	......	2	53·0627	....	....	......
¼	72·8367	72·8376	·0272	− 39·46	2	45·2140	....	....	......
2	72·4435	....	....	......	1	45·1690	45·2286	·0101	− 10·54
2	54·6952	....	....	......	½	27·3412	27·4192	·0066	+ 5·73
¼	53·8872	53·9352	·0346	− [39·82]	2	27·1682	....	....	......

Weighted mean	− 10·02
V_a	− 14·52
V_d	+ ·02
Curvature	− 28
Radial velocity	− 24·8

α CORONÆ BOREALIS, 1083.

1907. October 1.
G. M. T. 13h 44m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0679	......	......	......	2	45·3609	......	......	......
¼	72·9652	72·9078	·0430	+62·39	½	45·3694	45·2857	·0470	+49·07
2	72·5002	......	......	......	¼	27·5686	27·4492	·0366	+31·77
2	54·8129	......	......	......	2	27·3664	......	......	......
½	54·0989	54·0261	·0563	+[64·80]	1	12·0432	11·9027	·0513	+38·42
2	53·1867	......	......	......	2	11·6482	......	......	......

Weighted mean		+43·25
V_a	−12·21	
V_d	− ·28	
Curvature	− ·28	
Radial velocity		+30·5

α CORONÆ BOREALIS, 1084.

1907. Oct. 1.
G. M. T. 13h 56m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9948	......	......	......	2	45·2968	......	......	......
¼	72·8698	72·8852	·0204	+29·60	½	45·2912	45·2680	·0203	+30·59
2	72·4285	......	......	......					

Weighted mean		+30·27
V_a	−12·21	
V_d	− ·28	
Curvature	− ·28	
Radial velocity		+17·5

α CORONÆ BOREALIS, 1393.

1908. March 9.
G. M. T. 22h 08m

Observed by / Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·8725	......	......	......	2½	27·5088	27·4056	·0070	− 6·08
1½	54·0542	53·9269	·0429	−[49·38]	3	27·3499	......	......	......
2	53·2361	......	......	......	1½	11·9342	11·8522	·0008	+ 0·60
3	45·3847	......	......	......	3	11·5892	......	......	......
2	45·3252	45·2141	·0246	−25·68					

Weighted mean	−10·94	
V_a		+16·98
V_d	− ·05	
Curvature	− ·28	
Radial velocity		+ 5·7

α CORONÆ BOREALIS, 1393*.

1908. March 9.
G. M. T. 22h 08m

Observed by W. E. HARPER.
Measured by C. R. WESTLAND.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity
2	54·7344	....	....	....	1	27·3712	27·3992	·0134	−11·63
2	53·9241	53·9316	0382	−[43·97]	2	27·2184	....	....	....
2	53·1045	....	....	....	1	11·7835	11·8301	·0213	−15·95
2	45·2517	....	....		2	11·4603	....	....	....
2	45·1867	45·2087	0300	31·32					

Weighted mean.......................... −22·55
V_a.............................. +16·98
V_d.................................. − ·05
Curvature.............................. − ·28

Radial velocity.......................... − 5·9

Note.—(Mg. line omitted). * Check measurement.

α CORONÆ BOREALIS, 1393. *

1908. March 9.
G. M. T. 22h 08m

Observed by / Measured by } W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7502	....	....	....	1½	45·2112	45·2051	·0336	−35·08
1	53·9539	53·9413	·0285	−[32·80]	1	27·3758	27·3827	·0299	−25 95
2	53·1290	....	....	....	2	27·2397	....	....	....
2	45·2797	....	....	....					

Weighted mean.......................... −31·43
V_a.............................. +16·98
V_d.................................. − ·05
Curvature.............................. − ·28

Radial velocity.......................... − 14·8

* Check measurement.

α CORONÆ BOREALIS, 1402.

1908. March 16.
G. M. T. $21^h\ 02^m$

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	54·7845	.....	.....	.....	1	27·5345	27·3875	0251	−21·79
1	53·9802	53·9412	0286	−[32·92]	2	27·3906	.....	.....	.....
1	53·1475	.....	.....	.....	1½	11·9963	11·7940	0574	−43·00
1	45·3466	.....	.....	.....	2	11·7098	.....	.....	.....
1	45·2690	45·1960	0427	−44·58					

Weighted mean		−37·39
V_a	+20·74	
V_d		00
Curvature		− 28
Radial velocity		− 16·9

α CORONÆ BOREALIS, 1493.

1908. April 15.
G. M. T. $19^h\ 18^m$

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	45·2842	.....	.....	.....	2	15·5026	.....	.....	.....
1	45·2361	45·2254	0133	−13·88	½	15·5417	15·4377	0356	−27·55
1	27·4702	27·4039	·0087	− 7·55	1½	11·9500	11·8426	·0088	− 6·59
2	27·3135	.....	.....	.....	2	11·6149	.....	.....	.....

Weighted mean		−13·89
V_a	+ 5·85	
V_d		− ·04
Curvature		− ·28
Radial velocity		− 8·4

α CORONÆ BOREALIS, 1493.*

1908. April 15.
G. M. T. $19^h\ 18^m$

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9717	.....	.....	.....	2	45·2267	45·2191	0196	−20·46
1½	72·8300	72·8678	·0030	+ 4·35	1½	27·4633	27·4012	0114	− 9·89
2	72·4080	.....	.....	.....	2	27·3090	.....	.....	.....
2	45·2812	.....	.....	.....					

Weighted mean		− 9·85
V_a	+ 5·85	
V_d		− ·04
Curvature		− ·28
Radial velocity		− 4·3

*Check measurement.

α CORONÆ BOREALIS, 1565.

1908. June 1.
G. M. T. 18^h

Observed by T. H. PARKER.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9938	....	....	....	2	45·3014	....	....	....
1½	72·8490	72·8648	·0000	± 0·00	1	27·4890	27·4251	0125	+10·85
2	72·4310	....	....	....	2	27·3107	....	....	....
2	54·7550	....	....	....	½	15·5442	15·4528	·0105	− 8·13
1	54·0110	53·9920	·0222	+[25·56]	2	15·4900	....	....	....
2	53·1370	....	....	....	2	11 9275	11·8338	·0176	− 9·13
2	45·2605	45·2355	·0032	− 3·34	2	11 6009	....	....	....

Weighted mean	− 2·59
V_a	10·43
V_d	·20
Curvature	− ·28
Radial velocity	−13·5

α CORONÆ BOREALIS, 1566.

1908. June 1.
G. M. T. 18^h 42^m

Observed by } T. H. PARKER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	45·2929	....	....	....	½	27·4641	27·4107	·0019	− 1·64
2	45·2461	45 2267	·0120	−12·52	2	27·3000	....	....	....
2	43·5585	....	....	....					

Weighted mean	10·34
V_a	10·43
V_d	− ·20
Curvature	− ·28
Radial velocity	−20·2

α CORONÆ BOREALIS, 1571.

1908. June 3.
G. M. T. 16^h 32^m

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0427	....	....	....	1	27·4899	27·4253	·0127	+11·02
1	72·9099	72·9760	·0112	+16·25	2	27·3115	....	....	....
½	72·4822	....	....	....	½	15 5378	15·4464	0269	−20 82
2	45·2815	....	....	....	2	15·4900	....	....	....
2	45·2437	45·2358	·0029	− 3·03					

Weighted mean	+ 2·40
V_a	−11·02
V_d	− ·07
Curvature	− ·28
Radial velocity	9·0

α CORONÆ BOREALIS, 1572.

1908. June 3.
G. M. T. 16h 52m

Observed by J. S. Plaskett.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7690	....	....	....	2	27·3380	....	....	....
½	53·9965	53·9706	·0008	+ [1·16]	½	15·5674	15·4394	·0339	−26·24
2	53·1417	....	....	....	2	15·5266	....	....	....
2	45·3179	....	....	....	2	11·9767	11·8434	·0080	− 5·99
2	45·2866	45·2423	·0036	+ 3·76	2	11·6410	....	....	....
½	27·4982	27·4073	·0053	− 4·60					

Weighted mean	− 3·98
V_a	−11·02
V_d	− ·08
Curvature	− ·28
Radial velocity	− 15·4

α CORONÆ BOREALIS, 1572*.

1908. June 3.
G. M. T. 16h 52m

Observed by J. S. Plaskett.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
½	53·9962	53·9677	·0021	−[2·41]	2	27·3409	....	....	....
2	54·7700	....	....	....	1	15·5560	15·4260	·0473	−36·61
2	45 3195	....	....	....	2	15·5286	....	....	....
1	45·2856	45·2396	·0009	+ 0·93	2	11·9830	11·8501	·0013	− 9·74
2	43·5855	....	....	....	2	11·6401	....	....	....
2	27·5096	27·4153	·0027	+ 2·34					

Weighted mean	− 8·41
V_a	−11 02
V_d	− ·08
Curvature	− ·28
Radial velocity	− 19 8

* Check measurement.

α CORONÆ BOREALIS, 1581.

1908. June 5.
G. M. T. 17h 31m

Observed by / Measured by } W. E. Harper

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9780	......	......	......	1	27·3975	27·4026	·0100	8·63
1	72·8406	72·8688	·0040	+ 5·80	2	27·2433	......	......	......
2	72·4202	......	......	......	1	11·8584	11·8491	·0023	− 1·72
2	45·2545	......	......	......	2	11·5145	......	......	......
2	45·2387	45·2578	·0191	+19·94					

Weighted mean	+ 7·06
V_a	−11·62
V_d	− ·14
Curvature	− ·28
Radial velocity	− 5·0

α CORONÆ BOREALIS, 1601.

1908. June 12.
G. M. T. 16h 56m

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9665	......	......	......	2	53·0720	......	......	......
1	72·8330	72·8678	·0030	+ 4·35	2	45·2242	45·2568	·0181	+28·18
1	72·4060	......	......	......	2	45·2410	......	......	......
2	54·7068	......	......	......	1½	27·4228	27·4370	·0244	+21·27
½	53·9350	53·9725	·0027	+ [3·11]	2	27·2322	......	......	......

Weighted mean	+20·58
V_a	−13·59
V_d	− ·12
Curvature	− ·28
Radial velocity	+ 6·6

α CORONÆ BOREALIS, 1608.

1908. June 17.
G. M. T. 13h 53m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	72·9809	...	...	...	2	45·2620	...	...	...
1	72·8361	72·8662	·0014	+ 2·03	2	45·2390	45·2506	·0119	+12·42
2	72·4112	...	...	...	1	27·4892	27·4739	·0613	+53·21
2	54·7169	...	...	...	2	27·2621	...	...	...
1	53·9506	53·9716	·0018	+ [2·07]	1	11·9270	11·8964	0450	+33·70
2	53·0941	...	...	...	2	11·5379	...	...	...

Weighted mean		+23·76
V_a	−14·85	
V_d	·07	
Curvature	− ·28	
Radial velocity		+ 8·6

α CORONÆ BOREALIS, 1623.

1908. June 22.
G. M. T. 16h 27m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7556	...	...	...	1	27·4580	27·4130	·0004	+ 3·47
2	53·9719	53·9559	·0139	−[16·00]	3	27·2899	...	...	...
2	53·1320	...	...	...	1	11·9219	11·8454	·0060	− 4·49
2	45·2819	...	...	...	2	11·5853	...	...	...
1	45·2571	45·2511	·0124	+12·93					

Weighted mean	3·97	
V_a		−16·16
V_d		− ·16
Curvature		− ·28
Radial velocity		−12·

a CORONÆ BOREALIS, 1623.

1908. June 22.
G. M. T. 16h 27m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0044				2	45·3000			
1	72·8548	72 8598	·0050	− 7·25	1	45·2624	45·2364	·0023	− 2 40
2	72·4483				1	27·4675	27 4195	·0024	− 2 08
2	54 7536				3	27·2952			
2	53·9681	53 9531	·0167	[19·22]	1	11·9274	11 8594	·0080	+ 5·99
2	53·1381				2	11 5790			

Weighted mean.. .. .. − 1·44
V_a ... ... −16·16
V_d ... ... − ·16
Curvature ... ... − ·28

*Check measurement.

Radial velocity ... ... −18 0

a CORONÆ BOREALIS, 1624.

1908. June 22.
G. M. T. 16h 40m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity
2	54 7898				½	27·4840	27·4175	·0049	+ 4·34
1	54 0178	53·9700	·0002	±[0·00]	2	27·3131			
2	53·1597				1½	11·9423	11·8612	·0098	+ 7·34
2	45·3251				2	11·5883			
1½	45·2880	45·2365	·0023	− 2 40					

Weighted mean... ... + 4·02
V_a ... ... −16·16
V_d ... ... − ·16
Curvature ... ... − ·28

Radial velocity ... ... −12·6

a CORONÆ BOREALIS, 1628.

1908. June 24.
G. M. T. 15h 26m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7838				1	27·4598	27 4158	·0032	+ 2·7
½	53·9417	53·9000	·0698	−[80·33]	2	27 2908			
2	53·1536				1½	11·9065	11·8705	·0191	+14·30
2	45·3060				2	11·5432			
1	45·2761	45·2436	·0049	+ 5·12					

Weighted mean... ... + 8·38
V_a ... ... −16·65
V_d ... ... − ·07
Curvature ... ... − ·28

Radial velocity ... ... − 8·6

α CORONÆ BOREALIS, 1629.

1908. June 24. G. M. T. $15^h\ 49^m$

Observed by J. S. Plaskett. Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0846				2	45·3268			
½	72·9449	72·8698	·0050	+ 7·26	1	45·2795	45·2263	·0124	−12·95
1	72·5206				½	27·4625	27·4000	·0126	−10·93
2	54·7999				2	27·3093			
1½	54·0511	53·9939	·0241	+[27·74]	1	11·9286	11·8711	·0197	+14·77
2	53·1682				2	11·5643			

Weighted mean	0·00
V_a	−16·66
V_d	− ·11
Curvature	− ·28
Radial velocity	−17·0

α CORONÆ BOREALIS, 1638.

1908. June 26. G. M. T. $15^h\ 51^m$

Observed by W. E. Harper. Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0800				1½	45·3098	45·2238	·0149	−15·56
1	72·9496	72·8476	·0172	−24·96	2	45·3565			
1	72·5498				2	27·4673	27·3933	·0193	−16·80
2	54·8334				3	27·3236			
1	54·0511	53·9601	·0097	−[11·31]	2	11·9232	11·8627	·0113	+ 8·46
2	53·2007				3	11·5652			

Weighted mean	−10·00
V_a	−14·50
V_d	·11
Curvature	− ·28
Radial velocity	−24·9

α CORONÆ BOREALIS, 1639.

1908. June 26th. G. M. T. $15^h\ 51^m$

Observed by W. E. Harper. Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0632				2	53·1470			
1	72·9112	72·8562	·0086	−12·48	2	45·3037			
1	72·5014				1½	45·2656	45·2376	·0011	− 1·15
1½	54·7831				1½	27·4499	27·4169	·0043	+ 3·73
1	54·0126	53·9776	·0078	+[8·98]	2	27·2799			

Weighted mean	− 2·40
V_a	−14·81
V_d	− ·11
Curvature	− ·28
Radial velocity	−17·6

α CORONÆ BOREALIS, 1646,

1908. June 27. Observed by J. S. PLASKETT.
G. M. T. 16h 20m Measured by J. B CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings	Corrected Star Settings	Displacement in Revolutions.	Velocity.
1½	73·0138				1	45·2252	45 2282	·0105	−10 95
½	72·8550	72·8552	·0096	−13·92	2	45·2694			
1½	72·4403				1½	27·4472	27·4290	0164	+14 23
2	54·7419				3	27·2648			
1	53·9706	53·9751	·0053	+[6 17]	2	11 8531	11·8231	·0283	21·19
2	53·0627 (?)				3	11·5348			

Weighted mean	− 7·79
V_a	−14·98
V_d	− ·11
Curvature	− ·28
Radial velocity	− 23·2

α CORONÆ BOREALIS, 1646*.

1908. June 27. Observed by J. S. PLASKETT.
G. M. T. 16h 20m Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0388				2	45·2924			
½	72·8666	72·8466	·0182	−26·41	1½	45·2510	45·2325	·0062	− 6 41
1½	72·4615				1½	27·4381	27·4092	·0034	− 3·05
2	54·7608				3	27·2754			
½	54·0203	54 0038	·0340	+[39·13]	1	11·9032	11·8575	·0061	+ 5 29
2	53·1283				3	11·5531			

Weighted mean	− 4·91
V_a	−14·98
V_d	− ·11
Curvature	− ·28
Radial velocity	− 20·3

* Check measurement.

α CORONÆ BOREALIS, 1646.*

1908. June 27.
G. M. T. 16h 20m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
	72·9272	....	....	....	2	45·1872	....	....	....
	92·7747	72 8581	·0067	− 8·72	2	45·1430	45·2294	·0093	− 9 71
1	73·3578	....	....	....	1	27·3550	27 4286	·0160	−13·89
	54 6545	....	....	....	2	27·1731	....	....	....
½	53·8697	53·9617	·0081	−[9·32]	1	11·7667	11·8341	·0173	− 12 96
	53 0153	....	....	....	2	11 4398	....	....	....

Weighted mean	− 5 44
V_a	−14 98
V_d	− ·11
Curvature	·28
Radial velocity	20 8

* Check measurement.

α CORONÆ BOREALIS, 1647.

1908. June 27.
G. M. T. 16h 40m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0577	....	....	....	2	45·3388	....	....	....
½	72 9089	72·8589	·0059	− 8·56	1	45 3041	45·2387	·0000	± 0·00
1	72·5000	....	....	....	1	27·4771	27·3891	·0235	− 20·40
2	54·7978	....	....	....	2	27·3349	....	....	....
1	54·0373	53·9793	0095	−[10·93]	1	11 9502	11 8522	·0008	− 0·60
2	53·1731	....	....	....	2	11·6053	....	....	....

Weighted mean	− 6 59
V_a	−14·03
V_d	− ·16
Curvature	− ·28
Radial velocity	−21·1

α CORONÆ BOREALIS, 1652.

1908. July 1.
G. M. T. 15h 15m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	....	....	....	....	1	45·0548	45·3038	·0651	+67·96
½	72·6304	72·8917	·0269	+38 03	2	45 0254	....	....	....
1	72·1836	....	....	....	1	27·2466	27·4801	·0675	+58 59
2	54·4896	....	....	....	2	27·0134	....	....	....
½	53·7812	53·0387	·0689	+[79·30]	1	11·7141	11·9391	·0877	+64·69
2	52 8512	....	....	....	2	11·2829	....	....	....

Weighted mean		−60·07
V_a	−17·78	
V_d	− ·07	
Curvature	·28	
Radial velocity		−41·9

α CORONÆ BOREALIS, 1656.

1908. July 3.
G. M. T. 15h 17m

Observed by W. E. HARPER.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
½	54·7645	....	....	....	½	27·4941	27·4806	·0680	+59·02
1½	54·0431	54·0196	·0498	+[57·32]	2	27·2599	....	....	....
1	53·1362	....	....	....	½	11·8955	11·8895	·0381	+28·54
1	45·2983	....	....	....	2	11·5115	....	....	....
½	45·3190	45·2943	·0556	+58·05					

Weighted mean		+48·53
V_a	−18·18	
V_d	− ·11	
Curvature	− ·28	
Radial velocity		+30·0

α CORONÆ BOREALIS, 1657.

1908. July 3.
G. M. T. 15h 30m

Observed by W. E. HARPER.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
½	54·6727	....	....	....	1	45·2097	45·2817	·0430	+44·89
½	53·9471	54·0011	·0313	+36·03	2	44·1900	....	....	....
½	53·0497	....	....	....	1	27·3961	27·4586	·0460	+39·93
1	45·2008	....	....	....	2	27·1843	....	....	....

Weighted mean		+42·41
V_a	−18·18	
V_d	·14	
Curvature	− ·28	
Radial velocity		+23·8

α CORONÆ BOREALIS, 1665.

1908. July 6.
G. M. T. 16h 50m

Observed by T. H. PARKER.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	72·9602	....	....	....	1½	45·2173	45·2668	·0281	+29·34
½	72·8398	72·8876	·0228	+33·08	2	45·2240	....	....	....
1	72·3996	....	....	....	1	27·4083	27·4290	·0164	+14·24
2	54·6898	....	....	....	2	27·2265	....	....	....
¼	53·9145	53·9715	·0017	+ [1·96]	1	11·8914	11.9154	·0640	+47·93
2	53·0501	....	....	....	2	11·4830	....	....	....

Weighted mean		+31·18
V_a	−18·72	
V_d	− ·16	
Curvature	− ·28	
Radial velocity		+12·0

α CORONÆ BOREALIS, 1673.

1908. July 8.
G. M. T. 14h 59m

Observed by } J. B. CANNON.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	72·9993	...	...	...	2	45·2746	...	...	...
½	72·8626	72·8721	·0073	+10·60	1	45·2392	45·2382	·0005	− 0·52
1	72·4371	...	...	...	½	27·4564	27·4227	·0065	+ 5·64
2	54·7344	...	...	...	2	27·2810	...	...	...
½	53·9855	53·9920	·0222	+[25·55]	1½	11·9283	11·8883	·0369	+27·63
2	53·1071	...	...	...	1	11·5472	...	...	...

Weighted mean .... +14·01
V_a .... −19·07
V_d .... − ·11
Curvature .... − ·28

Radial velocity .... − 5·4

α CORONÆ BOREALIS, 1674.

1908. July 8.
G. M. T. 15h 11m

Observed by } J. B. CANNON.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7242	...	...	...	1	27·4496	27·4334	·0208	+18·05
1	53·9536	53·9711	·0013	+[1·50]	2	27·2631	...	...	...
2	53·0947	...	...	...	1½	11·8926	11·8651	·0137	+10·26
2	45·2616	...	...	...	2	11·5351	...	...	...
1	45·2583	45·2703	·0316	+32·99					

Weighted mean .... +18·98
V_a .... −19·07
V_d .... − ·11
Curvature .... − ·28

Radial velocity .... − 0·5

α CORONÆ BOREALIS, 1683.

1908. July 10.
G. M. T. 13h 34m

Observed by W. E. HARPER.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0309	...	...	...	2	53·1334	...	...	...
½	72·8884	72·8694	·0046	+ 6·67	2	45·3129	...	...	...
1	72·4603	...	...	...	½	45·2667	45·2274	·0113	−11·79
2	54·7682	...	...	...	1	27·4832	27·4112	·0014	− 1·22
1	54·0451	54·0211	·0513	+[59·04]	2	27·3188	...	...	...

Weighted mean .... − 1·89
V_a .... −19·38
V_d .... ·00
Curvature .... − ·28

Radial velocity .... − 21·5

α CORONÆ BOREALIS, 1684.

1908. July 10. G. M. T. 13h 57m

Observed by W. E. HARPER. Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0327	......	......	......	2	45·3009	......	......	......
½	72·8947	72·8737	·0089	+12·91	1	45·2694	45·2421	0034	+ 3·54
1	72·4598	......	......	......	1½	27·4744	27·4221	0095	+ 7·81
2	54·7653	......	......	......	2	27 2995	......	......	......
½	53·9629	53 9399	·0299	-[34·41]	½	11·9048	11·8363	0151	-11·30
2	53·1347	......	......	......	2	11·5759	......	......	......

Weighted mean......	− 4·59
V_a...	−19·38
V_d.........	− ·04
Curvature.....	− ·28
Radial velocity	−15·1

α CORONÆ BOREALIS, 1697.

1908. July 13. G. M. T. 15h 36m

Observed by J. S. PLASKETT. Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	72·9735	......	......	......	2	45·2596	......	......	......
½	72 8268	72 8608	·0040	− 5·80	1½	45·2284	45·2424	·0037	+ 3·86
1	72·4159	......	......	......	1½	27·4218	27·3975	·0151	−13·11
2	54·7199	......	......	......	2	27·2712	......	......	......
1	53·9583	53 9828	·0130	+[14 96]	1	11·8656	11 8236	·0278	−20·82
2	53·0846	......	......	......	2	11·5495	......	......	......

Weighted mean.............	− 8·35
V_a............	−19·79
V_d	− ·19
Curvature.....	− ·28
Radial velocity....	−28·6

α CORONÆ BOREALIS, 1698.

1908. July 13
G. M. T. 15h 42m

Observed by J. S. PLASKETT.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0061	....	....	....	2	45·2766	....	....	....
½	72·8661	72·8691	·0043	+ 6·24	1½	45·2388	45·2358	·0029	− 3·03
1	72·4437	....	....	....	1½	27·4391	27·4144	·0018	+ 1·56
2	54·7384	....	....	....	2	27·2716	....	....	....
1	53·9504	53·9544	·0154	−[17·72]	1	11·8994	11·8619	·0105	+ 7·86
2	53·1069	....	....	....	2	11·5450	....	....	....

Weighted mean........ + 1·84
V_a........ −19·79
V_d........ ·16
Curvature........ − ·28

Radial velocity........ −18·4

α CORONÆ BOREALIS, 1711.

1908. July 15.
G. M. T. 16h 24m

Observed by / Measured by } J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0341	....	....	....	1½	45·2779	45·2420	0033	+ 3·44
½	72·8891	72·8647	·0001	− ·15	1	27·4705	27·4115	·0011	− ·95
2	54·7729	....	....	....	2	27·3061	....	....	....
1½	54·0318	53·9990	·0292	+[33·61]	1	11·9256	11·8468	·0046	·34
2	53·1470	....	....	....	2	11·5865	....	....	....
2	45·3094	....	....	....					

Weighted mean........ + 3·79
V_a........ −20·03
V_d........ ·22
Curvature........ − ·28

Radial velocity........ −16·7

α CORONÆ BOREALIS, 1721.

1908. July 24. Observed by W. E. HARPER.
G. M. T. 13h 05m Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0620	......	...	....	2	45·3273	......	....	....
½	72·9251	72·9711	·0063	+ 9·14	1	45·3040	45·2503	·0116	+12·10
1	72·5018	......	...	......	1½	27·5037	27·4317	·0191	+15·57
2	54·7950	......	....	....	2	27·3187	......	....	....
½	54·0282	53.9742	·0044	+ [5·06]	1	11·9502	11·8812	·0298	+20·97
2	53·1587	......	...	.....	2	11·5759	......	....	....

Weighted mean	+15·25	
V_a		20·68
V_d		·04
Curvature		− ·28
Radial velocity		5·7

α CORONÆ BOREALIS, 1722.

1908. July 24. Observed by W. E. HARPER.
G. M. T. 13h 21m Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0441	......	....	......	2	45·3021	......	....	......
½	72·9200	72·8872	·0224	+32·50	1½	45·3022	45·2738	·0351	+36·64
1	72·4735	......	....	....	1	27·4681	27·4298	·0172	+14·93
2	54·7704	......	....	....	2	27·2830	......	....	....
¼	54·0159	53·9881	·0183	+[21·06]	1	11·9141	11·8766	·0252	+18·87
2	53·1390	......	....	......	2	11·5446	......	....	....

Weighted mean		+26·25
V_a	−20·68	
V_d	− ·04	
Curvature	− ·28	
Radial velocity		+ 5·25

α CORONÆ BOREALIS, 1739.

1908. July 29. G. M. T. 15^h 34^m

Observed by J. S. Plaskett. Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0080	......	......	......	2	45·2276	......	......	......
½	72·8406	72·8439	·0209	−30·33	½	45·1618	45·2078	·0309	−32·26
2	72·4370	......	......	......	½	27·3167	27·3607	·0519	−45·14
2	54·7106	......	......	......	2	27·1926	......	......	......
1	53·9688	54·0038	·0340	−[39·13]	¼	11·7853	11·8623	·0109	+ 8·16
2	53·0733	......	......	......	2	11·4290	......	......	......

Weighted mean	−29·78
V_a	−20·68
V_d	− ·24
Curvature	− ·28
Radial velocity	−50·0

α CORONÆ BOREALIS, 1739.*

1908. July 29. G. M. T. 15^h 34^m

Observed by J. S. Plaskett. Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0854	......	......	......	2	45·3015	......	......	......
½	72·9133	72·8398	·0250	−36·27	1	45·2452	45·2173	·0214	−22·34
2	72·5142	......	......	......	¼	27·3747	27·3581	·0545	−36·29
2	54·7789	......	......	......	2	27·2632	......	......	......
½	54·0256	53·9903	·0205	+[25·59]	1	11·8647	11·8697	·0183	+13·70
2	53·1456	......	......	......	2	11·5022	......	......	......

Weighted mean	−18·01
V_a	−20·91
V_d	− ·22
Curvature	− ·28
Radial velocity	−39·4

*Check measurement.

α CORONÆ BOREALIS, 1748.

1908. July 31.
G. M. T. $13^h\ 38^m$

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0081				2	53·1007			
½	72·8616	72·8641	·0007	−10·15	2	45·2666			
1	72·4501				1	45·1969	45·2039	·0348	−36·33
2	54·7326				1½	27·3938	27·3994	·0132	−11·45
1	53·9342	53·9445	·0250	−[28 77]	2	27·2521			

Weighted mean	−19·53
V_a	−20·98
V_d	− ·14
Curvature	− ·28
Radial velocity	−40 9

α CORONÆ BOREALIS, 1749.

1908. July 31.
G. M. T. $13^h\ 38^m$

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0321				2	45 2724			
½	72·8767	72·8559	0089	−11·91	1½	45 2269	45·2281	·0106	−11·07
1	72·4611				1	27·4144	27·4088	0038	− 3·30
2	54 7470				2	27 2523			
1	53·9854	53 9816	·0118	+[13·58]	1	11·8314	11·8384	·0160	− 11·98
2	53 1145				2	11·4999			

Weighted mean	− 9·46
V_a	−20·98
V_d	− ·14
Curvature	− ·28
Radial velocity	− 30·9

α CORONÆ BOREALIS, 1764.

1908. Aug. [illegible]
G. M. T. 15h 15

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity
1	73·0055	....	....	....	2	45·2722	..... .	....	....
¼	72·9250	72·9281	·0633	+91·85	1½	45·2899	45·2913	·0526	+54 91
1	72 4451	....	....	....	½	27·4955	27·4728	·0602	+52·25
2	54·7359	....	....	....	2	27·2595	....	....	....
1	54 0637	54·0699	1002	+[115·33]	1	11·9402	11·9365	·0851	+63 74
2	53 1055	. . . .	. . . .	....	2	11·5107	... .	....	.. ..

Weighted mean .... +58·42
V_a .... −20 96
V_d .... − ·23
Curvature .... − ·28

Radial velocity....... ... . 37·0

α CORONÆ BOREALIS, 1773.

1908. Aug. 7.
G. M. T. 14h 25m

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7903	....	. . . . . .	....	½	27·5854	27 5087	0961	+83 41
1	54·0770	54·0281	0583	+[67 10]	2	27 3236	......	....	....
2	53·1613	. ...	. . . .	....	½	12·0157	11·9397	·0883	+66 14
2	45·3261	....	. . . .	....	2	11·5833	. ...	. . .	....
1½	45·3538	45·3013	·0626	+65·35					

Weighted mean. .... +69 12
V_a .... −20·91
V_d .... − ·19
Curvature... ... ... − 28

Radial velocity............ . . . . . . +47·7

a CORONÆ BOREALIS, 1775.

1908. Aug. 7.
G. M. T. 14h 40m

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0279	...	...	...	2	45·3045	...	...	...
¼	72·9227	72·9056	·0408	+58·20	1½	45·3313	45·3004	·0617	+64·41
1	72·4568	...	...	...	1	27·5296	27·4692	·0566	+49·13
2	54·7633	...	...	...	2	27·3107	...	...	...
1	54·0103	53·9888	·0190	+[21·87]	1	12·0051	11·9305	·0791	+59·25
2	53·1363	...	...	...	2	11·5821	...	...	...

Weighted mean	+58·54
V_a	20·91
V_d	19
Curvature	− ·28
Radial velocity	+37·5

a CORONÆ BOREALIS, 1798.

1908. Aug. 20.
G. M. T. 13h 05m

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0365	...	...	...	2	53·1332	...	...	...
½	72·8789	72·8528	·0120	−17·41	2	45·2876	...	...	...
1	72·4693	...	...	...	1	45·2516	45·2376	·0011	− 1·15
2	54·7634	...	...	...	½	27·4337	27·4011	·0115	− 9·98
1	54·0034	53·9821	·0123	+[14·16]	2	27·2794	...	...	...

Weighted mean	− 7·42
V_a	−20·11
V_d	− 16
Curvature	·28
Radial velocity	− 28·0

α CORONÆ BOREALIS, 1798*

1908. Aug. 20.
G. M. T. 13h 05m

Observed by T. H. PARKER.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0592	....	....	....	2	45·3184	....	..	....
½	72 9039	72 8549	·0099	−14·36	1	45·2919	45 2471	0084	+ 8·76
2	72 4926	....	....	....	1	27·4682	27·4132	·0006	+ 0·52
2	54·7899	....	....	....	2	27·3016	....	....	....
½	54 0289	53·9824	·0126	+[14·50]	1	11·9196	11·8679	0165	+12·36
2	53·1569	....	....	....	2	11·5585	....	....	....

Weighted mean	− 4·13
V_a	−20·11
V_d	− ·16
Curvature	− ·28
Radial velocity	− 16·4

* Check measurement.

α CORONÆ BOREALIS, 1809.

1908. Aug. 21.
G. M. T. 15h 01m

Observed by / Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions	Velocity.
1	73·0208	....	....	....	2	45·2855	....	....	....
½	72·8951	72·8835	·0187	+27·13	1	45·2607	45·2488	0101	+10·54
1	72·4582	....	....	....	½	27·4744	27·4424	·0298	+25·87
2	54·7565	....	....	....	2	27·2787	....	....	....
¼	54·0087	53·9964	0266	+[30 62]	1	11·9107	11·8762	·0248	+18·58
2	53·1219	....	....	....	2	11 5418	....	....	....

Weighted mean	18·54
V_a	−20·00
V_d	− ·25
Curvature	− ·28
Radial velocity	− 2·00

α CORONÆ BOREALIS, 1816.

1908. Aug. 24.
G. M. T. 13ʰ 12ᵐ

Observed by W. E. Harper
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7497	....	....	....	1	45·3087	45·2922	·0535	+55·85
½	54·0267	54·0182	·0484	+[55·71]	½	27·5152	27·4672	·0546	+47·38
2	53·1212	....	....	....	2	27·2950	....	....	....
2	45·2902	....	....	....					

Weighted mean .... +53·03
V_a .... −19·63
V_d .... − ·20
Curvature.............. − ·28

Radial velocity .... + 32·9

α CORONÆ BOREALIS, 1817.

1908. Aug. 24.
G. M. T. 13ʰ 27ᵐ

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0283	....	....	....	2	45·2794	....	....	....
½	72·9461	72·9283	·0635	+92·13	1	45·2977	45·2920	·0583	+55·64
1	72·4579	....	....	....	½	27·5221	27·5085	·0959	+83·24
2	54·7488	....	....	....	2	27·2603	....	....	....
1	54·0279	54·0227	·0529	+[62·66]	½	11·9477	11·9257	·0743	+55·65
2	53·1145	....	....	....	2	11·5295	....	....	....

Weighted mean .... +68·45
V_a .... −19·63
V_d .... − ·20
Curvature.............. − ·28

Radial velocity .... + 48·3

α CORONÆ BOREALIS, 1827.

1908. Aug. 25.
G. M. T. 13ʰ

Observed by }
Measured by } J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·6765	....	....	....	1	45·2167	45·2857	·0470	+49·06
1	53·9543	54·0213	·0515	+[59·28]	¼	27·4307	27·4547	·0421	+36·54
2	53·0434	....	....	....	2	27·2226	....	....	....
2	45·2046	....	....	....					

Weighted mean .... +46·56
V_a .... −19·51
V_d .... − ·17
Curvature.............. − ·28

Radial velocity .... + 26·6 α CORONÆ BOREALIS. 1836.

1908. Aug. 27.
G. M. T. 14h 34m

Observed by / Measured by } J. B. Cannon

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0226	....	....	...	2	45·2911	....	....	....
½	72·8899	72·8770	·0122	17·70	1	45·2916	45·2741	·0354	−36·95
1	72·4579	....	....	...	½	27·4900	27·4623	·0497	+43·13
2	54·7549	....	....	....	2	27·2740	....	....	....
1	53·9889	53·9763	·0065	−[7·48]	½	11·9036	11·8701	·0187	−14·00
2	53·1241	....	....	...	2	11·5409	....	....	....

Weighted mean		29·74
V_a	19·21	
V_d	− 28	
Curvature	− ·28	
Radial velocity		10·0

α CORONÆ BOREALIS. 1841.

1908. Aug. 28.
G. M. T. 13h

Observed by / Measured by } J. B. Cannon

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0259	....	....	...	¼	27·5064	27·4684	·0558	−48·43
½	72·8870	72·8701	·0053	+ 7·69	2	27·2849	....	....	....
1	72·4641	....	....	....	1	11·9382	11·8832	·0318	23.82
2	45·2921	....	....	....	2	11·5626	....	....	....
1	45·2848	45·2663	·0276	+28·81					

Weighted mean		− 24·94
V_a	19·03	
V_d	·19	
Curvature	28	
Radial velocity		+ 5·4

α CORONÆ BOREALIS, 1842.

1908. Aug. 28.
G. M. T. 13h 14m

Observed by } J. B. Cannon.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings	Displacement in Revolutions.	Velocity.
1	73·0092	....	.	....	2	45·2878	....	....	....
¼	72·8733	72·8738	·0090	+13·06	1	45·2838	45·2696	·0309	+32·26
1	72·4448	....	...	....	⅓	27·4705	27·4412	·0286	+24·82
2	54·7462	....	.	....	2	27·2762	....	....	....
¼	54·0117	54·0051	·0353	+[39·63]	¼	11·9601	11·9223	·0709	+53·10
2	53·1214	.....	....	....	2	11·5452	....	...	....

Weighted mean		+30·60
V_a	−19·03	
V_d	20	
Curvature	− ·28	
Radial velocity		11·1

α CORONÆ BOREALIS, 1852.

1908. Aug. 31.
G. M. T. 13h 17m

Observed by W. F. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0311	....	....	....	1	27·4462	27·4423	·0297	+25·78
½	72·8743	72·8536	·0112	−12·89	2	27·2515	....	....	....
1	72·4637	....	....	....	¼	11·8686	11·8702	·0188	+14·08
2	45·2785	....	....	....	2	11·5056	....	....	....
1½	45·2366	45·2317	·0070	− 7·31					

Weighted mean	+ 3·66	
V_a		−18·53
V_d		− 22
Curvature		− ·28
Radial velocity		−15·4

α CORONÆ BOREALIS, 1852*.

1908. Aug. 31.
G. M. T. 13h 17m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0047	....	....	... .	½	27 4278	27·4397	·0271	+23·52
½	72·8550	72·8598	·0050	− 7·25	2	27 2347	....	....	....
1	72·4409	... .	....	. ....	½	11·8520	11·8750	·0236	+17 68
2	45·2570	....	....	. ...	2	11·4840	....	....	....
1	45·2188	45·2354	·0033	− 3·45					

Weighted mean	+ 4 05
V_a	−18·53
V_d	− ·22
Curvature...	− 28
Radial velocity....	− 15·0

* Check Measurement

α CORONÆ BOREALIS, 1861.

1908. Sept 3.
G. M. T. 12h 50m

Observed by J. S. Plaskett.
Measured by J B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0328	.. ..	....	....	½	27 4429	27·4029	·0097	− 8·42
½	72·8769	72 8535	·0113	−16·40	2	27·2866	....	....	....
1	72 4697	....	....	....	1	11·8911	11·8395	0119	− 8·91
2	45·2913	....	... ...	. ...	2	11·5592	....	. .. .	.. ..
1	45·2442	45·2265	·0122	−12·74					

Weighted mean	−11·35
V_a	−18·03
V_d	− ·21
Curvature...........	− ·28
Radial velocity.................... ..	− 29·9

α CORONÆ BOREALIS, 1865.

1908. Sept. 4.
G. M. T. $13^h 27^m$

Observed by T. H. PARKER.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	73·0201	....	...	....	2	45 2962	....	... ...	... .
½	72·8801	72·8693	·0045	+ 6·53	1	45 2687	45·2461	0074	+ 7 73
1	72·4571	.. ....	......	....	¼	27 4456	27 3976	·0150	− 10·02
2	54 7639	.. ..	... .	....	2	27·2949	....	..... .	....
1	53·9634	53·9411	·0287	−[33·03]	¼	11·9038	11·8461	·0053	− 3·97
2	53·1346	... ...	.. ...	....	2	11·5651	... ...	....	....

Weighted mean .... + 3·75
V_a .... −17·87
V_d .... − ·27
Curvature.... .... − ·28

Radial velocity......................... − 14·7

α CORONÆ BOREALIS, 1882.

1908. Sept. 14.
G. M. T. $12^h 51^m$

Observed by J. S. PLASKETT.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Settings	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity
1	73·0319	... .	.. ..	....	2	45·3247	.... ..	... .	....
½	72·9093	72·8867	·0219	+31·78	1	45·3219	45·2708	·0321	+33 51
1	72·4692	....	....	.. ....	½	27·5253	27·4463	·0337	+29·25
2	54 7787	....	... .	.... .	2	27·3257	....	....	....
¼	54·0006	53 9646	0052	−[5·99]	1½	12·0035	11·8975	·0451	+33·78
2	53 1472	... .	....	. . ....	2	11·6135	....	....	....

Weighted mean ... . +32·77
V_a ... . −15·95
V_d .... − ·23
Curvature............ − ·28

Radial velocity....... ... . + 16·3

α CORONÆ BOREALIS, 1883.

1908. Sept. 14.
G. M. T. 13h 07m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7551	.....	.....	.....	2	27·2799	.....	.....	.....
½	54·0166	54·0060	·0362	+[40·57]	¼	15·5465	15·4985	·0252	+19·50
2	53·1201	.....	.....	.....	2	15·4467	.....	.....	.....
2	45·2864	.....	.....	.....	1	11·9188	11·8737	·0223	+16·70
1	45·2824	45·2696	·0309	+32·26	2	11·5523	.....	.....	.....
¼	27·4653	27·4323	·0197	−17·10					

Weighted mean		+22·85
V_a	−15·95	
V_d	− ·23	
Curvature	− ·28	
Radial velocity		+ 6·4

α CORONÆ BOREALIS, 1894.

1908. Sept. 19.
G. M. T. 12h 02m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0180	.....	.....	.....	2	45·3163	.....	.....	.....
½	72·8619	72·8515	·0133	−19·30	½	45·2773	45.2346	·0041	− 4·28
2	72·4620	.....	.....	.....	½	27·4673	27·4000	·0126	−10·94
2	54·7725	.....	.....	.....	2	27·3142	.....	.....	.....
¼	53·9865	53·9545	·0153	−[17·51]	½	11·9190	11·8336	·0178	−13·33
2	53·1454	.....	.....	.....	2	11·5926	.....	.....	.....

Weighted mean	−11·96
V_a	−14·58
V_d	− ·22
Curvature	− ·28
Radial velocity	27·0

α CORONÆ BOREALIS, 1895.

1908. Sept. 19.
G. M. T. 12ʰ 17ᵐ

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0038	....	....	....	2	45·2814	....	....	....
½	72·8573	72·8633	·0015	−2 18	1	45·2429	45·2351	·0036	3·76
2	72·4388	....	....	....	¼	27 4293	27·4118	·0008	0·69
2	54·7388	....	....	....	2	27·2643	....	....	....
½	53·9565	54·9580	·0118	−[13·58]	1½	11·8895	11 8595	·0081	+ 6·07
2	53·1120	....	....	....	2	11·5373	....	....	....

Weighted mean	+ 1·26
V_a	−14·58
V_d	− ·22
Curvature	− ·28
Radial velocity	−13·8

α CORONÆ BOREALIS, 1896.

1908. Sept. 19.
G. M. T. 12ʰ 30ᵐ

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7526	....	....	....	1½	45 2619	45·2371	·0016	− 1·67
½	53·9992	53·9889	·0191	+[21·98]	1	27·4389	27·3969	·0157	−13·63
2	53·1219	....	....	....	2	27·2889	....	....	....
2	45·2984	....	....	....					

Weighted mean	− 6·26
V_a	−14·58
V_d	− ·22
Curvature	− ·28
Radial velocity	−21·3

α CORONÆ BOREALIS, 1897.

1908. Sept. 19.
G. M. T. 12ʰ 42ᵐ

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0197	....	....	....	2	45·3094	....	....	....
½	72·8669	11·8573	·0075	−10·88	1½	45·2797	45·2439	·0052	+ 5·43
2	72·4537	....	....	....	1	27·4750	27·4097	·0029	− 2·52
2	54·7572	....	....	....	2	27·3122	....	....	....
½	53·9924	53·9731	·0033	+[3·80]	1	11·9309	11·8492	·0022	− 1·65
2	53·1352	....	....	....	2	11·5892	....	....	....

Weighted mean	− 0·37
V_a	− 14 58
V_d	− ·22
Curvature	− ·28
Radial velocity	−15·5

α CORONÆ BOREALIS, 1949.

1908. Nov. 1.
G. M. T. 10h 41m

Observed by / Measured by: J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions	Velocity.
1	72·9672	....	....	....	1	45·3092	.....	....	....
¼	72·8800	72·9220	·0572	−82·99	1	45·2928	45·2928	·0185	+19·31
1	54·7508	....	....	....					

Weighted mean .... +39·88
V_a .... − ·38
V_d .... − ·27
Curvature .... − ·28

Radial velocity .... +38·9

α CORONÆ BOREALIS, 1950.

1908. Nov. 1.
G. M. T. 10h 58m

Observed by / Measured by: J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	48·7674	....	....	....	2	27·3286	....	....	....
1	45·3178	45·3118	·0631	+65·87	¼	12·0368	11·9236	·0722	+54·07
¼	27·5393	27·4850	·0724	+62·84	1	11·6326	....	....	....

Weighted mean .... +63·40
V_a .... − ·38
V_d .... − ·27
Curvature .... ·28

Radial velocity .... +62·5

α CORONÆ BOREALIS, 1951.

1908. Nov. 1.
G. M. T. 11h 14m

Observed by / Measured by: J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	45·3028	....	....	....	1	45·3170	45·2878	·0491	+51·26

Velocity .... +51·26
V_a .... − ·38
V_d .... − ·27
Curvature .... − ·28

Radial velocity .... 50·3

OBSERVING RECORD AND DETAILED MEASURES OF δ AQUILÆ.

P. Plaskett.
H. Harper.
C. Cannon.
P1.—Parker.
T.—Tribble.

RECORD OF SPECTROGRAMS.

Star.	No. of Negative.	Camera.	Plate.	Date.	Middle of Exposure. G. M. T.	Duration.	Hour Angle at end.	Temperature. Room. Beg.	Room. End.	Prism Box. Beg.	Prism Box. End.	Slit Width.	Seeing.	Observer.
				1906.	h. m.	m.	h. m.	Fahrenheit.		Centigrade				
δ Aquilæ.	368	..	Seed 27.	Aug. 6	17 35	85	2 55W.	71·0	69 4	27·7	28·0	·001	Good...	H
" ..	377	.	" R.	" 15	15 40	70	1 07W.	68·2	66 0	25 6	25·6	·001	" .	H
" ..	382	..	" ..	" 24	15 45	90	2 15W.	64·0	62·1	22 8	22 9	·001	Fair....	H
"	390	..	" .	Sept. 10	15 30	60	2 50W.	69·0	67·0	26·7	26·7	·001	Good...	H
" ..	399	..	" ..	" 27	14 45	60	3 15W.	60 0	59·6	21·8	21·8	·001	" ...	H
" ..	413	.	" 27	Oct. 23	13 45	90	4 10W.	50·3	46 2	15·1	15·3	001	Dancing	H
				1907.				Centi grade						
" ..	803	IL	" ..	May 31	19 04	25	35E.	12·6	12 6	18 7	18 7	·001	Good...	P
" ..	818	"	" ..	June 10	19 13	20	15W.	12·4	12 1	17 8	17·8	·0012	" ...	P
" ..	904	"	" ..	July 2	18 12	24	40W.	13·5	14·0	17·0	17·0	·0014	" ...	H
" ..	923	"	" ..	" 8	18 02	25	55W.	20 2	20 1	22·3	22·2	·0012	Poor to fair...	P
" ..	930	"	" ..	" 9	16 33	30	30E.	21·5	20·9	25·0	25·0	·0012	Good...	H
" ..	938	"	" ..	" 10	16 30	30	28E.	22 6	22·4	24·5	24·5	·0012	Fair to poor .	P
" ..	966	"	" .	" 25	16 30	60	48W.	21 5	21 5	28·0	27·8	·0014	Poor....	H
" .	980	"	" ..	Aug. 3	14 40	30	45E.	19 5	19·5	24·0	24·1	·0012	.. ....	P
" .	982	"	" ..	" 5	16 39	28	1 10W.	17·6	17·6	21 0	21 0	·0012	Fair to poor..	P
"	1034	"	" ..	Sept. 6	15 44	41	2 35W.	18·3	18·0	21·0	20·5	·0012	Fair....	T
" ..	1049a, 1049b	"	" }	" 18	13 56	47	1 42W.	14·0	12·5	17·1	17·1	·0014	"	T
				1908.										
" ..	1543	"	" ..	May 18	20 06	30	0 00	15 5	15·0	23·4	23·4	·0016	Hazy...	H
" ..	1550	"	" ..	" 22	20 34	42	39W.	19·0	19·0	25·0	25·0	·0017	Fair....	H
" ..	1575	"	"	June 3	20 01	40	45W.	13·0	12·5	18·3	18·3	·0015	"	H
" ..	1584	"	" ..	" 5	20 35	40	1 30W.	14 0	14 3	24·4	24·4	·0016	Notgood	P1
" ..	1633	"	" ..	" 24	18 31	37	40W.	19·0	19·0	27·5	27·5	·0015	Good...	H
" ..	1642	"	" ..	" 26	18 52	55	1 20W.	17·6	17·5	30·2	30·0	·0016	" ..	P1
" ..	1650	"	" .	" 27	18 09	35	30W.	19·5	19·1	23·6	23·4	·0014	. . .	P
" ..	1660	"	" ..	July 3	18 35	50	25W.	20·5	20·1	25·1	25·1	·0016	Fair....	HP1
" ..	1678	"	" ..	" 8	18 10	40	1 15W.	17·0	17·5	21·6	21·6	·0015	Good...	C-H
" ..	1690	"	" ..	" 10	18 35	45	1 55W.	21·1	20·5	27·5	28·0	0016	" ..	P1
" ..	1695	"	" ..	" 11	18 27	35	1 45W.	26·0	25·4	29 8	29·7	·0015	Fair....	P
" ..	1703	"	" .	" 13	18 52	45	2 25W.	18·2	18·0	23·0	23·0	·0015	Good...	P1
" ..	1753	"	" .	" 31	16 41	32	1 10W.	19·5	19 5	26·0	25·9	·0015	" ...	P1
" .	1754	"	" .	" 31	17 17	34	1 48W.	19·5	19·0	25·9	25·6	·0015	" ..	H
" ..	1768	"	" ..	Aug. 5	18 05	40	2 55W.	20·8	20·5	26 7	26·5	·0015	....	P-C
" .	1783	"	" ..	" 15	17 38	30	3 05W.	18·0	17·6	22·5	22·4	·0015	Fair....	P
" .	1837	"	" ..	" 27	15 03	35	1 20W.	18·0	17 0	23·2	23·0	·0015	Good...	C

δ AQUILÆ 368.

1906. Au[illegible]
G. M. T. [illegible]

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Lengths.	Corrected Wave Lengths.	Normal Wave Lengths.	Displacement.	Velocity.
3	S 68·3790	4528·798				
3	65·3512	4494·626		·738		
1	64·1176	4480·972	·000	·400	·400	−26·76
2	63·6677	4476·194		185		
2	62·7948	4466·791		727		
½	61·5939	4454·023	973	·552	·579	39·63
3	S 56·8011	4404·927				
2	54·6445	4383·756		·720		
3	50·0285	4340·237	184	·634	·450	31·05
3	48·4614	4325·992		·939		
3	S 46·4500	4308·081				
1	45·4172	4299·044		·074		
3	44·8605	4294·217		·301		
2	44·3248	4289·601	·642	·032	·390	−27·22

Weighted mean	−31·16
V_a	10·00
V_d	− ·16
Curvature	− ·50
Radial velocity	−41·8

δ AQUILÆ 377.

1906. Aug. 15.
G. M. T. 15h 40m

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Lengths.	Corrected Wave Lengths.	Normal Wave Lengths.	Displacement.	Velocity.
2	S 70·1969	4549·642				
2	70·1460	4549·039	·039	642	·603	−39·73
½	68·8403	4533·723	·753	168	·415	27·43
3	68·4118	4528·757		·798		
2	65·4082	4494·722		·738		
2	64·1638	4481·013	·953	·400	447	29·90
2	63·7291	4476·277		·185		
½	63·0706	4469·152	·062	·545	·485	32·36
2	62·8551	4466·835		·727		
½	58·1412	4417·700	·670	·038	·368	24·95
3	S 56·8682	4404·927				
2	54·6973	4383·606		·720		
3	50·0813	4340·115	·184	·634	·450	31·05
3	48·5181	4325·926		·939		
3	S 46·5100	4308·081				
2	44·9317	4294·348		·301		
1	44·9073	4294·138		·301		
1	44·3830	4289·632	·590	·032	·442	−30·85

Weighted mean	−30·89
V_a	−13·62
V_d	− ·19
Curvature	− ·50
Radial velocity	−45·2

δ AQUILÆ 382.

1906. Aug. 24.
G. M. T. 15h 45m

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Lengths.	Corrected Wave Lengths.	Normal Wave Lengths	Displacement.	Velocity.
2	70 1122	4549·520	.. ....	·642		....
1	70·1029	4549·410	·530	905	375	-24·71
3	S 68 3400	4528·798	....	..	.....	....
1	67·7987	4522·566	·558	·855	297	19·69
1	65·9371	4501·472	....	505	......	....
2	65·3329	4494 735	......	738	......	....
1	64·0791	4480·926	·930	·400	·470	31 44
2	63·6431	4476·176	....	185	......	....
2	62·7647	4466·688	......	·727	......	....
½	59·7630	4435·058	078	450	·372	25·14
2	S 56·7937	4404·927	....	....	......	....
1	56·3165	4400·188	·188	·738	·550	37 45
½	55·7715	4394·808	·804	·286	·482	32·87
2	54·6357	4383·715	......	·720	......	....
½	53·7124	4374·809	·821	·103	·282	19·31
2	50·0145	4340·120	·134	634	·500	34·50
2	48·4534	4325·930	....	·939	......	....
1	47·9225	4321 164	....	...	......	....
2	S 46·4482	4308 081	·164	......	......	....
2	44·8650	4294·280	......	301	......	....
½	44·8327	4294·002	·018	·301	·283	19·78
½	44·3189	4289·578	·596	032	436	−30·52

Weighted mean	−27·54
V_a....	−16·98
V_d	− .12
Curvature........	− ·50
Radial velocity.......	45·1

δ AQUILÆ 390.

1906. Sept. 10.
G. M. T. 15h 30m

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Lengths.	Corrected Wave Lengths.	Normal Wave Lengths.	Displacement.	Velocity.
1	65·2901	4494·811	....	·738	......	....
1	64·0719	4481·396	·360	·400	·040	− 2·67
1	63·6037	4476·296	....	·185	......	....
2	54·5817	4383·730	....	·720	......	....
½	49·9026	4339·632	·620	·640	·020	− 1·38
3	48·3953	4325 945	....	·939	......	....

Weighted mean	− 2·00
V_a	−22·26
V_d....	− ·19
Curvature	− ·28
Radial velocity.....	−25·0

δ AQUILÆ 399.

1906. Sept. 27.
G. M. T. 14h 45m

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Lengths.	Corrected Wave Lengths.	Normal Wave Lengths.	Displacement.	Velocity.
3	70·1090	4549·618		642		
1	68 7305	4533·425	432	419	·013	– 0·85
	S 68 3316	4528·798				
3	65·3312	4494·755		·738		
2	64·7742	4488·581	·573	495	·078	+ 5·21
1	64·1215	4481 405	405	400	·005	+ 0·33
3	63 6427	4476·178		·185		
3	62·7675	4466 710		·727		
1	62·3372	4462·093	·109	·165	·056	– 3·75
2	62·0765	4459·309		301		
1	61·1665	4449 662	·676	·785	·109	– 7·33
1	58 0743	4417·705	695	·884	189	– 12·81
	S 56·8037	4404·927				
1	55·8229	4395·202	·210	·201	009	+ 0·61
1	54·6149	4383·677		·720		
1	53·6987	4370·905		·144		
2	50·0504	4340·559	564	634	070	– 4 83
2	48·4750	4325·930		·939		
	S 46·4725	4308·081				
2	44·8957	4294·319		301		
2	44·3930	4289·984	964	·032	·068	– 4·75
½	42·1961	4271·329	·305	·325	·020	– 1·40

Weighted mean	– 2·68
V_a	– 25 74
V_d	– ·22
Curvature	– ·50
Radial velocity	– 29·0

δ AQUILÆ 413.

1906. Oct. 23.
G. M. T. 13h 45m

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Lengths.	Corrected Wave Lengths.	Normal Wave Lengths.	Displacement.	Velocity.
1	70·1315	4549·642	·642	·642	·000	0·00
1	S 70·1315	4549·642				
2	68·3595	4528·840		·798		
1	65·3580	4494·715		738		
2	64·1318	4481·159	·190	·400	·210	– 14·04
1	63·6731	4476·145		185		
3	S 56·8482	4404·927				
2	54·6954	4383·707		·720		
1	53·7352	4374·423	·439	·628	189	– 12·94
1	50·1309	4340·528	·540	·640	·100	– 6·90
3	48·5299	4325·938		939		
3	S 46·5280	4308·081				
½	46·4975	4307·813	·813	·023	·210	– 14·61

Weighted mean	– 10·04
V_a	– 26·88
V_d	– ·25
Curvature	– ·50
Radial velocity	– 37·7

δ AQUILÆ 803.

1907. May 31.
G. M. T. 19h 04m

Observed by J. S. PLASKETT.
Measured by T. H. PARKER.

Wt.	Mean of Settings.	Corrected Star Settings	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	57·8154	......	......	......	½	45·9607	·9592	·0280	29·45
1	57·7707	·7847	·0421	−50·68	2	45·2762	......	......	......
2	54·7232	......	......	......	1	45·1958	·1938	·0449	46·87
1	53·9416	·9516	·0182	20·94	2	43·5392	......	......	......
2	53·1061	......	......	......	2	37·9741	......	......	......
2	48·7682	......	......	......	1	37·2332	·2192	·0696	66·73
1	48·6938	6958	·0682	75·38	1	27·3962	·3422	·0704	−61·10
1	47·4378	·4383	·0321	34·34	2	27·2954	......	......	......

Weighted mean		−47·92
V_a	+18·24	
V_d	+ ·07	
Curvature		− ·28
Radial velocity		−29·9

δ AQUILÆ 818.

1907. June 10.
G. M. T. 19h 13m

Observed by J. S. PLASKETT.
Measured by T. H. PARKER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	57·8253	......	......	......	1	45·9704	·9304	·0568	59·75
1	57·7820	·7780	·0488	−58·75	2	45·3146	......	......	......
2	54·7558	......	......	......	1	45·2333	·1923	·0464	48·44
2	48·8030	......	......	......	2	43·5841	......	......	......
1	48·7360	·7034	·0606	65·75	1	27·4760	·3520	·0606	−52·60
1	47·4522	·4162	·0542	57·99	2	27·3713	......	......	......

Weighted mean		−57·21
V_a	+14·68	
V_d	0·00	
Curvature		− ·28
Radial velocity		−42·8

δ AQUILÆ 904.

1907. July 2.
G. M. T. $18^h 12^m$

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Computed Wave Lengths.	Corrected Wave Lengths.	Normal Wave Lengths.	Displacement.	Velocity.
3	72·9426	4864·756		·943	....	....
2	72·7683	4860·608	·837	527	·690	−42·57
2	72·3857	4851·637	....	·686	....	....
1	57·8055	4550·333	....	·642	....	....
$1\frac{1}{2}$	57·7888	4550·031	·332	·642	310	20·43
$1\frac{1}{2}$	54·0165	4483·099	....	413	....	....
$1\frac{1}{2}$	53·9383	4481·751	·050	400	·350	23·41
2	52·2394	4452·897	....	180	....	....
3	48·7760	4396·316	....	382	....	....
1	48·7398	4395·740	·820	·286	466	31·78
$1\frac{1}{2}$	47·4590	4375·754	774	107	333	22·88
2	45·2878	4342·183	....	·162	....	....
1	45·2205	4341·168	·108	·634	526	36·29
....	42·1262	4295·425	....	290	....	....

Weighted mean .... − 24·85
V_a .... + 5·63 ....
V_d .... − ·04
Curvature .... − ·28

Radial velocity .... − 19·5

δ AQUILÆ 923.

1907. July 8.
G. M. T. $18^h 02^m$

Observed by J. S. Plaskett.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7604	....	....	....	2	45·3152	....	....	....
1	53·9708	·9458	0240	−27·62	1	45·2452	·2042	0345	36·01
2	53·1390	....	....	....	2	38·0093	....	....	....
$\frac{1}{2}$	52·4227	·3947	0201	22·73	1	37·3176	·2651	·0237	22·72
2	52·2767	....	....	....	2	35·4883	....	....	....
2	48·8029	....	....	....	1	27·4678	·3798	0328	−28·47
1	45.9830	·9440	·0400	42·08	2	27·3349	....	....	....

Weighted mean .... 30·63
V_a .... + 2·96
V_d .... − ·07
Curvature .... − ·28

Radial velocity .... − 28·0

δ AQUILÆ 930.

1907. July 9.
G. M. T. 16h 33m

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	57 8333	...	...	...	1	48·7412	·7360	0280	30·40
1	57 8169	8129	·0139	− 16·73	1	47 4795	4670	0034	03·63
2	54·7487	...	...	...	2	45·2875	...	...	...
1	53·9750	·9680	·0018	02·07	1	45·2244	·2104	0283	29·54
2	53·1198	...	...	...	2	37·9870	...	...	...
2	48·7812	...	...	...	1	37·2898	2620	0268	25·70

Weighted mean		−17·98
V_a....	2·54	
V_d.......	·08	
Curvature		− ·28
Radial velocity........		− 15·6

δ AQUILÆ 938.

1907. July 10.
G. M. T. 11h 30m

Observed by J. S. Plaskett.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	59·8376	...	...	...	2	42 1585	...	...	...
½	58·6448	6188	·0209	+25·41	1	41·8098	7538	·0778	−78·26
2	57·8525	...	...	...	2	38·0165	...	...	...
1	57·8362	8107	·0161	− 19·38	½	36·5035	·4365	·0597	−56·77
2	54·7745	...	...	...	2	35·4998	...	...	...
2	48·8114	...	...	...	2	30·9556	...	...	...
½	47·4796	4351	·0353	− 38·47	½	30·8842	·8082	0674	− 60·52
2	45·3240	...	...	...	1	27·4150	·3270	·0856	− 74·30
1	45·2632	·2128	0255	− 26·62	2	27·3430	...	...	...
1	44·2754	·2239	0148	− 15·28	2	22·6567	...	...	...
2	43·5880	...	...	...	½	22·6152	·5153	·0791	− 65·49

Weighted mean		− 20·40
V_a....	+ 2·18	
V_d....	·00	
Curvature...		− ·28
Radial velocity..		− 18·5

δ AQUILÆ 966.

1907. July 2[illegible]
G. M. T. 16h [illegible]

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	57·7993	......	......	......	2	45·2612	......	......	......
1	57 7957	·8227	0041	−04·93	½	45·2242	2252	·0135	14·09
2	54 7201	......	......	......	2	43 5371	...	......	......
1	53·9306	·9601	.0097	11·16	½	27·4259	3856	·0267	−23·17
2	53 0970	......	......	......					

Weighted mean	−11·57
V_a	− 4·63
V_d	− ·02
Curvature	− ·28
Radial velocity	−16·5

δ AQUILÆ 980.

1907. Aug. 3.
G. M. T. 14h 40m

Observed by J. S. Plaskett.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	59 8416	......	......	......	½	46·0142	·3765	·0100	−10·52
½	59·0484	·0185	·0222	−27·10	2	45·3113	......	......	......
2	57·8562	......	......	......	1	45·2599	2222	·0168	17·55
1	57·8448	·8178	·0090	10·83	½	44 2852	·2468	·0130	13·42
2	54 7701	......	......	......	2	43 5768	......	......	......
1	53·9962	9672	·0026	−02·99	1	41·8349	·7965	0387	38·93
2	48·8045	......	......	......	½	27·4712	·3986	·0124	−10·76
1	47·5163	4803	0099	−10·59					

Weighted mean	−16·87
V_a	− 8·53
V_d	− ·04
Curvature	− ·28
Radial velocity	−25·7

δ AQUILÆ 982.

1907. Aug. 5.
G. M. T. 16h 36m

Observed by J. S. Plaskett.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	57·8462	....	....	....	1	45 2591	·2231	.0156	−16·28
½	57·8389	·8221	·0047	−05·65	2	44·2644	·2274	·0318	32 84
1	56·9690	·9515	·0140	16·68	2	43·5747	....	....	....
1	56·6945	....	....	....	2	42·1445	....	....	....
2	48·8009	....	....	....	1	41·8297	·7872	·0441	44 36
1	47·5019	·4698	·0006	−00·64	2	30 9363	....	....	....
1½	46·0152	·9812	·0060	+06·31	1	30·8976	8317	·0439	−39·42
2	45·3083	....	....	....					

Weighted mean	−19·60
V_a	− 9·42
V_d	− ·09
Curvature	− ·28
Radial velocity	−29·4

δ AQUILÆ 1034.

1907. Sept. 6.
G. M. T. 15h 44m

Observed by J. N. Tribble.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	59 8664	....	....	....	2	43·5443	....	....	....
1½	57·8788	·8313	·0045	+05·42	1	43·4850	....	....	....
1	57·8768	....	....	....	2	37·9634	....	....	....
2	54·7733	....	....	....	1	37·2692	·2682	·0196	−18·79
1	54·0167	·9887	·0189	+21·75	2	35·4242	....	....	....
2	48·7842	....	....	....	1½	35·1650	·1650	·0160	+15 00
1	48·7878	·7736	·0096	+10·42	2	30·8659	....	....	....
2	45·2868	....	....	....	1	30·8385	·8425	·0331	−29·72
1	45·2454	·2322	·0065	−06·78	1	27·3874	·3944	·0182	−15·79

Weighted mean	− 3·84
V_a	−21·09
V_d	− ·16
Curvature	− ·28
Radial velocity	−25·4

δ AQUILÆ 1049 (*a*).

1907. Sept. 18.
G. M. T. 8h 56m

Observed by J. N. Tribble.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	59·8694	......	......	......	2	41 3069	......	......	......
1	57·8779	·8279	0011	+01·32	2	37·9839	......	......	......
2	57·8775	......	......	......	1	37·2896	·2646	0242	−23·20
1	57·6237	·5757	0189	+22·68	1	30·8967	......	......	......
½	55·1806	·1351	0099	+11·54	1	30·8663	·8403	·0353	−30 69
1	54·0309	·9859	·0161	+18·56	1	27·4422	4182	·0056	+04·86
2	53·1554	......	......	......	2	27·2681	......	......	......
2	45·3054	......	......	......	2	24·8642	......	......	......
1½	45·2848	·2508	·0121	+12·63	1	24·8329	·8136	·0316	−26·78
2	43·5724	......	......	......	2	22·5796	......	......	......
1	41·8318	·8078	·0238	−23·94	½	22·5650	·5412	0146	−12·08

Weighted mean	− 3·66
V_a	−24·00
V_d	− ·09
Curvature	·28
Radial velocity	−28 0

δ AQUILÆ 1049 (*b*).

1907. Sept. 18.
G. M. T. 8h 56m

Observed by J. N. Tribble.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	59·8589	......	......	......	1	42·5064	·4794	·0314	− 31·80
1	57·8824	·8409	·0141	+16·97	2	42 1333	......	......	......
2	57 8709	......	......	......	½	41·8333	·8073	·0243	−24·44
1	57·6069	·5659	·0091	+10·92	2	41·3082	......	......	......
½	55 1507	·1142	·0110	−12·82	2	37·9828	......	......	......
¼	54·0154	·9804	·0106	+12·20	½	37·3204	·2984	0096	+09·20
2	45·3012	......	......	......	2	·24·8630	......	......	......
1	45·2860	·2575	·0188	+19·62	½	24·8351	8173	·0279	−23·63
2	43·5663	......	......	......					

Weighted mean	− 1·58
V_a....	−24·00
V_d	− 09
Curvature	− ·28
Radial velocity....	−25·9

δ AQUILÆ 1543.

1908. May 18.
G. M. T. 20h 06m

Observed by W. E. Harper.
Measured by T. H Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	59·8118	...	...	...	2	45·2857	...	...	...
1	59·6115	6090	0655	–80·56	1	45·1924	·1819	·0568	59·29
1½	57·7867	·7867	·0401	48·28	1	44·2082	·1967	·0625	64 56
½	56·9378	·9388	·0267	31·82	2	43 5501	...	...	...
2	56·6665	...	...	...	1	39·9986	·9811	·0352	34·35
½	55·0793	·0793	·0459	53 51	½	37·2334	·2134	0754	72·30
1	53·9367	·9352	·0346	39·82	2	37·9775	...	...	...
2	53·1154	...	...	...	2	30·8437	·8107	·0649	58·27
1½	52·3898	·3868	·0280	31·66	½	27·3944	·3544	·0582	–50·50
1	51·6895	·6860	0715	80·22	2	27·2870	...	...	...
2	48 7751	...	...	...					

Weighted mean........................ 43·49
V_a.................. –21·88
V_d.................. – ·01
Curvature.................. – ·28

Radial velocity.................. – 21·9

δ AQUILÆ 1550.

1908. May 22.
G. M. T. 20h 34m

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	59·8566	...	...	...	2	43·5800	...	...	...
1	53·9680	·9260	·0438	–50·41	1	43·5040	·4590	·0742	75·90
2	53·1527	...	...	...	½	42·4743	·4268	·0840	85·09
½	52·4092	·3682	·0466	52·70	2	37·3817	...	...	...
1	51·7194	·6799	·0796	89·31	1	37·3052	·2552	·0336	32·22
2	50·0548	...	...	...	½	30·8480	·7940	·0816	73·26
2	45·3223	...	...	...	1	27·4542	·3942	·0184	–15 97
1	45·2179	·1724	·0663	70·54	2	27·3097	...	...	...

Weighted mean........................ –60·57
V_a.................. +20·77
V_d.................. 00
Curvature.................. – ·28

Radial velocity.................. – 40·1

δ AQUILÆ 1575.

1908. June 3.
G. M. T. 20h 01m

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	59·8247	......	......	......	2	50·0325	......	......	......
1	58·9976	·9581	·0581	−71·11	1	48·7496	·7236	·0404	43·95
2	57·7944	·7574	·0473	57·04	2	45·3116	......	......	......
2	57·8347	......	......	......	½	45·2466	·2206	·0281	29·42
1	56·9377	·9027	·0426	50·86	1	44·2465	2215	0508	52·62
2	56·6840	......	......	......	2	43·9300	9060	0345	35·60
½	55·1020	·0700	·0391	45·70	2	41·3243	......	......	......
1	53·9550	·9250	·0316	36·22	1½	37·3066	·2946	0304	−29·24

Weighted mean. ... . −45·35
V_a .... +16·94
V_d .... − ·04
Curvature.... ... . − ·28

Radial velocity......... .... − 28 7

δ AQUILÆ 1575.

1908. June 3.
G. M. T. 20h 01m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Vel city.
2	57 7480	......	......	......	2	45·2208	......	......	......
2	57·7020	·7562	·0475	−57·28	1	45·1452	·2080	·0307	32·14
1	56·8536	·9100	·0353	42·15	1	44·1533	·2163	·0560	58·02
2	56·5944	......	......	......	½	42·3660	·4300	·0406	41·29
1	55·0194	·0796	·0295	34·48	2	42·0584	......	......	......
2	54·6613	......	......	......	1	41·2210	·2860	·0337	33·83
1½	53·8672	·9287	·0279	32·20	2	39·6969	......	......	......
2	53·0411	......	......	......	1	38·6841	·7516	·0318	31·07
1	52·2948	·3573	·0479	54 27	1	37·2157	2842	0408	39·25
2	52·1800	......	......	......	2	30·8595	......	......	......
2	48·7090	......	......	......	1½	30·7894	·8774	·0585	52·77
½	48·6414	·7039	·0601	65·39	2	22·5580	......	......	......
1	45·8895	·9522	·0430	45·36	1	22·4961	·5909	·0619	−51·56

Weighted mean................ .. −44·84
V_a ... . +16.94
V_d........ .... .04
Curvature 28

Radial velocity.... .. .. −28 2

δ AQUILÆ 1584.

1908. June 5.
G. M. T. 20h 35m

Observed by } T. H. Parker.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
1	59·8185	....	....	....	1	45·1990	·1958	·0429	44 78
1	59·6231	·6140	·0605	−74·41	2	37·9604	....	....	....
1	57·7645	·7645	·0623	75·00	½	37·2349	·2404	0484	46·41
2	56·6595	....	....	....	2	36·4205	·4255	·0707	67·23
1	53·9346	·9376	·0322	37·06	1	35·1146	·1186	·0304	28·51
2	53·1106	....	....	....	2	35·4265	....	....	....
1	52·3912	·3908	·0240	27·14	1½	30 8236	·8176	·0580	52·08
½	51·7052	·7022	·0553	62·04	1	27·3774	·3664	·0462	40·10
1½	50·9223	·9183	·0348	38·69	1	27·2576	....	....	....
1	50·0435	....	....	....	½	18·8335	....	0441	−35·23
1	48·7062	·7012	0618	67·10	1	18.8776	....	....	....
2	45 2770	....	....	....					

Weighted mean..................		−51·40
V_a..................	+16·22	
V_d..................		− 09
Curvature..................		− ·28
Radial velocity..................		35·5

δ AQUILÆ 1633.

1908. June 24.
G. M. T. 18h 31m

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	59·8112	....	....	....	1	45.2090	·2005	·0382	39·88
1	57·7871	·7941	·0327	−39·37	2	44·2642	....	....	....
2	57·8218	....	....	....	2	41·2960	....	....	....
½	55·4842	·4887	·0355	41·33	1	40·4965	·4875	0385	38·09
2	54·7384	....	....	....	2	35·4349	....	....	....
1	53·9350	·9365	·0333	38·32	1	35·3907	·3857	·0419	39·42
2	53·1133	....	....	....	½	27·3962	·3792	·0334	−28·99
2	45·2822	....	....	....	2	27·2636	....	....	....

Weighted mean..................		−37·91
V_a..................	+ 8·74	
V_d..................	·00	
Curvature..................		− ·28
Radial velocity..................		−29·5

δ AQUILÆ 1642.

1908. June 26.
G. M. T. 18ʰ 52ᵐ

Observed by } T. H. PARKER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	59·8137	...	...	...	2	43·5225	...	...	...
1	59·4942	...	...	...	½	42·6036	·6166	·0230	23·34
½	58 9788	·9748	0659	− 80·46	2	42·1050	...	...	...
1	58·5962	·5922	·0057	6·93	½	41·7834	·7807	·0352	35·41
2	57·8290	...	...	...	1	40·4726	·4755	·0413	40·96
1	57·7667	7637	·0631	75·97	2	39·7305	...	...	...
3	56·6748	...	...	...	2	37·9465	...	...	...
1	53·9205	9215	·0483	55·59	1½	37·6986	7096	·0451	43·47
[illegible]	53·1059	...	...	...	½	37·2113	·2218	·0670	64·25
1	51·6633	6683	·0892	100·08	2	35·4224	...	...	...
2	48·7623	...	...	...	2	30·8643	...	...	...
1	48 7182	·7272	0368	39 94	1	30·7867	7907	·0849	80·64
3	45 2623	...	...	...	1	27·3707	·3691	·0434	−37·67
1	45·1842	·1967	·0420	43·84	2	27·2482	...	...	...
1	44 1888	·2018	·0574	59·29					

Weighted mean		− 47·30
V_a	+ 7·87	
V_d		− ·09
Curvature		− ·28
Radial velocity		− 39 8

δ AQUILÆ 1650.

1908. June 27.
G. M. T. 18ʰ 09ᵐ

Observed by J. S. PLASKETT.
Measured by T. H. PARKER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	59·8350	...	...	...	1	40 5070	·4860	·0400	39·68
2	57·8130	·7880	·0388	−46·71	2	39·7571	...	...	...
2	57·8512	...	...	...	1½	39·6936	·6736	·0532	52·34
1	56·9804	·9559	·0096	11·40	1	38·7283	7123	·0400	48·70
2	56·6977	...	...	...	3	37·9723	...	...	...
1	55·1051	·0841	·0411	47·92	1	37·2502	·2362	·0526	50·44
2	54·7645	...	...	...	1	36·4397	·4257	·0715	67·28
1½	53·9517	·9337	·0361	41·55	2	35·4463	...	...	...
3	53·1253	...	...	...	2	30·9004	...	...	...
1	51·6990	·6860	·0715	80·22	1½	30·8548	8248	·0508	45·70
½	49·3733	·3583	0091	10·21	1	27·3920	·3600	·0526	45·65
2	48·7901	...	...	...	2	27·2785	...	...	...
1	48·7440	·7270	·0370	40 14	½	24·8214	·7912	·0554	46·86
2	45·2955	...	...	...	1	24·1079	·0789	·0543	45·12
2	45·2045	1835	·0552	57·62	2	24·8754	...	...	...
1	44·2292	·2077	·0515	53·19	2	22·5904	...	...	...
2	43·5514	...	...	...	1	22·5118	·4782	·0786	65·08
2	42·1240	...	...	...	1	18·8332	·7823	·0609	−48·65
1	41 2768	2558	·0414	41·40	2	18·8943	...	...	...
½	40·7092	·6882	0610	60·79					

Weighted mean		− 48·20
V_a	+ 7·54	
V_d		− ·04
Curvature		− ·28
Radial velocity		41·0

δ AQUILÆ 1660.

1908. June 27.
G. M. T. 18h 09m

Observed by J. S. Plaskett.
Measured by T. H. Parker

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	59·8256	......	......	......	2	45·2745	......	......	......
1	57·7919	·7829	·0070	− 8.42	1½	45·2107	2097	0290	30·27
2	57·8327	......	......	......	1	44·2220	·2215	·0377	38·94
½	56·9519	9499	·0206	24 55	1	41 7726	7741	0575	57 84
2	56·6750	......	......	......	2	41 2848	......	......	......
2	54·7459	......	......	......	2	41·2964	......	......	......
1	53·9418	·9398	·0300	34·53	1	39·0028	·9838	0325	31·75
1	53·7200	·7215	·0360	40·39	2	37·9669	......	......	......
1	48·7544	7579	·0079	8·57	1	37·2796	·2726	·0162	−15 53
2	48·7663	......	......	......	2	35·4331	......	......	......

Weighted mean		−29 35
V_a	+ 7·66	
V_d	·00	
Curvature		− 28
Radial velocity		21·9

δ AQUILÆ 1678

1908. July 8.
G. M. T. 18h 10m

Observed by J. S. Plaskett.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	59·8005	......	......	......	2	43·5657	......	......	......
½	58·9967	·0037	·0370	−45·21	2	41·8142	·7845	·0471	47 38
½	58 5482	·5552	·0427	51·88	2	41·3185	......	......	......
1	57·7767	·7837	·0431	51·89	2	37 9962	......	......	......
2	57·8125	......	......	......	1½	37·7667	·7297	·0250	24 10
1	56·9345	.9415	·0240	28·60	1½	37·2799	·2429	·0459	44 01
2	56·6620	......	......	......	2	35·4685	......	......	......
1	53·9232	·9322	·0376	43 27	2	30·9250	......	......	......
2	53·1017	......	......	......	1	30·8610	8064	·0692	62·14
2	53·1317	......	......	......	1	27·4311	·3611	·0515	44·70
1	51·7239	·7039	·0536	60·13	2	27·3166	......	......	......
1	48·7590	7370	0270	29·29	2	24 9101	......	......	......
2	48 7919	......	......	......	1½	24·8730	·8080	·0372	31·50
1	47·4680	4434	·0270	28·89	2	22·6292	......	......	......
2	45·3027	......	......	......	1½	22·5788	·5063	·0505	41 81
1½	45·2398	·2138	·0249	25·99	2	18·9394	......	......	......
1	44·2427	·2157	·0435	44·93	½	18·9059	8099	·0335	−26 76

Weighted mean		−38·83
V_a	+ 2·80	
V_d		− ·09
Curvature		− ·28
Radial velocity		− 36·4

δ AQUILÆ 1690.

1908. July 10.
G. M. T. $18^h\ 37^m$

Observed by / Measured by } T. H. PARKER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	59·8492	....	....	....	½	45·2276	·2066	·0321	33·51
1	57·8233	·7873	·0395	−47·55	2	44·2779	....	....	....
2	57·8653	....	....	....	½	44·2522	·2336	·0256	26·44
½	55·1478	·1183	·0069	8·04	2	43·5578	....	....	....
2	53·9789	·9519	·0179	20·60	1	43·5248	·5053	·0279	2[illegible]·59
2	54·7702	....	....	....	2	39·7623	....	....	....
1	53·6528	·6260	·0415	47·60	1	38·7677	·7407	·0116	11·29
2	53·1388	....	....	....	1	37·7768	·7483	·0161	−15·52
1	47·4598	·4377	·0327	34·98	2	37·9904	....	....	....
2	45·2945	....	....	....					

Weighted mean....		−27·41
V_a	+1·71	
V_d........		− ·12
Curvature		− ·28
Radial velocity...		−26·1

δ AQUILÆ 1695.

1908. July 11.
G. M. T. $18^h\ 27^m$

Observed by J. S. PLASKETT.
Measured by T. H. PARKER.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	59·8527	....	....	....	2	45·3050	....	....	....
1	59·6739	·6354	·0391	−48·13	½	45·2435	·2215	·0172	17·95
½	59·0715	·0335	·0396	48·39	2	44·2905	....	....	....
1	57·8545	·8185	·0083	11·19	½	44·2539	·2224	·0368	37·97
2	57·8587	....	....	....	2	42·1319	....	....	....
½	56·9778	·9428	·0233	27·77	1½	41·8032	·7749	·0567	57·04
2	56·7102	....	....	....	2	39·7632	....	....	....
1	55·1281	0941	·0311	36·26	1	38·7665	·7405	0118	11·49
2	54·7768	....	....	....	2	30·9112	....	....	....
1	53·9813	·9473	·0225	25·89	½	30·8476	·8146	·0610	54·74
2	53·1442	....	....	....	1	27·4370	·3990	0136	11·80
1	52·4120	·3790	·0358	40·48	2	27·2825	....	....	....
1	51·7425	·7085	·0490	54·97	2	18·8835	....	....	....
2	48·8042	....	....	....	1	18·8525	·8124	·0310	−24·8
1½	47·4810	·4485	·0219	23·43					

Weighted mean..............		−35·50
V_a........	+1·26	
V_d........		− ·12
Curvature		− ·28
Radial velocity		−34·6

δ AQUILÆ 1703.

1908. July 13.
G. M. T. 18h 52m

Observed by } T. H. PARKER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	59·8090	......	......	......	2	37·9609	......	......	......
½	57·7842	7832	0436	– 52·49	1	37·2499	·2469	0419	40·18
½	56·9494	9484	0171	20·38	2	30·8904	......	......	......
2	54 7423	......	......	......	1	30·8531	·8331	0425	38 15
2	45 2766	......	......	......	1	27·4061	·3769	·0357	30 98
½	45·1916	·1896	0491	51 26	2	27·2758	......	......	......
2	43 5362	......	......	......	2	22·5816	......	......	......
1	43·4567	·4587	0745	76·36	1	22 5331	·5083	·0485	– 39 77

Weighted mean		– 43·25
V_a	– 0·36	
V_d		·16
Curvature		·28
Radial velocity		– 43 3

δ AQUILÆ 1753.

1908. July 31.
G. M. T. 16h 41m

Observed by } T. H. PARKER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	30 8945	......	......	......	2	22·5725	......	......	......
1	30·8828	·8588	·0168	– 15·08	1	22·5388	·5231	·0387	32·04
½	27·4102	·3822	·0304	26 38	2	18·8774	......	......	......
2	27·2757	......	......	......	1	18·8637	......	·0137	– 10 94

Weighted mean	– 22·81
V_a	– 7·60
V_d	– 09
Curvature	28
dial velocity	– 30 7

δ AQUILÆ 1754.

1908. July 31.
G. M. T. 17h 17m

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7652	......	....	....	2	43·5520	....	....	....
2	53·9794	·9574	·0124	14·27	2	37·9742	....	...	....
2	53 1334	......	...	....	1	37·2646	2496	0402	38 55
2	48·7862		....	...	2	30 8961		......	......
1	47 4588	4418	0286	30·60	1	30 8566	·8346	0420	37·71
1	45 9683	9533	·0307	32 29	1	27 4200	·3950	0176	−15·27
2	45 2930	...	....	......	2	27 2709	..	....	....
1	45·2278	2128	0259	27 03					

Weighted mean.....	26 25
V_a.......	7·61
V_d...	12
Curvature	− ·28
Radial velocity	−34 2

δ AQUILÆ 1754.*

1908. July 31.
G. M. T. 17h 17m

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	54·7189	......	....	....	1	45·1899	·2129	·0258	26·93
1	53·9370	·9575	·0123	−14·15	½	44·2025	·2255	·0337	34 81
2	53·0936	......	....	.....	2	43·5112	....	......	......
½	52·3557	3772	0376	42·52	2	37·9405	.....	.	.....
2	48·7477	.....	....	.....	1	37 2294	·2504	·0384	36·82
½	48 6982	·7212	·0428	46·48	½	27·3766	·3883	·0240	20·84
½	47·4122	4352	0352	37·66	2	27·2349	.....	......	....
2	45·2530	.....	....	.					

Weighted mean......	−36 05
V_a	− 7·61
V_d..........	·12
Curvature........	·28
Radial velocity.....	44·0

*Check measurement.

δ AQUILÆ 1768.

1908. Aug. 5.
G. M. T. 18h 05m

Observed by J. S. Plaskett.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	59·8186	...	...	...	1	45·9871	·9876	·0036	+3·78
1	57·8102	·8077	·0191	−22·99	2	45·2749	...	...	...
2	57·8271	...	...	...	1	45·2148	·2168	·0219	−22·86
2	54·7437	...	...	...	1	44·2346	·2376	·0216	22·31
½	53·9784	·9784	·0086	+9·89	2	43·5328	...	...	...
2	53·1097	...	...	...	1	41·7874	·7924	·0392	39·43
½	52·4313	·4303	·0155	17·53	2	41·2791	...	...	...
2	52·2541	...	...	...	2	30·8758	...	...	...
2	48·7696	...	...	...	½	27·3845	·3779	·0361	−31·33
1	48·7376	·7361	·0279	−30·29	2	27·2532	...	...	...

Weighted mean	−19·51
V_a	9·77
V_d	19
Curvature	−·28
Radial velocity	−29·7

δ AQUILÆ 1783.

1908. Aug. 15.
G. M. T. 17h 38m

Observed by J. S. Plaskett.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	57·8126	...	...	...	2	45·2802	...	...	...
1	57·8193	·8023	·0245	−29·49	1	45·2457	·2404	·0020	+2·08
2	54·7335	...	...	...	½	44·2265	·2205	·0387	−39·97
1	53·9473	·9573	·0125	14·38	2	43·5434	...	...	...
2	53·0995	...	...	...	1	41·3061	·2951	·0021	2·10
½	52·4002	·4072	·0076	8·58	½	40·5358	·5258	·0021	2·08
2	52·2469	...	...	...	2	37·9743	...	...	...
½	51·7060	·7120	·0455	51·05	1	37·2659	·2499	·0389	37·30
1	49·3467	·3487	·0213	23·25	2	30·9025	...	...	...
1	48·7663	...	...	...	1	29·8983	·8643	·0105	9·31
½	48·7345	·7360	·0280	−30·38	½	27·4506	·4116	·0010	−0·86
1	47·4838	·4828	·0124	+13·26	2	27·2858	...	...	...
½	45·9813	·9773	·0073	−7·67					

Weighted mean	−14·85
V_a	−13·84
V_d	−·22
Curvature	−·28
Radial velocity	−29·2

δ AQUILÆ 1837.

1908. Aug. 27.
G. M. T. 15h 03m

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Displacement in Revolutions.	Velocity.
2	73·0183	....	.....	....	2	45·2880	....	...	....
½	72 8513	·8430	0218	− 31 63	1	45·2372	·2232	·0155	− 16·18
2	72·4532	....	....	....	1	44 2395	·2264	0328	33 91
2	59·8129	......	....	......	2	43·5517	....	....	....
1	57·8288	8283	·0015	+ 1 80	1	41 8079	·7949	0367	36·92
2	54·7500	....	...	....	1	37·9771	.....	.....	....
1	53·9747	9667	·0031	− 3·56	1	37·3070	·2925	·0037	+ 3·54
2	53·1197	......	......	....	2	30 9079	....	....	....
½	51·7273	·7173	·0402	− 45 10	½	30·8756	8386	·0370	33 22
2	48·7819	....	......	....	1	30·4141	·3751	·0375	− 32 55
1	47·4976	·4846	·0142	+ 15·19	2	30·2857	....	....	....
½	46 0043	9915	·0041	+ 4 31					

Weighted mean	− 20 95
V_a	− 18 18
V_d.	− ·09
Curvature	− ·28
Radial velocity	− 39·5

APPENDIX 3.

REPORT OF THE CHIEF ASTRONOMER, 1909.

MERIDIAN WORK AND TIME SERVICE

BY

R. M. STEWART, M.A.

CONTENTS.

ILLUSTRATIONS.

APPENDIX 3.

REPORT OF R. M. STEWART, M.A., ON MERIDIAN WORK AND TIME SERVICE.

OTTAWA, March 31, 1909.

W. F. KING, Esq., LL.D., C.M.G.,
Chief Astronomer,
Department of the Interior,
Ottawa.

SIR,—I have the honour to report as follows on the work carried out under my charge during the past fiscal year.

A great part of the year has been taken up with work in connection with the fitting up of the Transit Annex, including the reconstruction of the piers, and with tests and alterations of the Meridian Circle. As will be seen below, the latter has proved to be defective in many respects, necessitating a great deal of work in the alterations required before it can be made to perform creditably; among the most important and laborious of the operations were the renewing of the pivots and the truing up of the planes of the circles; further alterations still remain to be made. The usual amount of observation and computation has been done for determination of clock error, more particularly in connection with the operations carried on in the field for determination of longitudes. The question of personal equation was considered, and a special series of observations made in an attempt to discover the laws which it followed. The differences of personal equation found were in some cases comparatively large; the personal equations of at least two of the observers appeared to be due to a tendency always to set the movable wire asymmetrically with respect to a star image when estimating a bisection; in the case of one observer this error of bisection amounted to over a second of arc. The time service has been maintained as in the past, and has been extended to include the Mint and the Archives Building. An analysis was made of the rate of the Standard Sidereal Clock; an account of this is given in Appendix A below.

THE TRANSIT ANNEX.

The Transit Annex, which is located at the western end of the main building, consists of two rooms, the Transit Room and the Meridian Circle Room. The former is connected to the main building by two doors, one opening into the Chronograph Room, and through it into the Time Room, the other communicating with the main hall-way. In it are situated two piers for the portable astronomical transits belonging to the Observatory, the western one of which is also provided with two collimator piers. The inside dimensions of this room are 21 ft. 4 in. in the meridian by 21 ft. 9 in. in the prime vertical. The Meridian Circle Room, situated to the west of the former, communicates with it by two doors. It is 34 ft. 3 in. by 15 ft. 6 in., and contains the piers for the Meridian Circle and its two collimators; the instrument is situated somewhat to the south of the centre of the room.

The walls of the building are of stone, containing a number of louvred windows to allow circulation of air between the outside walls and the inner lining. The latter is of galvanized iron, and covers the whole of the outer walls except the observing slits. The roof is a flat concrete one; between it and the galvanized iron ceiling is an air-space of about two feet, through which the outer air circulates freely by means of a number of small louvred openings. Ventilation of the room itself, when the observing slits are closed, can be controlled by a number of shafts which pierce the walls, terminating just above the floor in registers which may be opened or closed as desired. The observing slits, which extend downward to within three feet of the floor, are three feet in width; they are closed by vertical doors in the walls, and by shutters on the roof. The opening mechanism for these, which was installed during the past winter, is described below.

As mentioned in my last report, the Meridian Circle piers had suffered upheaval during the winter of 1907-8, shortly after the instrument had been mounted. During the period between the early part of January and the end of March the level error changed from about ten seconds to nearly six minutes of arc. During the next two weeks it rapidly decreased to about two and a half minutes, and thereafter continued decreasing with a gradually diminishing rate; by the middle of May it had reached a value of about one minute. As the graduated circles had been returned to the makers for repairs there was no convenient means of measuring the change of nadir point, *i.e.*, the angular displacement of the piers in the meridian; it also, however, was no doubt considerable. The collimator piers were also displaced by a number of minutes. The two field-transit piers and the two collimator piers in the Transit Room fared even worse, having all been broken across in the basement a few feet above the floor.

The trouble was evidently due to the action of frost; if further confirmation were needed, it was supplied by an examination of the earth beneath the basement of the Transit Room, which was found to have been saturated with water and frozen. A drain had been provided to carry away surplus water, but the system of drainage was not sufficiently thorough. It was also evident that the foundations of the piers were not sufficiently protected. It was decided that the only satisfactory remedy lay in the reconstruction of all the piers, sinking their bases several feet deeper into the earth, and providing a system of drainage as thorough as could be installed. The matter was taken up by the Department of Public Works, and the demolition of the old piers—an undertaking of considerable magnitude in itself—was begun in May.

It had been previously decided that the azimuth marks for the Meridian Circle should depend on the same principle as those designed by Sir David Gill for the Cape Observatory, the primary marks consisting of lenses fixed some distance underground to ensure stability, while above would be movable marks capable of being adjusted accurately over the optical centres of the underground lenses. A similar arrangement would be required in the case of the collimator piers, to ensure the stability of the long-focus collimating lenses which form a part of the azimuth-mark system. As the original collimator piers had not been designed with this end in view, the necessity of reconstruction afforded an opportunity of so altering the design as to facilitate the introduction of this principle. It was necessary also in this connection to consider the disposition of the collimators. If these were placed in a horizontal line it was found that it would be impossible to obtain a line of sight under them upon azimuth marks at a sufficient distance; nor was it considered advisable to raise the azimuth marks to the horizontal line and, by rendering them intervisible, use them as collimators, on account of the height to which it would then be necessary to build the azimuth piers. It was decided finally to do away with the south collimator, using the azimuth mark in its place, and placing a mounting for the other collimator on the north pier, above the collimating lens of the north azimuth mark. This was also advantageous in another respect, since the southern pier, being required only for the long-focus collimating lens, need not extend so far towards the Meridian Circle, thus increasing the range of reflection observations towards the south; the north collimator would not interfere with those towards the north, on account of its greater distance from the telescope. It is possible, however, that the north collimator may also finally be dispensed with;

if, as seems likely, the azimuth marks should prove sensibly stable for considerable periods, it will be possible to control the collimation by readings on them, in conjunction with occasional reversals of the Meridian Circle. Determinations of flexure might also be made by means of the azimuth marks, by an interchange of eye and object ends of the telescope. Should this arrangement prove possible it will be of advantage; the lenses of the collimators being of only 4½ inches aperture, the full aperture of the Meridian Circle is not made use of in readings upon them, and it is perhaps doubtful whether the line of collimation so obtained will coincide exactly with that depending on full aperture.

The footings of the reconstructed piers extend 16½ feet below the level of the floor. Beneath the transit room is a basement with a concrete floor, which lies 10 feet below the upper floor, so that the transit piers extend 6½ feet underground; the Meridian Circle and collimator piers, on the other hand, are surrounded with earth to a height of about 10 feet. All the piers are surrounded at the base by drains of broken stone. It was my wish to have these drains continued to within a few inches of the surface, so that there could be no doubt as to the thorough drainage of the piers throughout their whole height; the Public Works Department, however, decided that drainage around the bases would be sufficient, and it was so done.* On account of the depth to which the piers were sunk, it was impossible to lead these drains to the sewage system; accordingly a special concrete cistern of about 1,000 gallons capacity was built below the level of the piers and the drains were led into this; a pipe leading from the cistern to a motor pump serves to empty it as often as necessary. A float connected to a light rod has been so arranged that the top of the rod may be flush with the basement floor when the cistern is empty; the length of rod projecting through the floor gives a measure of the depth of water in the cistern. The amount of water which collects in the cistern at certain seasons is remarkable; on several occasions this spring, immediately after or during a prolonged heavy rain, it has been filled overnight; this circumstance, coupled with the fact that during periods of dry weather comparatively little water is collected, points to surface water as the source of the accumulation. It would appear that the surface drainage flows down beside the outside walls of the building and so under the foundations, often in considerable quantities; this being the case, there would appear to be serious danger not only of finally blocking up the broken stone drains by accumulated silt, but also of undermining the foundations of the Transit House. This danger could probably be avoided by building a suitable drain to surround the three exposed walls of the building.

The parts of the two collimator piers below the floor are similar. The footings are nine feet by six, the longer side being in the east-west direction. The western part of each pier is penetrated by a vertical pit three feet square, to allow access to the underground lens which will serve as the fixed mark; this part of the pier terminates some six feet below the level of the floor of the Meridian Circle Room, and the opening is covered by two hatchways, between which is packed mineral wool. The main part of the pier tapers upwards to the floor, where it measures three and a half feet in the meridian by two and a half in the prime vertical. Through the centre of this is a vertical shaft about six inches in diameter, extending down to the level of the pit previously mentioned, into which it opens by a small arch. At the bottom of the arch the underground lens will be fastened firmly to the concrete, with space underneath for a basin of mercury. Access is had to these when necessary by the pit at the side, while the necessary readings are taken from above through the small shaft.

Above the floor the piers are dissimilar. The northern one, which is intended to support both collimator and long-focus azimuth lens, is built with an overhang to the north, so as to allow as much space as possible to the south for observation of stars by reflection; the dimensions of the top are 5 ft. 4½ in. by 2 ft. 4 in. The southern pier,

* This has since proved to be inadequate.

which will ultimately be required only for the long-focus lens, tapers from the floor to a size of 20 inches by 28 inches at the top. It will also be necessary, however, to fasten a temporary frame-work to the southern pier to support a collimator until the azimuth mark piers shall have been built.

The foundations of the main telescope piers are intended also to carry a pier which rises to the level of the floor, to support the carriage upon which rests the mercury horizon for observation of stars by reflection. In the original pier this had not been included, but it was found that the cement floor was not sufficiently free from vibration to serve the purpose. This part of the pier is, at the floor level, 10 ft. 6 in. in length by 1 ft. 10½ in. in width, extending 3 feet south of the axis of the Meridian Circle, and 7 ft. 6 in. to the north. The foundation is in the form of a cross, with an extreme length of 13 feet, and width of 10 ft. 6 in., tapering upwards to within a foot of the floor, where the size is 10 ft. 6 in. by 8 ft. The two columns supporting the bed-plates of the instrument are 2 ft. 3 in. square at the floor, tapering to 1 ft. 4 in. at the top, which rises to a height of 6 ft. 2 in. from the floor. The inner faces of the piers, which are vertical, are at a distance of 3 ft. 6 in.

In the Transit Room, the two transit piers and the two collimator piers, the latter forming part of the system of the western transit equipment, extend to the same depth as the Meridian Circle piers; as stated above, however, owing to the basement which underlies this part of the building, they are surrounded with earth to a height of only 6½ feet; the concrete cistern above referred to lies immediately to the south of the eastern transit pier. A floor plan of the Meridian Circle Room and Transit Room, showing the positions of the various piers is given in Fig. 1; sections of the piers are shown in Fig. 2 and Fig. 3.

All the piers are protected above the level of the floor by a layer of thick felt; surrounding this, with the interposition of an air-space, is a casing of wood. These casings, as well as the piers themselves, are of course free from the floor; the space between piers and floor, instead of being vacant, is filled with felt. To promote cleanliness, as well as for increased comfort during the winter months, the original concrete floor has been covered by a wooden one.

To exclude snow from the spaces between the inner and outer walls and above the ceiling it was necessary to have winter coverings for the louvred openings. These were made in the fall of 1908 and have worked satisfactorily during the past winter. They consist of frames to fit on the outside of the openings, covered with copper wire gauze of a fairly fine mesh; for protection against accidents this is covered by a somewhat heavy galvanized iron mesh. It has been found that these, while affording a reasonable circulation of air, exclude the greater part of the snow; if a little snow drifts through, it is caught by the louvres and prevented from penetrating to the space inside the walls. To ensure a freer circulation of air during the summer, the frames are removed in the spring.

The roof shutters for covering the observing slit are divided into three sections in the case of the Meridian Circle, and into two in the case of each of the transit slits. An opening mechanism had previously been applied to the central section in the Meridian Circle Room; that for the other six sections was installed during the past winter. The mechanism works on the same principle as that at Greenwich; each section of the shutter is supported by the outer ends of two curved arms which are fastened by keyways on a shaft hung in bearings parallel to the slit; the other ends of these arms carry counterpoises approximately equal in weight to the shutter. Keyed on the shaft is another arm extending horizontally nearly to the wall, and connected by another nearly vertical jointed arm to a winch on the wall, which serves to open or close the shutters by turning a handle. The joint between every two sections is covered by an independent flap, which is raised by either shutter indifferently; the flap is prevented from falling back when open by a flat curved spring which presses against it near the hinge, and starts it down with the shutter when the latter is being closed.

The vertical wooden wall-shutters, six in number, have been made in two sections, closing respectively the lower and upper halves of the observing slits in the walls. Both sections open outwards; either the upper section alone, or both, may be opened; the lower section, however, can not be opened alone; in general only the upper section need be open, except for reading on azimuth marks. The upper section is controlled by a rod bent at right angles near its upper extremity, and fastened by a flexible joint nearly in the centre of the shutter; when closed the horizontal part of the rod passes over a hook on the shutter and the vertical part springs into place between two hooks on the casement, holding the shutter firmly closed; when open it is held in a similar manner.

The difference of longitude between the middle of the observing slit in the Meridian Circle Room and the pier in the old transit hut was measured January 20, 1909. A theodolite was set up to the south of the old hut and set on the transit wires; the azimuth of a point on the wall of the transit annex was measured from this point and the distance chained. The resulting longitudes of the Meridian Circle and of the centres of the two transit piers, referred to the old pier, are as follows:—

Meridian Circle,	214·9 ft..	·201 sec.
Western transit pier,	199·9 ft..	·187 "
Eastern transit pier,	188·65 ft..	·176 "

The approximate latitude of the Meridian Circle, as obtained from a few pairs of stars observed in August, 1908, is 45° 23′ 37″·6; this may be in error by several tenths of a second.

The positions of the azimuth marks for the Meridian Circle were laid down in the early part of last summer. The line of sight to the north mark passes through the pinery immediately to the north of the Observatory; the pier will be situated just beyond the top of a ridge running in the east-west direction, and within about 30 feet of the road which forms the southern boundary of the city; its distance from the collimating lens will be about 250 feet. It was originally intended to have the south azimuth mark, if possible, at a distance of about 300 feet, situated on the other side of the driveway which runs in a northwest-southeast direction past the western end of the Observatory. As this ground belonged to the Department of Agriculture it was necessary to have its consent to the erection of the mark, and this unfortunately proved impossible. It was therefore necessary to locate the mark on the grounds of the Observatory; as the line of sight of the Meridian Circle crosses the above-mentioned driveway at an angle, the greatest distance obtainable was about 160 feet.

The piers and the buildings to protect them have been planned, but no provision has as yet been made for their erection.

THE MERIDIAN CIRCLE.

No observations were made with the Meridian Circle during the period covered by this report. The year has been occupied with the many alterations which were found necessary before the instrument could be got into condition to do creditable work. There is scarcely an essential part of the instrument which has not required alteration in at least some detail. Much of this work has been done; much still remains to do. It is hoped, however, if the repairs which still remain can be completed in the workshop in time, to be able to begin regular work in both right ascension and declination about the beginning of 1910.

The graduated circles, which had been returned to the makers for repair of damages sustained in shipping, were received in June. They were immediately mounted and their planeness tested by the same method as used previously, as described in my last report. It was found that the extreme deviation of the fixed circle from a true plane at right angles to the axis was now about ·001 inch; that of the movable circle was, however, ·006 inch, a quantity large enough to throw the microscopes very slightly out of focus at the extreme points. It was also discovered that on reversing the instrument the microscopes were no longer in focus; in fact, the circles were unsymmetrically fixed on the axis by about one twenty-fifth of an inch; it developed later that this was at least partly due to the fact that in truing up the fixed circle, not only had the band carrying the graduations been turned down but also a cut had been taken off the bearing on the other side of the circle, without any compensating alteration on the movable circle.

To rectify the latter point, it would appear to be immaterial whether the circle were set farther out on the axis, or the end of the pivot shortened, or, what amounts to the same thing, the other pivot lengthened; the desideratum being that the distance from plane of graduations to end of pivot should be the same for both ends. Accordingly, as being the easiest undertaking, a bushing of hardened steel was made to fit into the hollow of the pivot corresponding to the movable circle, carrying a disc of the required thickness which fitted against the end of the pivot. This worked fairly satisfactorily, but as will be seen below, another alternative was adopted later.

With regard to the other error of the circles, which we may for brevity designate the deviation from mean plane, it may be composed of two parts—(1) a divergence of the average plane of the graduations from true perpendicularity to the axis; (2) a deviation of the graduated band itself from the true plane form; the former may be remedied by alteration of the bearing surfaces between circles and axis, the latter only by re-graduation. If p be the perpendicular distance of the object glass of any microscope from the graduated band, and d the distance of the graduation set upon from the centre of the field, then the measured angle will be

$$\theta = \frac{d}{p}.$$

Differentiating with respect to θ and p

$$\partial \theta = -\frac{d}{p^2}\,\partial p = -\,\theta\,\frac{\partial p}{p}.$$

Hence the error in the angle measured by one microscope is proportional to that angle and to δp, which is the deviation from mean plane of the circle at that point. The maximum effective value of θ, provided settings of the telescope are made without regard to the position of the division marks in the field of the microscopes, and provided also that only one division mark is set on for each setting of the telescope, will be the same as the interval between successive graduations, in this case 5′; also the value of p is 2·7 inches. Thus if p be ·001 inch, the maximum error arising from this source of an angle measured by one microscope will be ·11″. Further, this will be practically a constant error for any particular star, except as influenced by reversal of the instrument and more particularly by alterations of the position of the circle on the axis. If, however, as is practically always the case, angles be measured by a pair of opposite microscopes, the part of this error due to lack of perpendicularity of graduated band and axis will be eliminated, p being of opposite sign for the two microscopes. That part, however, which depends on deviations of the graduations from a true plane, will still remain; if the deviations are due to a simple bend of the circle along a diameter the effect will be reduced, though not eliminated, by reading four microscopes. It may be noted here that the error $\delta\theta$ varies inversely as p; hence the advantage of long focus microscopes; those on this instrument are probably too short.

All errors arising from deviation from mean plane may be eliminated by setting exactly on division marks, throwing the brunt of the measurement on the declination micrometer. In this case it is sufficient if the circles are nearly enough true that the graduations may be always in focus. This must, however, be qualified by the recollection that focal lengths, &c., vary with temperature; hence it is desirable even in this case that the circles should be as true as possible, in order that the necessity of refocussing may be reduced to a minimum.

Having regard to these facts, it was decided in the first place to attack the adjustment of the movable circle, as being the one most requiring it; it was also decided that the only feasible method lay in scraping the bearings between circle and axis, in conjunction with tests by a surface-plate. In order to save time, since the reconstruction of the piers in the meridian circle room was being proceeded with, it was decided to erect temporary piers outside for the necessary tests, and to shelter them by a wooden hut. In the meantime a special surface plate in the form of a ring was constructed, in order to make the necessary tests for flatness of the bearing on the axis against which the circle was clamped.

As before, the lower southern microscope on the western pier was replaced by a steel rod sliding in bearings, one end of which could be brought into contact with the graduations when desired. A mark on this was set on with the microscope, which had been mounted with its axis perpendicular to the rod. Readings were taken at every 30° around the circle; the latter was then shifted 90° on the axis and the process repeated; the same was done for positions of the circle 180° and 270° from its initial position.

Assume in the first instance that the graduations all lie in one plane; also that the bearing surface on the circle and that against which it engages on the axis are true planes. Let the angle between the axis of the telescope and the normal to the surface of the bearing on the axis be a'', and let the plane containing these two lines intersect the position of the lower southern microscope when the pointer reading on the fixed circle is φ. Also let the normals to the plane of the graduations and the plane of the circle bearing (on the movable circle) include an angle b'', and, for the initial position of the movable circle, let χ be the pointer reading on the fixed circle when the plane containing these two normals cuts the lower southern microscope. Then, for the position of the telescope corresponding to a pointer reading θ on the fixed circle, the displacement from its mean position of the graduated band (on the movable circle), as measured by the microscope, will be

$$a \cos (\theta - \varphi) + b \cos (\theta - \chi).$$

Taking a series of readings at intervals of 30° around the circle, and diminishing each by the mean of all, we shall have twelve equations of the form,

$$a \cos (\theta - \varphi) + b \cos (\theta - \chi) = m,$$

θ having the values 0°, 30°, 60°, &c. For the second position of the circle we have twelve equations of the form

$$a \cos (\theta - \varphi) + b \cos \left(\theta + \frac{\pi}{2} - \chi\right) = m',$$

and similarly for the two remaining positions. From these 48 equations we may determine a, b, φ and χ with considerable accuracy, thus obtaining a complete knowledge of the magnitude and location of the errors considered. Further, by substituting the values so found in the observation equations, we may from an examination of the residuals determine by how much the circle departs from the plane form.

The first test with the new surface plate showed a high spot at one point on the axis bearing; when this had been scraped off the deviation of the circle was considerably lessened. The first set of measurements after this had been done gave a value of 9″ for a and about 4″ for b; in one position of the circle on the axis this corresponds to a variation of over ·002 inch, exclusive of irregularities. It was found also that the circle was distorted by the pressure of the screw collar which holds it against the axis, so that when the collar was forced home the irregularities reached a value of 7″ on each side of the mean, as against about 4″ when it was only moderately tight: this was found to be due to the fact that the circle bearing was not a plane; the same was true of the face of the screw collar and the face on the circle against which it bore.

For these latter, since the only requirement was that they should be plane, one scraping, in conjunction with tests by a surface plate, was sufficient; in the case of the bearings between circle and axis, however, on account of the difficulty of knowing just how much was taken off at a time, it was necessary to proceed by trial, taking care that both surfaces should always be plane when measurements were taken. In this way, after some half dozen trials, the values of a and b were each reduced to about 1″.

Some preliminary measurements had previous to this been made for determination of pivot error; it had been assumed without testing that the pivots were hardened; it was accidentally discovered, however, about the end of August, while the adjustment of the circles was still going on, that this was not the case. Such a serious defect as this had not been anticipated, though considering the many other imperfections of the instrument it should perhaps not have proved surprising.

After consideration, it was decided to turn the pivots down to a smaller size, and to force over them hardened steel bushings of the original diameter (4 inches). We were much handicapped by lack of previous experience in such operations, and by the lack of machines large enough to accommodate the axis, but after several failures have finally succeeded in obtaining pivots which give every promise of being satisfactory.

As the lathe at the Observatory was not large enough for the purpose, the axis was taken to a machine shop in the city, and the original pivots turned down to a diameter of about 3½ inches; they were then carefully ground with a very slight taper, to facilitate the forcing on of the bushings. Here again difficulty was encountered, as nowhere in the city was there a grinder capable of accommodating the instrument; inquiries in Montreal and Toronto were equally unavailing. The grinding was finally done in a lathe, by fastening a small portable motor-driven cutter-grinder in the tool-post of the lathe. The first bushings were made from forgings obtained from a local firm; after turning, boring and hardening these, they were ground inside to the required taper, and outside to very nearly the finished size, and then forced over the ground surfaces on the axis. They were then reground, and finished by using flour emery in a circular lap of gun-metal. Not until this final process was reached was it discovered that the metal was permeated by minute flaws which made the attainment of a perfect surface impossible.

At this stage Messrs. Warner and Swasey, the well known instrument makers of Cleveland, were communicated with; in their reply they very kindly gave a complete description of the processes they employed in finishing pivots. The details of the process were practically the same as had been followed here, with the exception that they advised making the bushings not from forgings, but from blocks cut out of bar steel, to insure as far as possible homogeneity and freedom from strains and flaws. Accordingly a bar of steel was obtained and new bushings made from it; on this occasion the use of the workshop at the Royal Mint, where large lathes were available, was very kindly offered by Mr. Cleave, and was thankfully accepted. Trouble was again experienced with the lapping, it being found impossible to get a satisfactory surface. The Observatory mechanician, Mr. Mackey, who has had long practical experience in all kinds of machine work, finally gave it as his opinion that the difficulty arose from the small inequalities left in the surface by the portable grinder employed, the machine not having sufficient rigidity to ensure an even surface; as a matter of fact this proved in the end to be the case.

One of the machines at the Mint is a large grinder, sufficiently long to carry the meridian circle axis, but capable of swinging only fourteen inches, while the largest diameter of the axis is eighteen inches. This machine Mr. Cleave very readily permitted to be altered by raising the centres to a sufficient height; in fact the work in connection with the alteration was all performed at the Mint, and nearly all by his own workmen. When this had been done, the pivots were re-ground in it, and no further trouble was experienced in the lapping. At the same time, the tapered bearings on which the circles fit, were trued up, as a slight eccentricity with respect to the new pivots had been introduced; this made it necessary also to turn a corresponding amount off the faces against which the circles are clamped. During the process a small cut was also taken off the end of one pivot, to eliminate the asymmetry mentioned above in the positions of the circles.

In this connection I wish to express my appreciation of the very great kindness of Mr. Cleave in practically placing his whole workshop at our disposal. Had it not been for his generous offer the work could hardly have been done in Canada.

As stated above, a great deal of work still remains to be done on the instrument. The two bearings on the axis, against which the circles are clamped, will doubtless require to be scraped, as will also the bearing on the fixed circle; this alone will require considerable time. The counterpoises are very unsatisfactory; a weight of about 350 pounds is at present counterpoised through a lever system by 10 pounds; with such a multiplication factor, especially with the arrangement used, the friction is so great as to prohibit effective control of the weight resting on the pivots; new counterpoises will require to be made. The right ascension micrometer, or rather the eye-piece slide driven by it, does not work freely, and will require overhauling. Several of the micrometer slides in the circle microscopes do not work freely; the springs in these are also unsatisfactory. The double spider lines in right ascension and declination micrometers and circle microscopes are at unsuitable and varying distances, and will require to be renewed. Besides these, there are many other details which require attention. The necessary alterations can best be made at the Observatory, where personal supervision will be possible; as, however, the machine shop is always overcrowded with work, it may take considerable time.

The observing couch, which was ordered some time ago, has been received. It is of somewhat different design from the ordinary form, and is intended to afford facility for quick setting in any desired position, together with the possibility of easy adjustment after the observer has taken his place upon it. Four wheels, running upon the same tracks as the reversing carriage, carry a wooden frame-work which in its turn supports a central transverse axis. On the latter is pivoted a light steel frame, which is also supported near one end by two screws connected with the wooden frame-work; by rotating these the frame may be tilted through a small angle in either direction. On the same axis are mounted two movable leaves; each of these is supported near its outer end by two rack sectors which engage pawls fastened to the steel frame; the pawls engage in the racks by their own weight, but may be released by a conveniently placed handle. The slow-motion screws are connected by means of a sprocket chain and bevel gears with two hand-wheels mounted one at each end of the transverse axis. The leaves of the couch can thus be quickly set in the approximate position required by means of the sectors, and after the observer has taken his place upon the couch he can tilt the whole upper frame into the proper position by means of the hand-wheels, which are always within easy reach. This slow motion has been found in practice to be a great convenience.

TRANSIT OBSERVATIONS.

Observations with the portable Cooke transit were conducted during the greater part of the year, as heretofore, in the temporary transit shed at the eastern end of the Observatory. About the end of January, however, the instrument was moved to the new Transit Room and set up on the western pier, where it has since remained. The difference in longitude between the new pier and the old is 199·9 feet, or ·187 sec.

Observations were made on 142 nights, involving 281 determinations of clock error, as well as some observations for other purposes; on a number of nights two, and sometimes three, observers worked simultaneously, for determination of personal equation. The observations throughout the summer were principally for the purpose of longitude determinations at different points. As clock exchanges were frequently required with two different stations on the same night, sometimes at intervals of an hour or two, it would have been troublesome to arrange the observing so that it would not conflict with the exchanges. For this reason the two features were kept independent throughout the season, a separate chronograph being used for the exchanges; the latter were held at the hours most convenient to the field observers, irrespective of observations or weather conditions at Ottawa; whenever possible two determinations of clock error were made on every night, preferably, but not necessarily, about the time at which the exchanges were held; for nights on which no observations were obtained the clock error was interpolated from the two adjacent nights. This arrangement, which is of course permissible only with a clock of demonstrated reliability, has proved quite sufficiently accurate for all ordinary purposes; in the case of very important stations the interpolation from night to night might perhaps not be advisable; the independence of observations and exchanges is of advantage, especially on nights broken by clouds, in that it frees the observer from the interruptions and delay inseparable from an exchange. The number of exchanges was 156, occupying 116 nights; the observing was divided among Mr. Nugent, Mr. Smith and myself, the greater part being done by the two former. A first computation of the observations was made by Mr. Tobey; they were then recomputed by the observers, and a final check including occasional recomputations was made.

The accuracy of determinations of level error during the summer was not up to standard. Early in the season the tip was broken off the level vial belonging to the transit; as no other good vial was available, and as several months were required before delivery of a new one, it was necessary to seal up the old one and continue using it. Though the mean value of a division was practically unaltered, it was found that the bubble had become rather sluggish and uncertain in its action, and considerable trouble was experienced with measurements of level error during the whole summer. The apparent probable error of a complete determination of level (comprising usually six independent measurements) was ·011 sec.; that for 1907 was ·006 sec., and for the spring of 1909, after renewal of the vial, ·005 sec. This difference has probably quite an appreciable effect on the accuracy of the work.

The fluctuations in azimuth throughout the summer were reasonably small; adjustments in level were, however, frequently necessary; another peculiarity of the level error was its tendency to progressive change during the evening's work, the western end of the instrument usually rising as the evening progressed; usually a compensating change took place in the opposite direction during the day, though the general tendency of movement throughout the summer was in the former direction. The average rate of elevation of the western pivot was ·017 sec. (of time) per hour; the rate varied between − ·016 sec. and 073 sec. per hour, being negative on 16 nights out of 89. There was no apparent connection between change of level and change of temperature during the hours of observation.

The method of observation was that described in my last report; a set consisted of seven or eight southern stars well up towards the zenith, combined with three or four north stars between 70° and 80° declination; the telescope was reversed during the observation of each star; as a rule only one group of observations on each star was taken in each position of the instrument. The star-list used contained all the stars in Newcomb's Fundamental Catalogue between 10° and 40° and between 70° and 80° declination; the places of the Berliner Jahrbuch were used for all stars contained therein; for the other stars the places were taken from the Nautical Almanac, the Connaissance des Temps and the American Ephemeris without the application of any systematic correction; as the number of such stars was not very large, and as substantially the same list was used for the field observations, any resulting errors in the longitudes deduced would be small.

In the same way as described in my last report, the average discordance between two sets observed on the same night (after allowing for clock-rate) was used as a measure of accuracy; from this quantity the probable error of a single set may be deduced as follows:—The chance of an error x occurring in the first set on any particular night is

$$\frac{h}{\sqrt{\pi}} \cdot e^{-h^2 x^2} \cdot \delta x,$$

where h is the measure of accuracy, and δx is the smallest quantity measured. Similarly the chance of an error $x + z$ occurring in the second set is

$$\frac{h}{\sqrt{\pi}} \cdot e^{-h^2 (x+z)^2} \cdot \delta x.$$

The chance of both errors occurring on the same night is the product of these quantities; if we take into account the case where an error $x + z$ occurs in the first set and an error x in the second the chance is doubled. Hence the number of pairs of errors x and $x + z$ occurring in N nights is

$$2N\frac{h^2}{\pi} \cdot e^{-h^2(2x^2+2xz+z^2)} \cdot \delta x \cdot \delta x.$$

Hence the number of discordances z (irrespective of sign) occurring in N nights is

$$2N\frac{h^2}{\pi} e^{-\frac{h^2 z^2}{2}} \cdot \delta x \int_{-\infty}^{+\infty} e^{-h^2(\sqrt{2} \cdot x + \frac{1}{\sqrt{2}} \cdot z)^2} \cdot \delta x$$

$$\text{or } N h \sqrt{\frac{2}{\pi}} \cdot e^{-\frac{h^2 z^2}{2}} \cdot \delta x.$$

Hence the sum of all discordances is

$$N h \sqrt{\frac{2}{\pi}} \int_0^{\infty} e^{-\frac{h^2 z^2}{2}} \cdot z\, d\, z = \frac{N}{h} \sqrt{\frac{2}{\pi}},$$

and if the average discordance be denoted by Δ we have

$$\Delta = \frac{1}{h} \sqrt{\frac{2}{\pi}}.$$

But the probable error $r = \frac{\cdot 4769}{h}$; hence $r = \cdot 5978\ \Delta$.

In the third column of Table I. are given the clock corrections obtained from each set throughout the summer; the fifth column gives the discordance (after allowing for clock rate) in every case where two sets were taken by the same observer on a single night; the average of all the discordances is ·033 sec., being practically the same for all three observers; the probable error deduced from this is ·0197 sec. The value of Δ deduced in my last report for the old method of observation was ·039 sec., corresponding to a probable error of ·0233 sec.; as the weight, or efficiency, is inversely proportional to the square of the probable error, the increase of efficiency indicated is 40 per cent; and presumably this has arisen from the alterations in methods of observation and grouping of stars.

As stated above, however, the probable error of the measurement of level was ·011 sec. in 1908 as against ·006 sec. in 1907 and previous years. If we assume that this effect enters for its full value in the observations of 1908, we should, for a proper comparison, reduce the probable error of a set for the latter year accordingly; that is, we would have a probable error of ·0174 sec. for 1908, as against ·0233 sec. for previous years, an increase in efficiency of about 80 per cent.

TABLE I.—TRANSIT OBSERVATIONS IN 1908.

Date.	Time.		ΔT	Observer*	Discordance.	T_o
	h	m	s			s
May 14	14	50	2·434	N	·033	2·355
	17	10	2·478	N		2·399
" 15	12	50	2·466	C S	·013	2·466
	14	40	2·488	C S		2·488
" 18	13	10	2·761	C S	·024	2·761
	14	55	2·793	C S		2·793
" 20	14	45	2·960	C S	·058	2·960
	16	30	3·026	C S		3·026
" 22	13	25	3·270	S		3·304
	16	25	3·287	C S		3·287
" 27	12	50	3·843	C S	.026	3·843
	14	40	3·878	C S		3·878
June 1	13	20	4·960	C S		4·960
" 2	13	30	5·110	N	·014	5·031
	16	05	5·102	N		5·023
" 3	14	30	5·017	C S	·033	5·017
	16	40	5·055	C S		5·055
" 4	14	15	5·250	N	·017	5·171
	15	45	5·270	N		5·191
" 5	13	40	5·231	C S	·042	5·231
	15	55	5·278	C S		5·278
" 6	14	25	5·336	N		5·257
" 8	13	45	5·323	C S		5·323
" 9	17	05	5·553	N	·037	5·474
	19	00	5·519	N		5·440
" 10	13	55	5·478	S	·001	5·512
	15	30	5·480	S		5·514
" 11	13	50	5·639	N	·003	5·560
	15	45	5·639	N		5·560
" 12	13	55	5·559	S	·012	5·593
	15	20	5·549	S		5·583
" 17	14	25	5·722	S	·049	5·756
	15	40	5·773	S		5·807
" 18	15	05	5·856	N		5·777
" 20	16	00	5·913	N	·079	5·834
	17	55	5·995	N		5·916
" 21	14	40	6·149	N	·026	6·070
	16	30	6·128	N		6·049
" 22	14	45	6·120	C S	·028	6·120
	16	05	6·151	C S		6·151
" 24	14	25	6·302	C S	·077	6·302
	16	00	6·228	C S		6·228
" 25	14	35	6·418	N	·006	6·339
	16	20	6·416	N		6·337

TABLE I.—TRANSIT OBSERVATIONS IN 1908—*Continued.*

Date.	Time. h.	Time. m.	T	Observer.*	Discordance.	T
			s			s
June 26	15	40	6·408	C S	·019	6·408
	17	00	6·430	C S		6·430
" 27	17	20	6·632	N		6·553
" 28	15	00	6·649	S	·045	6·683
	16	15	6·607	S		6·641
" 29	14	55	6·740	C S		6·740
30	15	05	6·910	N	·009	6·831
	17	00	6·906	N		6·827
July 1	16	00	6·869	C S	·019	6·869
	17	50	6·855	C S		6·855
" 3	15	15	6·963	C S	·024	6·963
	16	35	6·990	C S		6·990
	18	50	6·944	S	·014	6·978
	20	00	6·961	S		6·995
" 5	15	05	7·066	S		7·100
" 6	17	50	7·110	C S		7.110
" 8	15	30	7·261	C S	·036	7·261
	17	10	7·229	C S		7·229
" 9	15	05	7·371	N	·025	7·292
	17	00	7·401	N		7·322
10	15	10	7·388	C S	062	7·388
	16	40	7·330	C S		7·330
" 11	17	25	7·489	N	·051	7·410
	18	35	7·441	N		7·362
" 12	15	40	7·423	S	·049	7·457
	18	05	7·380	S		7·414
" 13	18	10	7·533	N	·022	7·454
	19	25	7·514	N		7·435
" 14	15	15	7·553	C S	·058	7·553
	16	30	7·498	C S		7·498
" 15	15	35	7·604	C S	·006	7·6 4
	18	00	7·610	C S		7·610
" 16	15	55	7·670	N	·077	7·656
	17	35	7·593	N		7·579
" 20	17	55	7·644	C S		7·644
" 24	16	35	7·593	C S	·038	7·593
	17	55	7·631	C S		7·631
" 25	16	45	7·547	S	·011	7·581
	18	10	7·534	S		7·568
" 26	16	05	7·508	C S	·008	7·508
	17	30	7·498	C S		7·498
" 28	17	05	7·341	N	·051	7·327
	19	05	7·286	N		7·272
" 29	17	15	7·271	C S	·008	7·271
	18	40	7·263	C S		7·263

TABLE I.—TRANSIT OBSERVATIONS IN 1908—*Continued.*

Date.	Time.		$\triangle T$	Observer.*	Discordance.	$\triangle T_0$
	h.	m.	s			s
July 30	16	35	7·289	N	·018	7·275
	18	20	7·271	N		7·257
„ 31	16	50	7·258	C S	065	7·258
	18	20	7·323	C S		7·323
Aug. 2	17	25	7·370	S		7·404
„ 5	17	55	7·665	C S	·088	7·665
	19	15	7·756	C S		7·756
„ 6	20	50	7·701	N	·030	7·687
	22	15	7·733	N		7·719
„ 7	18	25	7·767	C S	·044	7·767
	19	25	7·813	C S		7·813
„ 9	17	40	7·986	S	·050	8·020
	19	15	7·940	S		7·974
„ 11	17	40	8·156	N	·040	8·142
	19	00	8·119	N		8·105
„ 13	18	20	8·280	N	002	8·266
	19	55	8·286	N		8·272
„ 15	18	55	8·336	N		8·322
„ 17	18	50	8·404	C S	·005	8·404
	20	05	8·411	C S		8·411
„ 18	19	40	8·427	N		8·413
„ 19	18	05	8·576	N	·069	8·562
	19	20	8·509	N		8·495
„ 20	20	05	8·546	C S	·045	8·546
	21	10	8·591	C S		8·591
„ 21	18	00	8·616	C S	007	8·616
	19	20	8·625	C S		8·625
„ 22	18	30	8·620	N	042	8·606
	19	45	8·664	N		8·650
„ 23	21	20	8·608	S		8·642
„ 24	17	45	8·683	C S	·067	8·683
	19	05	8·752	C S		8·752
„ 25	18	15	8·793	N	·005	8·779
	19	25	8·790	N		8·776
„ 26	20	10	8·789	C S		8·789
„ 27	18	00	8·826	N	·018	8·812
	19	20	8·810	N		8·796
„ 28	19	00	8·803	C S	·006	8·803
	20	05	8·811	C S		8·811
„ 30	18	30	8·833	S	·062	8·867
	19	40	8·773	S		8·807
„ 31	18	10	8·859	C S	·032	8·859
	19	20	8·893	C S		8·893

TABLE 1.—TRANSIT OBSERVATIONS IN 1908.—*Continued.*

Date.	Time.		△ T	Observer.*	Discordance.	△ T₀
	h.	m.	s			s
Sept. 3	18 19	15 40	8·986 9·019	N N	·031	8·972 9·005
" 4	18 19	05 15	9·070 9·035	C S C S	·037	9·070 9·035
" 5	19 21	40 00	9·076 9·107	N N	·029	9·062 9·093
" 6	18 19	30 40	9·030 9·064	S S	·032	9·064 9·098
" 7	19 21	40 05	9·110 9·171	N N	059	9·096 9·157
" 8	19 21	55 05	9·199 9·186	C S C S	·015	9·199 9·186
" 11	20 21	15 35	9·388 9·379	C S C S	·011	9·388 9·379
" 12	19 20	05 50	9·419 9·386	N N	·036	9·405 9·372
" 14	19 20	05 25	9·453 9·519	C S C S	064	9·453 9·519
" 16	19 20	10 15	9·561 9·499	C S C S	·064	9·561 9·499
" 19	19 20	10 30	9·676 9·713	N N	035	9·662 9·699
" 20	19 20	25 50	9·616 9·570	S S	·048	9·650 9·604
" 21	19	50	9·616	S		9·650
" 25	20	45	9·706	C S		9·706
" 29	20 21	25 25	9·813 9·782	S S	·033	9·847 9·816
Oct. 1	20	50	9·906	C S		9·906
" 2	19 22 22	55 10 10	9·994 9·958 9·910	C S C S S	·040	9·994 9·958 9·944
" 3	20 21	25 35	9·939 9·933	S S	·008	9·973 9·967
" 5	21 22 22	10 40 40	10·060 10·040 10·017	C S C S S	·023	10·060 10·040 10·051
" 6	20 22	35 05	10·073 10·099	N N	·023	10·059 10·085
" 7	21 22	00 20	10·076 10·081	C S C S	·002	10·076 10·081
" 9	19 20	40 45	† 366 ·417	C S C S	049	† 366 ·417
" 11	21	00	276	S		·310

TABLE I.—TRANSIT OBSERVATIONS IN 1908.—*Continued.*

Date.	Time.		ΔT	Observer.*	Discordance.	ΔT
	h.	m.	s.			s.
Oct. 12	20	40	·400	C S	·002	·400
	22	25	·401	C S		·401
	20	40	·336	S	·024	·370
	22	25	·363	S		·397
" 13....	20	45	·454	N	·086	·440
	22	25	·371	N		·357
	22	25	·390	S		·424
" 14	21	50	·444	N		·430
	21	50	·456	S		·490
" 15	21	30	·591	N		·577
	21	30	·520	S		·554
Nov. 21	0	55	2·291	S	·088	2·325
	2	35	2·382	S		2·416
	0	55	‡2·260	N	·016	
	2	35	2·247	N		
" 26.	23	50	2·952	N		
	23	50	2·988	C S		2·988
" 29.	0	30	3·253	S	·002	3·287
	2	20	3·259	S		3·293
	0	30	3·307	C S	·002	3·307
	2	20	3·309	C S		3·309
Dec. 2	0	20	3·664	C S	·056	3·664
	1	50	3·611	C S		3·611
	1	50	3·516	N		
" 5...	23	05	3·981	S	·009	4·015
	0	55	3·994	S		4·028
	23	05	3·864	N	·041	
	0	55	3·827	N		
Mean Discordance	..	...	......	.....	± ·033	

* The letters used to denote the observers are as follows:—R. M. Stewart, S; D. B Nugent, N; C. C. Smith, CS.

† On Oct. 9, owing to a blown-out fuse, the winding circuit of the clock failed for a few minutes; though the pendulum continued to swing uninterrupted, the reading of the clock-face was changed.

‡ The personal equation of N had changed between Oct. 15 and Nov. 21; hence the observations of N are not entered in the last column after Nov. 21.

PERSONAL EQUATION.

An examination of the values of clock error for successive days, as given in the third column of Table I., shows that the differences of personal equation are not negligible. This was very clearly seen on plotting the results in a curve, using different coloured inks for each observer; it was also quite noticeable that the personal equation of N had suffered a sudden change between July 13 and July 16. To determine the values of the personal equations the summer was broken up into periods during which the curve appeared most regular; then for any one period the mean of the observations on each night was represented by the observation equation

$$a + bt + ct^2 + e = \Delta\ T,$$

t being the interval from a fixed epoch, a, b and c arbitrary constants, ΔT the observed clock error, and e the personal equation of the observer referred to the standard observer. It will be seen that this amounts to assuming that the clock-rate, during the period considered, varied uniformly with the time; the periods were so chosen, by inspection of the curve, that this condition should be approximately fulfilled; even if this were not the case the deduced values of e would still be trustworthy, provided the work of each observer were distributed fairly uniformly over the whole period. After combining the observation equations and deducing the values of e for N and CS, referred to S as standard, and also of a, b and c, these values were substituted in the observation equations and the residuals formed. As the average of the residuals for those parts of the summer included in the periods considered was ·022 sec., the largest being ·06 sec., it follows that the observations are fairly well represented by the formula. The relative personal equations derived for each period, with their probable errors, are given in Table II. From these figures it would appear that during June and July the personal equation of CS underwent a gradual progressive change; from a consideration of the observations as a whole, however, and considering the fact that, especially in the first period, the observations of CS were not distributed over the whole period, it was decided to treat the personal equations of CS and of S as constant throughout the season, and to assume (as was evidenced by the clock-curve) a sudden change in that of N about July 15. Combining the results for the whole season on this assumption, the values of personal equation derived are as follows:—

$CS-S$ ·034 sec.

$N-S$ ·113 sec. up to July 15; afterwards ·048 sec.

As will appear below, it seemed likely from some later developments that the absolute personal equation of CS was nearly zero; for this reason the above results were altered so as to make his observations the standard; the corrections to be applied to the clock errors of each observer were then as follows:—

S ·034 sec.

N − ·079 sec. up to July 15; afterwards − ·014 sec.

CS ·000 sec.

These corrections have been applied to form the last column in Table I.

To obtain the personal equations of the two field observers M* and J†, some additional observations were made, the field observers occupying a hut immediately to the south of the one in which the home observations were taken. The observations with M extended from September 14 to October 14; those with J, who did not return from the field until later, from November 21 to December 5. During a part of this time two of the home observers frequently observed together, in order to strengthen the determination both of their own personal equations and of those of the field observers. This was rendered possible by the fact that the transit used (Cooke I) was fitted with an attachment which caused it to record over every alternate four revolutions (of the micrometer screw) throughout the field; one observer would follow the star over a group of contacts at a considerable distance from the centre of the field, the other over a group somewhat closer; after reversal the same series of observations was repeated in the reverse order; thus the observations of each observer were complete in themselves; the groups of contacts made by each observer were interchanged for alternate stars. Each observer also took an independent series of level readings; as it was found, however, that there was no systematic difference in this regard, the mean of all the level readings was taken in making the reductions.

The observations for M's personal equation are collected in Table III.; those for that of J in Table IV. It is evident from Table IV. that for the November and December observations the personal equation of N had again suffered a decided change; those of S and CS, however, appear to have remained relatively unchanged; consequently in obtaining the personal equation of J only the observations of S and CS have been used.

* F. A. McDiarmid.
† W. C. Jaques.

The values of personal equation obtained above for the five observers engaged were applied throughout in the computations for longitude. Though perhaps not as accurate as might be desired, the agreement of the longitudes derived on different nights has been in general improved by their application, and there is at least no doubt of the real existence of personal differences of about the magnitudes indicated. It follows that it is never safe to assume the absence of personal equation with the transit micrometer, as was the tendency for some time after its introduction; though some of the differences involved above are small enough to be neglected except in the most refined work, several of them are of quite appreciable magnitude. They are, however, much smaller than the personal equations ordinarily occurring in key observations.

In considering *à priori* the question of personality with the transit micrometer, it would appear that there are two factors capable of affecting the result. On account of the motion of the star, there may be a tendency always to keep the moveable wire either ahead of or behind the star, irrespective of its apparent direction of motion; the distance between star and wire, expressed in angular measure, might be expected to be somewhat less for the more slowly moving stars, but this tendency would be, to some extent at least, counterbalanced by the greater value (expressed in time) of any particular angular interval for the latter class of stars; thus the tendency would be for the record to be made either too soon or too late by a quantity which might be sensibly the same for stars of all declinations; this is a personal equation of the same kind as the so-called 'reaction-time' in observations by eye and ear or with the telegraphic key, but it might be expected to be smaller. The second factor is the personal error of bisection, by virtue of which an observer may tend always to set the wire either to the right or left of the centre of the star-image which he attempts to bisect; this effect would change sign with the direction of apparent motion, and its absolute value would be proportional to the secant of the declination, changing sign at the zenith and at the pole; it might also be expected to vary with the magnitude. This error is also present in the case of estimation of transits across fixed wires; there is, however, so far as the variation with magnitude is concerned, the difference that in the latter case the tendency is usually to estimate the bisection of a bright star sooner than that of a faint one, irrespective of the direction of motion, while in the case of the transit micrometer, differences of magnitude will presumably simply have the tendency to increase or diminish the error of bisection.

Errors of the first class arise from the motion of the star, but are independent of its direction; those of the second class do not arise from the motion, but (when expressed as corrections to the time of transit) change sign with its apparent direction; the former will affect the time, but not the azimuth; the latter both, but more markedly the azimuth.

It had long ago been noticed by the writer that, for his own observations, it was impossible satisfactorily to combine observations of south stars with those of north stars at both upper and lower culmination; this for the reason that the stars at upper culmination, when combined with the south stars, gave values of clock error and azimuth consistently differing from those derived from the stars at lower culmination. This circumstance was explicable by supposing that the observations were affected by a systematic error of bisection, and by no other hypothesis except that of systematic catalogue error; it was found that the observations could be reconciled by supposing that the wire was set always to the left of the star by somewhat over a second of arc.

During the summer of 1908 it was decided to make some special observations to test, qualitatively at least, the validity of this hypothesis. In order to obtain as many independent tests as possible, several methods of observation were devised. The most obvious of all, the observation of transits of zenith stars facing alternately north and south, was impracticable with the telescope used, since the standards interfered with the proper manipulation of the micrometer wheels. The first method used was the measurement of zenith distances; as the telescope was fitted with an erecting diagonal eye-piece, this was comparatively simple. After setting on a star at some distance from the zenith, preferably a slow-moving north star (the micrometer head having been previously turned so that the moveable wire was horizontal), the diagonal eye-piece was turned in either direction about 45° from the vertical plane; on looking into it with the line joining the eyes horizontal, the micrometer wire appeared vertical, the direction of increasing zenith distance being towards the right or left according to the direction in which the eye-piece had been turned. By making a number of settings with eye-piece alternately right and left the error of bisection was readily found. In this method the question is not complicated by the motion of the star, which appears to move *along* the wire, the motion in any case being very slow if high polars be chosen; thus the result is practically the simple error of bisection for a stationary object. By combining the results from different stars the variation depending on magnitude may also be found. The stars principally used were Polaris and λ Ursæ Minoris; with the latter as many as a hundred settings could easily be made at one culmination. Several other stars of high declination were also used, the total number of bisections made being about 400. Observations of a similar kind on Polaris and λ Ursæ Minoris were also made by C. C. Smith.

The other methods used, which were three in number, all depended on the observation of transits. They were as follows:—

I. Observations of the same star (over different parts of the field) were made with the ordinary diagonal eye-piece (erecting), and also with a simple eye-piece of about the same magnifying power; as the apparent direction of motion is altered by interchanging the eye-pieces, the difference in times of transit (reduced to the meridian) was taken to be double the error of bisection. In this case the observations are not made under exactly similar conditions; with the direct eye-piece a movement of the hand-wheels appears, to an observer accustomed to the erecting eye-piece, to move the wire in the wrong direction, and there is no assurance *à priori* that this will not alter the 'lag' effect, if this exists. The definition is also somewhat better with the direct eye-piece, which might tend to diminish the error of bisection in that case; the result might also be affected by the difference in the observer's position. On account of the use of the direct eye-piece, observations were not possible within 35° of the zenith; stars were observed near the equator and near the pole, both above and below. When reduced to equatorial interval it was found that the error of bisection was practically the same for polar and equatorial stars, the difference in times of transit being, as was expected, of opposite sign for north stars at upper culmination. Care was taken to have the magnitudes varied enough to determine the magnitude equation. The whole number of stars observed was 45.

II. Observations of a few equatorial stars were made in the ordinary way, and also with the diagonal eye-piece turned through 180°, so that the observer faced upwards at an angle in looking into it. As before, the error of bisection was taken to be one-half the difference in the reduced times of transit. Theoretically this method is free from objection, as the conditions of observation are the same in both cases; practically, however, the difficulty of observing with the eye-piece down, without a suitable reclining chair, was found to be a very serious objection; only twelve stars were observed.

III. As in the case of the zenith distance observations above, the star was observed with eye-piece both left and right, and also (over another part of the field) in the ordinary way. With eye-piece left the apparent motion of the star was upward, the wire appearing horizontal; with eye-piece right the motion was downward; the mean of these two observations was taken to be free from error of bisection; hence the error for the ordinary observation was derived. The number of stars observed was 43.

In the several methods described above the results are indepeudent of catalogue places, and include both the absolute value of the error of bisection and its variation with magnitude. Computations were also made from the residuals of the southern Berliner Jahrbuch stars occurring in the ordinary observations to determine the magnitude equation in the case of both S and CS; this involves the assumption that the B. J. places are free from maguitude equatiou, which is probably very nearly the case. The residual of each B. J. star in a set was diminished by the mean of all; the same was done with the magnitudes; there results for each star an observation equation of the form $b\ m = v$, m being the magnitude of the star diminished by the mean magnitude for the set, v the residual dimiuished in the same way, aud b the unknown magnitude equation; the reduction to this form enables stars from different sets to be combined indifferently to obtain the value of b. 170 stars were used in deducing the magnitude equation of S, 143 for that of CS.

From the observations by S and CS in October and November, on the nights on which the two observers worked simultaneously with the same instrument, a computation was made of their difference of personal equation and its variation with magnitude, on the supposition that it was wholly due to bisection error. This supposition appeared extremely probable from the fact that of 19 north stars (at upper culmination) and 43 south stars, every one of the north stars gave a negative difference in the sense $S - CS$, and every one of the south stars a positive difference. The signs of the differences for the north stars having been changed, each star furnished an observation equation of the form $a + bm = v \cos \delta$ for the determination of difference of bisection error, a and b being the quantities to be determined, m the magnitude, and v the observed difference. The 62 equations were combined by least squares, and a and b evaluated.

The results of all the observations and computations described above are collected in Table V. In the case of the zenith distances the bisection errors, for the sake of uniformity, have been reduced to their equivalents in time; all the results are expressed in equatorial interval; the bisection error has throughout been considered positive when the wire is set to the apparent left of the star. The inter-agreement of the means is no doubt much closer than might have been expected from the varied nature of the observations and their comparatively limited number. The results, however, point very strongly to the reality of a large bisection error for the observer S, and to its variation with magnitude; the agreement for the two observers points to the probability that their personal equations arise almost wholly from this cause. For a set observed at the latitude of Ottawa (45° 24′), composed of north stars of magnitude 5·5 at declination 77° and south stars of magnitude 4 at declination 25°, which is about the average composition, the personal equation between S and CS due to error of bisection, assuming the latter to be ·074 sec. − ·0129 $(m - 4)$, would be ·036 sec.; the actual value as obtained directly above was ·034 sec. The closeness of this agreement is, however, no doubt partly attributable to chance.

The observations of N in October, on the three nights when he worked simultaneously with S, appear to follow a similar law, the differences being all negative for the north stars, and nearly all positive for the south stars; for his observations in November and December, however, after the second change in his personal equation, this is not the case. The observations were considered too few to make a definite analysis; his magnitude equation during the early part of the summer, as deduced from the residuals, was − ·0019 sec. per magnitude, a practically evanescent quantity.

It may be remarked that transits of stars near the zenith, observed with a broken type telescope. will be free from error of bisection when the telescope is reversed during the observation of each star. For an ordinary telescope the condition of elimination, so far as effect on the deduced clock-error is concerned, is that the sines of the mean zenith distances of south and of north stars should be proportional to the errors of bisection corresponding to their respective mean magnitudes, provided that the zenith distances and magnitudes of individual stars do not differ widely from these means. As, however, the fulfilment of this condition, even approximately, would be extremely difficult in actual practice, and as the resulting error varies fairly rapidly with changes in the conditions, the only practical remedy would appear to be the measurement by each observer of his bisection error and the correction of each separate observation for it if large. Observations of both Polaris and λ Ursæ Minoris at a single culmination, by the method outlined above, would be sufficient to determine whether the error and its variation with magnitude were sufficiently large to be taken into account; if so, further observations of the same kind could be made if desired.

In the measurement of azimuth by the transits of close circumpolars, the clock error being supposed known, the error of bisection enters for more than its full value into the deduced azimuth. In this case the error might either be measured directly as above, and a correction applied, or it might be eliminated by observing with eyepiece alternately left and right as described under III. above.

TABLE II.—PERSONAL EQUATIONS OF HOME OBSERVERS.

Period, 1908.	CS—S	N—S	
	s	s	
June 1-20	− ·011 ± ·021	·098 ± ·016	Preliminary.
June 21-July 15	·025 ± 014	·099 ± ·015	
Aug. 2-31	·046 ± ·014	·057 ± ·015	
Sept. 3-29	·056 ± ·018	077 ± 019	
Oct. 1-7	·050 ± ·016	·061 ± ·022	
May 14-July 15	034 ± ·007	·113 ± ·009	Adopted.
July 16-Oct. 15		·048 ± ·009	

TABLE III.—PERSONAL EQUATION OF F. A. McDIARMID.

Date.	Time.		Clock Corrections.				Personal Equation of M.		
			M	S*	N†	C S	S-M	N-M	C S-M
1908.	h.	m.	s	s	s	s	s	s	s
Sept. 14	19	00	9·444			9·453			·009
	20	25	9·424			9·519			·095
„ 16	19	10	9·505			9·561			·046
	20	20	9·493			9·499			·006
„ 19	19	10	9·619		9·662			·043	
	20	10	9·562		9·699			·137	
„ 20	19	20	9·565	9·650			·085		
	20	35	9·540	9·604			064		
„ 21	20	05	9·656	9·650			− 006		
„ 25	20	45	9·684			9·706			022
„ 29	19	50	9·812	9·847			·035		
	21	15	9·844	9·816			− ·028		
Oct. 1	20	05	9·918			9 906			− ·012
„ 14	22	00	0·522	0·490	0·430		− ·032	− 092	
Means							·020	.029	·028
Weighted mean								0·025	

*With personal equation + ·034 sec. applied.
†With personal equation − 014 „ „

TABLE IV.—PERSONAL EQUATION OF W. C. JAQUES.

Date	Time.		Clock Corrections.				Personal Equation of J.		
			J.	S*	N†	C S	S—J	N—J	CS—J
1908.	h	m	s	s	s	s	s	s	s
Nov. 21	0	55	2·319	2·325	2·246	....	·006	– ·073	
" 26	23	50	2·988	....	2·938	2·988	....	– ·050	·000
" 29	0	30	3·259	3·287	....	3·307	·028	....	·048
	2	20	3·210	3·293	....	3·309	·083	....	·099
Dec. 2	0	20	3·516	....	....	3·664	....	....	·148
	1	50	3·586	....	3·502	3·611	....	– ·084	·025
" 5	23	05	3·947	4·015	3·850	....	·068	– ·097	....
	0	55	3·920	4·028	3·813	....	·108	– ·107	....
Means							·059	– ·082	·064
Weighted mean from observations of S and C S, 0·061 sec.									

* With personal equation + ·034 sec. applied.

† With personal equation – ·014 sec. applied.

TABLE V.—ERRORS OF BISECTION.

Method.	Observer.	Bisection Error.		
		s	s	
Zenith Distance	S	·074	– ·0119	(m –4)
Transits I	S	·101	– ·0091	(m—4)
" II	S	·066	– ·0088	(m—4)
" III	S	·151	– ·0252	(m—4)
Residuals	S		– ·0118	(m—4)
Zenith Distance	C S	·033	+ ·0000	(m—4)
Residuals	C S		– ·0038	(m—4)
Direct Differences	S—C S	·074	– 0129	(m—4)
Means.	S	·098	– ·0134	(m—4)
	C S	·033	– ·0019	(m—4)
	S—C S	·074	– ·0129	(m—4)

TIME SERVICE.

The ordinary work in connection with the Time Service has consisted, as in the past, of the necessary attention to the up-town service, the sending out of time-signals to the telegraph company, dropping of the time-ball on Parliament Hill, supplying of mean and sidereal time by telephone to those requiring it, occasional rating of chronometers, testing of aneroid barometers, &c., together with the maintenance of the clocks and apparatus at the Observatory.

In addition to the daily time-signals to the telegraph company, the beats of the mean-time clock were on one occasion sent to a member of the Geological Survey staff at Blackwater, B.C., several hundred miles north of the main line of the Canadian Pacific Railway. On this occasion the transcontinental copper wire of the Canadian Pacific Telegraph was used as far as Vancouver; the signals were received at Blackwater satisfactorily.

During the winter season, unless required for special purposes, observations for time were taken usually not oftener than once a week, and occasionally at slightly longer intervals. When required only for ordinary time-keeping purposes (the clock error not being required more accurately than to within one or two-tenths of a second) this is found amply sufficient with our Riefler Standard Clock.

Some trouble has been experienced with the maintenance of a perfectly uniform pressure within the case of the Sidereal Standard. During May, 1908, a leak at the rate of several millimetres per month developed; by careful resealing this was reduced, though not entirely eliminated; throughout the whole summer and the ensuing winter a practically uniform leak of one millimetre per month persisted; as, however, the leak was uniform, it did not interfere seriously with the performance of the clock; no attempt was made to keep the pressure at its original value by periodical exhaustion, as it was considered that this would interfere with the continuity of rate. In March, 1909, the electric seconds-contact failed; the necessity of dismounting the clock was taken advantage of to have it cleaned and oiled, after which it was again mounted and exhausted to a pressure of 688 millimetres. An analysis of its rate from June to October, 1908, is given in Appendix A below.

Reference was made in my last report to the proposed extension of the Time Service to the Printing Bureau, the Mint and the Archives Building. It was, however, later decided by the Public Works Department not to equip the Printing Bureau at present. A switch-room to contain the apparatus for serving the two remaining buildings was obtained in the Mint, and was fitted up under my supervision by the electricians of the Public Works Department; this work was completed on September 18. The master-clock for operating the dials was the one which had been formerly used in the basement of the Supreme Court Building as primary for the experimental system installed in 1902. For use as a secondary master-clock it required to be fitted with a minute-contact and a synchronization magnet, as well as with the cut-out described in my last report. This was done in the Observatory workshop, and the clock was set up in the switch-room at the Mint for regulation of rate on August 11. On September 19 at noon the dials in the Mint and Archives Building were started; the master-clock was not put under direct control from the Observatory until some little time later.

In the other departmental buildings there have, as usual, been changes and some additions to the dials in operation. The necessary attention to the system has in the main, as heretofore, devolved upon Mr. Robertson; Mr. Nugent has also frequently assisted in this work. Below is a list of the number of clocks in operation in the city and at the Observatory:—

	Mar. 31, '09.	Mar. 31, '08.
Minute dials—Parliament Building	49	46
East Block	36	35
West Block	63	61
Langevin Block	48	48
Post Office	20	20
Thistle Block	2	2
Ottawa Electric Co	1	1
Mint	16	..
Archives	7	..
Observatory	28	28
Tower clocks	2	2
Program clock	1	1
Seconds dials	3	2
Total electrically driven clocks	276	246

	Mar. 31, '09.	Mar. 31, 08.
Secondary Master-clocks	8	7
Primary clocks	4	4
Total	288	257

I have the honour to be, sir,
Your obedient servant,

R. M. STEWART.

APPENDIX A.

RATE OF THE STANDARD CLOCK OF THE DOMINION OBSERVATORY.

R. M. Stewart.

The construction of astronomical clocks has arrived at such a degree of perfection that, for the present at least, it is probably useless to look for much improvement in this direction. Attention requires to be directed more especially to the conditions under which the clock operates, with a view to keeping these as constant as possible. There are three main factors which influence the performance of a clock: (1) rigidity of mounting and freedom from vibration; (2) compensation for or elimination of variations in atmospheric pressure; (3) compensation for temperature.

The Sidereal Standard of the Dominion Observatory (Riefler No. 75) is of Riefler's well known primary type. The whole clock is enclosed in an air-tight glass cylinder to eliminate all changes of air pressure; it may be remarked here that the rate-variation due to barometer, if not eliminated, is very considerable, amounting in the present case to nearly half a second per day per inch change of barometer. The pendulum rod is of the particular composition of nickel-steel known as invar, whose temperature coefficient of expansion is very small. The temperature compensation is effected by a short compound cylinder of brass and steel, upon which the pendulum-bob is supported. The escapement is of Riefler's own type, one of the principal characteristics being that the impulse to the pendulum is given through the suspension spring; it combines many of the advantages of the two best fundamental types, the 'free' and 'gravity' escapements. The winding is electrical, and is operated automatically at intervals of 20 to 30 seconds.

Though the temperature-compensation of a good pendulum is sufficiently accurate for all ordinary purposes, the refinements of astronomical observations make it necessary in addition to keep the temperature to which it is subjected as constant as practicable. It is considered by many authorities that a variation of a degree or two is not attended by any appreciable effects, but in our case the principle has been followed of aiming at a fairly high degree of refinement in temperature control. The temperature of the clock-room as a whole is kept nearly constant by means of a thermostat controlling an electric heater, while a fan keeps the air in constant circulation throughout the room. This, however, was not found to give the refinement desired, and a separate case was built around the clock. The temperature within the case is maintained slightly above that of the room by a Callender Electric Recorder, which controls a small electric heater, the air being kept in circulation as above by a small fan; the maximum variation is of the order of a tenth of a degree centigrade.

A good test of the rate of the clock is given by the longitude operations of the summer of 1908. Observations for clock error were made on every clear night for four and a half months, from the beginning of June* up to the middle of October; in general at least two independent determinations were made on each night; the total number of nights was 91; three observers took part in the work, two of them observing usually on alternate nights, and the third less frequently.

Owing to the continuity of the work and the accurate running of the clock, it was found possible to compute the relative personal equations of the observers from the regular observations. To do this, the season was broken up into convenient periods, averaging about a month in length, and a rigorous least square computation of the relative personal equations obtained for each; these separate values were combined with the results of some special observations for personal equation, and final values adopted. The application of these quantities to the observations gave clock errors presumably free from relative personal equation. The general rate showed great uniformity throughout the season, with the exception of the latter part of July; as the rate in this period was so evidently anomalous, it has been left out of consideration in what follows.

In computing clock-rates the effect of errors of observations must not be neglected; where the observations from which the rate is computed are separated by only a short interval, the apparent effect of such errors may be considerable; this, however, decreases as the interval is increased. For this reason the rates in Table I. have been computed, as shown, for intervals of five days, so far as the observations would permit. The second column shows the observed daily rate in seconds for each period, the third the difference between each of these observed rates and their mean, the average difference being ± ·015 sec. per day. Assuming a constant change of rate with the time and solving by least squares the rate-formula obtained is $^{s}{\cdot}0500 - {}^{s}{\cdot}00023\ (T - \text{Aug. } 8)$; the rates computed from this formula are given in the fourth column, while the fifth gives the differences between these and the observed rates, the average deviation being ± ·013 sec.

For the sake of comparison with another clock of the same kind, and to show the effect of temperature-control, Table II. gives a similar analysis of the rate of the United States Naval Observatory clock (Riefler No. 70) for a period of three months in 1904, as published by Prof. Eichelberger†; in this case one period of ten days is omitted; the average interval between observations is 4·2 days. As the variation of temperature during this test was considerable, a temperature-term is introduced in the computed rate. It will be observed that the mean deviation from computed rate is almost the same for both clocks; this may be taken to mean that the ideal performance (that is, the best performance of which the clock is capable) is practically the same in both cases; this is of course to be expected from two clocks of the same type and manufacture. So far as actual performance goes, however, they are to be judged by the residuals from mean, and not computed, rate, and here the Ottawa clock has a very decided advantage, its actual performance being reasonably close to the ideal one. The reason is not far to seek; it lies in the absence of temperature-variations and their disturbing effects. It would not be fair to close this comparison without stating that the United States Naval Observatory has now a new clock room, where, I believe, greater attention is paid to temperature control.

As mentioned above, the interval between observations for clock error will influ-

* The observations made in May were not considered in this paper because the rate was affected by several changes of pressure and a certain amount of direct disturbance due to adjustments and re-sealing.

† Science, 1907, p. 451.

ence the accuracy of the deduced rate, owing to the effect of errors of observation. In general, the residual rate V (observed minus computed) will consist of three parts:—(1) the actual variation of clock rate v_1, (2) an apparent part v_2 depending on errors of observation and interval, (3) another apparent part v_3 due to error in the personal equation employed (if the observations have been made by different observers). Hence

$$V = v_1 + v_2 + v_3$$

and, as may easily be shown, if the number of intervals considered be large,

$$[V^2] = [v_1^2] + [v_2^2] + [v_3^2];$$

or denoting the corresponding probable errors by R, r_1, r_2 and r_3.

$$R^2 = r_1^2 + r_2^2 + r_3^2.$$

Now if r denote the probable error of a single determination of clock-error, and if, on two nights separated by an interval of N days, there be made respectively n_1 and n_2 determinations of clock error, we shall have for that particular interval

$$r_2^2 = \frac{\frac{1}{n_1} + \frac{1}{n_2}}{N^2} \cdot r^2.$$

The value of r for the observations considered, obtained by an independent method, is ·020 sec. Substituting this value and deducing that of r_2^2 for each of the intervals in Table I., and taking the mean, the result is

$$r_2^2 = (\cdot 0046)^2.$$

Again, if r^1 denote the probable error of the value of personal equation employed, we have

$$r_3 = \frac{1}{N} \cdot r^1;$$

the value of r^1 is ·008 sec.

Also, the value of R obtained from the residuals in Table I. is ·012; hence $r_1 = \sqrt{R^2 - r_2^2 - r_3^2} = \pm$ ·011 sec.; this is the probable value of the actual accidental change in (daily) rate from one period of five days to the next.

Proceeding in exactly the same way, but using, instead of five-day intervals, all the observations available, the average interval being 1·47 days, the values of the quantities are as follows:—

R = ·025 sec.
r_2 = ·0183 sec.
r_3 = ·0054 sec.
and hence r_1 = ·016 sec.

Hence it appears that a clock is liable to small irregular fluctuations of rate from day to day, it being in the present case an even chance that such fluctuations shall lie within the limits $\pm$ ·016 sec.; when, however, the interval is increased, the fluctuations tend to counterbalance one another.

It would appear also that the clock is liable in addition to anomalous changes of rate for longer or shorter periods; from July 16 to July 31 the average rate was − ·022 sec., as against ·050 sec. for the remainder of the summer. It has been suggested that this is a peculiarity of invar pendulums, due to some not well understood irregularities in the interval constitution of the material; similar effects have been noticed in other Riefler clocks, but the question can hardly be considered definitely settled as yet. Such changes in rate are, however, for astronomical purposes, less objectionable than the irregular ones (here eliminated) due to irregular variations in temperature and pressure.

TABLE I.—DOMINION OBSERVATORY CLOCK.

Date.	Daily Rate.	O – M	Computed Rate.	O – C
1908.	s.	s.	s.	s.
June 1-6	·059	·009	·065	– ·006
" 6-11	·061	·011	·064	– ·003
" 11-17	·037	– ·013	·063	·026
" 17-21	·069	·019	·062	·007
" 21-26	·072	·022	·060	·012
" 26-31	·088	·038	·059	·029
July 1-6	·049	– ·001	·058	– ·009
" 6-11	·055	·005	·057	– ·002
" 11-16	·046	– ·004	·056	– ·010
Aug. 0-5	·083	·033	·051	·032
" 5-9	·072	·022	·050	·022
" 9-15	·054	·004	·049	·005
" 15-20	·049	– ·001	·048	·001
" 20-25	·042	– ·008	·047	– ·005
" 25-30	·012	– ·038	·046	– ·034
" 30-35	·043	·007	·044	– ·001
Sep. 4-8	·034	·016	·043	– ·009
" 8-14	·049	– ·001	·042	·007
" 14-19	·039	– ·011	·041	– ·002
" 19-25	·004	– ·046	·040	– ·036
" 25-31	·033	– ·017	·038	– ·005
Oct. 1-6	·033	– ·017	·037	– ·004
" 6-11	·048	– ·002	·036	·012
" 11-15	·061	·011	·035	·026
Mean.	·050	± ·015		± ·013
Range.		·084		·068

Computed rate = $\overset{s.}{\cdot 0500} - \cdot 00023\,(T - \text{Aug. } 8)$.

TABLE II.—U. S. NAVAL OBSERVATORY CLOCK.

Date.	Daily Rate.	Mean Temp.	O – M	Computed Rate.	O – C
1904.	s.	C.	s.	s.	s.
Feb. 8-11	·019	28·3°	·003	·009	·010
" 11-15	– ·014	28·5	– 030	– ·006	– ·008
" 15-20	·005	28·3	– ·011	– ·002	·007
Mar. 1-4	– ·026	28·2	– ·042	– ·012	– ·014
" 4-9	– ·010	28·2	– ·026	– ·016	·006
" 9 16	·022	28·1	– ·038	– ·018	– ·004
" 16-18	– 043	28·1	– ·059	– ·022	– ·021
" 18-22	– ·022	28·0	– ·038	– ·021	– ·001
" 22-25	– ·029	28·0	– ·045	– ·024	– ·005
" 25-28	·002	27·7	·014	·014	·016
" 28-34	– 007	27·7	– ·023	– ·018	·011
Apl. 3-5	·017	27·4	·001	– ·009	·026
" 5-13	·002	26·9	– ·014	·014	– ·012
" 13-16	·026	26·5	·010	·021	·005
" 16-19	·034	26·3	018	·027	·007
" 19-22	·002	26·4	– ·014	·020	– ·018
" 22-31	·029	25·0	·013	·077	– ·048
May 1-4	·113	24·3	·097	103	·010
" 4-7	·082	24·1	·066	·109	– ·027
" 7-12	·161	24·0	145	·109	·052
Mean.	·016		± ·035		± 015
Range.			·204		·100

Computed rate = ·0161^s – ·00103^s (T – Mar. 29) – ·0456^s (t – 27°·0).

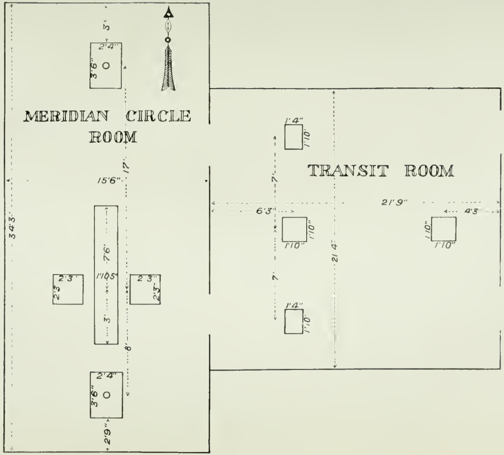

Fig. 1—Floor Plan of Transit Annex.

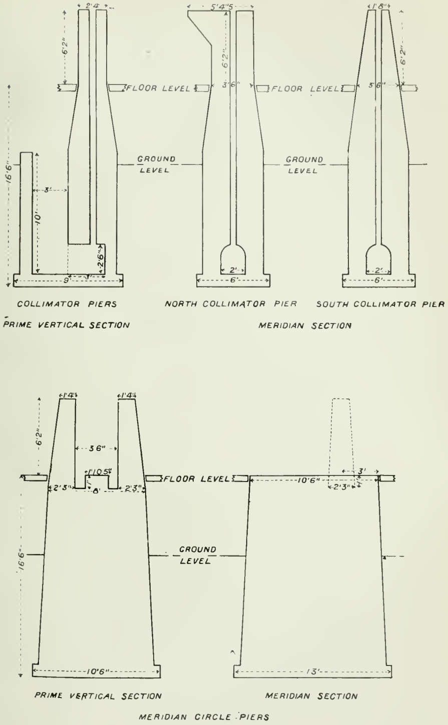

Fig. 2 Piers in Meridian Circle Room.

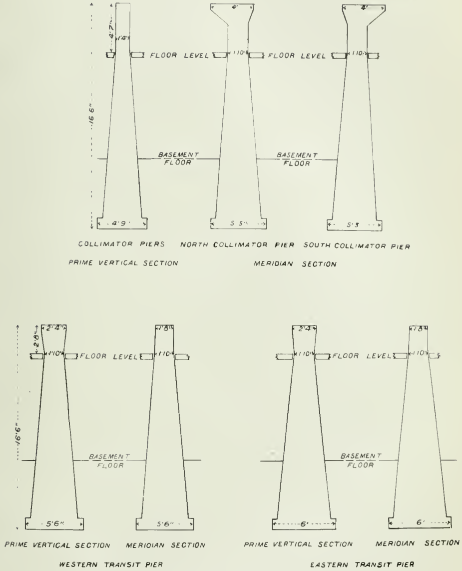

FIG. 3—Piers in Transit Room.

APPENDIX 4.

REPORT OF THE CHIEF ASTRONOMER, 1909.

TABULAR STATEMENT OF LONGITUDE AND LATITUDE OBSERVATIONS.

BY

J. MACARA.

CONTENTS.

MAP.

APPENDIX 4.

TABULAR STATEMENT OF LONGITUDE AND LATITUDE OBSERVATIONS.

DOMINION ASTRONOMICAL OBSERVATORY,
DEPARTMENT OF THE INTERIOR,
OTTAWA, CANADA, March 31, 1909.

W. F. KING, Esq., LL.D., C.M.G.,
Chief Astronomer,
Ottawa.

SIR,—I have the honour to transmit herewith a tabular statement of the differences of longitude and the latitude results of stations observed in 1908. Annexed thereto is also a description of the stations occupied. A synopsis of the statement giving the longitude and latitude of the various stations will be found on page 619.

The accompanying map shows the position of the various astronomical stations established up to the date of this report.

I have the honour to be, sir,
Your obedient servant,

J. MACARA.

DIFFERENCE OF LONGITUDE BETWEEN GATEWAY, B. C. AND SEATTLE.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	*r*.	
1908.	m. s.	m. s.	s.	s.	m. s.	m. s.	m. s.	s.	s.
April 27	28 51·293	28 51·122	1·729	−13·715	28 39·307	28 39·136	28 39·222	023	086
" 28	28 50·397	28 50·210	1·932	−13·073	28 39·256	28 39·069	28 39·163	·036	·094
" 29	28 49·112	28 48·924	2·899	−12 698	28 39·313	28 39·125	28 39·219	·020	·094
May 3	28 45·358	28 45·149	−7·078	−13·142	28 39 294	28 39·085	28 39·190	·009	·105

Observers: { West—W. C. Jaques. / East—F. A. McDiarmid.

	h.	m.	s.
d λ		28	39 199
λ Seattle	8	09	20 274
λ Gateway	7	40	41 075

DIFFERENCE OF LONGITUDE BETWEEN BOUNDARY (WANETA) B.C. AND SEATTLE.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	r.	
1908.	m. s.	m. s.	s.	m. s.	m. s.	m. s.	m. s.	s.	s.
May 13	20 11·550	20 11·400	−12·552	−1 34·781	18 49·321	18 49·171	18 49·246	−·043	·075
" 16	20 14·271	20 14·126	−12·815	−1 37·742	18 49·344	18 49·199	18 49·271	·018	·072
" 22	20 19·838	20 19·671	−13·851	1 44·258	18 49·431	18 49·265	18 49·347	·058	·082
" 25	20 22·901	20 22·747	−15·025	−1 48·534	18 49·392	18 49·238	18 49·315	·026	·077
" 26	20 23·732	20 23·565	−15·338	−1 49·722	18 49·348	18 49·191	18 49·265	−·024	·074

Observers { West—W. C. Jaques.
{ East—F. A. McDiarmid.

	h.	m.	s.
$d\lambda$		18	49·289
λ Seattle	8	09	20·274
λ Boundary	7	50	30·985

DIFFERENCE OF LONGITUDE BETWEEN ST. JOHN, N.B., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	v.	
1908.	m. s.	m. s.	s.	s.	m. s.	m. s.	m. s.	s.	s.
May 13	38 51·225	38 51·121	+2·277	13·412	38 35·836	38 35·735	38 35·785	·001	·050
" 14	38 52·305	38 52·202	+2·377	14·092	38 35·836	38 35·733	38 35·785	·001	·052
" 15	38 54·299	38 54·213	+2·477	16·005	38 35·817	38 35·731	38 35·774	·010	·043
" 16	38 55·284	38 55·193	+2·577	16·911	38 35·796	38 35·705	38 35·751	·034	·046
" 18	38 57·052	38 56·959	+2·777	18·404	38 35·871	38 35·778	38 35·825	·041	·047

Observers: { West—D. B. Nugent, C. C. Smith.
East—C. A. French.

	h.	m.	s.
$d\lambda$		38	35·784
λ Ottawa	5	02	51·797
λ St. John	4	24	16·013

DIFFERENCE OF LONGITUDE BETWEEN SPRAGUE, MAN., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	v.	
1908.	h. m. s.	h. m. s.	m. s.	s.	h. m. s.	h. m. s.	h. m. s.	s.	s.
June 5	1 12 30·467	1 12 30·201	7 05·961	+5·255	1 19 41·683	1 19 41·417	1 19 41·550	·019	·133
" 7	1 12 25·618	1 12 25·337	7 10·843	+5·290	1 19 41·751	1 19 41·470	1 19 41·610	·041	·140
" 9	1 12 24·998	1 12 24·712	7 11·211	+5·457	1 19 41·669	1 19 41·383	1 19 41·526	·043	·143
" 11	1 12 23·721	1 12 23·436	7 12·375	+5·560	1 19 41·656	1 19 41·371	1 19 41·514	·055	·143
" 12	1 12 21·451	1 12 21·127	7 14·767	+5·588	1 19 41·806	1 19 41·482	1 19 41·644	·075	·162

Observers: { West—F. A. McDiarmid.
{ East—C. C. Smith, D. B. Nugent, R. M. Stewart.

	h.	m.	s.
$d\lambda$	1	19	41·569
λ Ottawa	5	02	51·797
λ Sprague	6	22	33·366

DIFFERENCE OF LONGITUDE BETWEEN RAINY RIVER, ONT., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	r	
1908.	h. m. s.	h. m. s	s.	s.	h. m. s.	h. m. s.	h. m. s.	s	s
June 16	1 14 42·762	1 14 42·490	− 35·753	+ 5·743	1 15 24·258	1 15 23·986	1 15 24·122	− ·050	·136
" 19	1 14 36·517	1 14 36·262	− 41·862	+ 5·826	1 15 24·206	1 15 23·951	1 15 24·079	− ·007	·128
" 20	1 14 34·599	1 14 34·327	− 43·661	+ 5·875	1 15 24·135	1 15 23·863	1 15 23·999	·073	·136
" 23	1 14 27·302	1 14 27·004	− 50·737	+ 6·200	1 15 24·237	1 15 23·939	1 15 24·088	− ·016	·149

OBSERVERS { West—F. A. McDIARMID.
East.—R. M. STEWART, D. B. NUGENT, C. C. SMITH.

	h.	m.	s.
$d\lambda$	1	15	24·072
λ Ottawa	5	02	51·797
λ Rainy River	6	18	15·869

DIFFERENCE OF LONGITUDE BETWEEN MONCTON, N.B., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	v	
1908.	m. s.	m. s.	s	s	m s	m s	m s	s	s
May 21....	43 12·893	43 12·741	+ 3·145	+ 32·371	43 42·119	43 41·967	43 42·043	·010	·076
" 22....	43 14·338	43 14·182	+ 3·296	+ 31·090	43 42·132	43 41·976	43 42·054	·001	·078
June 23	43 40·951	43 40·804	+ 6·200	+ 07·334	43 42·085	43 41·938	43 42·012	− ·041	·073
" 25....	43 18·735	43 18·575	+ 6·338	+ 29·762	43 42·159	43 41·999	43 42·079	+ ·026	·080
" 26....	43 08·121	43 07·956	+ 6·419	+ 40·495	43 42·197	43 42·032	43 42·114	+ ·061	·082
" 27....	43 10·311	43 10·185	+ 6·553	+ 38·319	43 42·077	43 41·951	43 42·014	− ·039	·063

	h	m	s
$d\lambda$		43	42·053
λ Ottawa	5	02	51·797
λ Moncton	4	19	09·744

OBSERVERS { West—R. M. STEWART.
C. C. SMITH.
D. B. NUGENT.

" { East—C. A. FRENCH, in May.
W. C. JAQUES, in June.

DIFFERENCE OF LONGITUDE BETWEEN FORT FRANCES, ONT., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	v	
1908.	h m s	h m s	s	s	h m s	h m s	h m s	s	s
June 21	1 10 53·779	1 10 53·544	+15·209	+6·265	1 10 44·835	1 10 44·600	1 10 44·717	·020	·117
" 25	1 10 52·468	1 10 52·230	+13·949	+6·338	1 10 44·857	1 10 44·619	1 10 44·738	·041	·119
" 26	1 10 50·306	1 10 50,055	+11·973	+6·419	1 10 44·752	1 10 44·501	1 10 44·627	·070	·126
" 27	1 10 47·587	1 10 47·306	+ 9·227	+6·553	1 10 44·913	1 10 44·632	1 10 44·772	·075	·140
" 28	1 10 45·209	1 10 44·967	+ 7·120	+6·662	1 10 44·751	1 10 44·509	1 10 44·630	·067	·121

Observers { West—F. A. McDiarmid.
{ East—R. M. Stewart, D. B. Nugent, C. C. Smith.

	h m s
$d\lambda$	1 10 44·697
λ Ottawa	5 02 51·797
λ Fort Frances	6 13 36·494

DIFFERENCE OF LONGITUDE BETWEEN TRURO, N.S., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	v.	
1908.	m s	m s	s	s	m. s.	m. s.	m. s.	s.	s.
June 29	50 07·859	50 07·692	+6·740	−14·346	49 46·773	49 46·606	49 46·690	·064	·084
" 30	50 09·048	50 08·858	+6·829	15·427	49 46·792	49 46·602	49 46·697	·057	·095
July 1	50 10·786	50 10·610	+6·862	−16·976	49 46·948	49 46·772	49 46·860	·106	·088
" 4	50 08·093	50 07·900	+7·044	−14·182	49 46·867	49 46·674	49 46·771	·017	·097

Observers { West—R. M. Stewart, D. B. Nugent, C. C. Smith.
East—W. C. Jaques.

	h	m	s
$d\lambda$		49	46·754
λ Ottawa	5	02	51·797
λ Truro	4	13	05·043

DIFFERENCE OF LONGITUDE BETWEEN NORTH LAKE, ONT., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	v.	
1908.	m. s.	m. s.	s.	s.	m. s.	m. s.	m. s.	s.	s.
July 1	58 10·942	58 10·741	42·692	+6·862	59 00·496	59 00·295	59 00·395	·088	·100
" 2	58 10·603	58 10·390	−42·885	+6·920	59 00·408	59 00·195	59 00·302	−·005	·107
" 3	58 09·864	58 09·653	−43·529	+6·977	59 00·370	59 00·159	59 00·265	−·042	·106
" 3	58 09·547	58 09·327	−43·843	+6·987	59 00·377	59 00·157	59 00·267	·040	·110

Observers { West—F. A. McDiarmid.
East—C. C. Smith, R. M. Stewart.

	h.	m.	s.
dλ		59	00·307
λ Ottawa	5	02	51·797
λ North Lake	6	01	52·104

DIFFERENCE OF LONGITUDE BETWEEN NIPIGON, ONT., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	r.	
1908.	m. s.	m. s.	m. s.	s.	m. s.	m. s.	m. s.		s.
July 6	45 57·114	45 56·886	−4 07·202	+7·110	50 11·126	50 11·198	50 11·312		·111
" 7	45 55·976	45 55·755	−4 08·247	+7·178	50 11·401	50 11·180	50 11·291		·111
" 8	45 54·340	45 54·093	−4 09·833	+7·215	50 11·418	50 11·171	50 11·295		·121

Observers { West—F. A. McDiarmid.
East—C. C. Smith.

	h.	m.	s.
$d\lambda$		50	11·299
λ Ottawa	5	02	51·797
λ Nipigon	5	53	03·096

DIFFERENCE OF LONGITUDE BETWEEN JACKFISH, ONT., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	r.	
1908.	m. s.	m. s.	s.	s.	m. s.	m. s.	m. s.	s.	s.
July 11	45 32·453	45 32·289	+38·013	+7·386	45 01·826	45 01·662	45 01·744	·015	·082
" 12	45 31·514	45 31·294	+37 117	+7·436	45 01·833	45 01·613	45 01 723	·006	·110
" 13	45 30·882	45 30 650	+36·491	+7·444	45 01·835	45 01 603	45 01·719	·010	·146

Observers: { West—F. A. McDiarmid.
{ East —D. B. Nugent, R. M. Stewart.

	h.	m.	s.
$d\lambda$		45	01·729
λ Ottawa	5	02	51·797
λ Jackfish	5	47	53 526

DIFFERENCE OF LONGITUDE BETWEEN HALIFAX, N.S. AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	c.	
1908.	m. s.	m. s.	s.	m. s.	m. s.	m. s.	m. s.	s.	s.
July 23	50 38·372	50 38·124	+7·622	−2 03·504	48 27·246	48 26·998	48 27·122	009	·124
" 24	50 39·629	50 39·434	+7·612	−2 04 785	48 27 232	48 27·037	48 27·134	·021	097
" 26	48 37·904	48 37·715	+7·503	03·220	48 27 181	48 26 992	48 27·087	026	095
" 28	48 39·992	48 39·806	+7·299	05·475	48 27·218	48 27·032	48 27·125	·112	·093
" 29	48 40·655	48 40·495	+7·267	06·211	48 27·177	48 27·017	48 27·097	016	·080

Observers: West—C. C. Smith, D. B. Nugent, R. M. Stewart.
East—W. C. Jaques.

	h.	m.	s.
$d\lambda$		48	27·113
λ Ottawa	5	02	51·797
λ Halifax	4	14	24·684

DIFFERENCE OF LONGITUDE BETWEEN MATHESON, ONT., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	v	s
1908.	m s	m s	m s	s	m s	m s	m s	s	s
July 22	20 16·678	20 16·573	+1 21·354	+7·633	18 59·957	18 59·852	18 59·904	·038	·052
" 23	20 14·991	20 14·809	+1 22·712	+7·622	18 59·901	18 59·719	18 59·810	·056	·091
" 24	20 13·231	20 13·046	+1 20·883	+7·612	18 59·960	18 59·775	18 59·868	·002	·093
" 25	20 11·010	20 10·864	+1 18·585	+7·575	18 60·000	18 59·854	18 59·927	·061	·073
" 26	20 08·557	20 08·389	+1 16·157	+7·503	18 59·903	18 59·735	18 59·819	·047	·084

Observers: West—F. A. McDiarmid.
East { C. C. Smith.
{ R. M. Stewart.

	h	m	s
$d\lambda$		18	59·866
λ Ottawa	5	02	51·797
λ Matheson	5	21	51·663

DIFFERENCE OF LONGITUDE BETWEEN NEWCASTLE, N.B., AND DOMINION OBSERVATORY, OTTAWA.

Date	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	r	
1908.	m s	m s	s	s	m s	m s	m s	s	s
Aug. 3	40 35·246	40 35·107	+ 7·506	+ 6·129	40 33·869	40 33·730	40 33·600	·054	·070
" 9	40 45·090	40 44·932	+ 7·997	− 3·209	40 33·884	40 33·726	40 33·805	·059	·079
" 10	40 46·185	40 45·993	+ 8·061	− 4·361	40 33·763	40 33·571	40 33·667	− ·079	·096
" 11	40 47·287	40 47·113	+ 8·124	− 5·335	40 33·828	40 33·654	40 33·741	− ·005	·087
" 15	40 52·983	40 52·794	+ 8·322	− 10·794	40 33·867	40 33·678	40 33·773	·027	·095
" 16	40 53·190	40 52·995	+ 8·365	− 11·037	40 33·788	40 33·593	40 33·691	− ·055	·098

Observers: West—R. M. Stewart, C. C. Smith, D. B. Nugent.
" East—W. C. Jaques.

	h	m	s
$d\lambda$		40	33·746
λ Ottawa	5	02	51·797
λ Newcastle	4	22	18·051

DIFFERENCE OF LONGITUDE BETWEEN MEGANTIC, QUE., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	v	
1908.	m s	m s	s	m s	m s	m s	m s	s	s
Aug. 4	18 26·404	18 26·271	+7·608	+1 00·937	19 19·733	19 19·600	19 19·677	·048	·077
" 7	18 34·469	18 34·348	+7·790	53·136	19 19·815	19 19·694	19 19·754	·029	·060
" 8	18 36·718	18 36·650	+7·893	51·000	19 19·825	19 19·757	19 19·791	·066	·034
" 9	18 39·347	18 39·204	+7·997	48·432	19 19·782	19 19·639	19 19·710	·015	·071
" 10	18 41·573	18 41·438	+8·060	46·245	19 19·758	19 19·623	19 19·691	·034	·068

Observers : West—R. M. Stewart, C. C. Smith, D. B. Nugent.
East—F. A. McDiarmid.

	h	m	s
$d\lambda$		19	19·725
λ Ottawa	5	02	51·797
λ Megantic	4	43	32·072

DIFFERENCE OF LONGITUDE BETWEEN BLACK LAKE, QUE., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	v	
1908.	m s	m s	s	s	m s	m s	m s		s
Aug. 11	18 30·886	18 30·761	+8·124	−55·479	17 27·283	17 27·158	17 27·221	− ·009	·063
" 14	18 36·997	18 36·838	+8·295	−61·370	17 27·332	17 27·173	17 27·252	·022	·079
" 15	18 38·713	18 38·571	+8·322	−63·085	17 27·306	17 27·164	17 27·235	·005	·071
" 16	18 39·541	18 39·422	+8·365	−63·905	17 27·271	17 27·152	17 27·212	− ·018	·060

Observers: West—D. B. Nugent, C. C. Smith.
East—F. A. McDiarmid.

	h	m	s
$d\lambda$		17	27·230
λ Ottawa	5	02	51·797
λ Black Lake	4	45	24·567

DIFFERENCE OF LONGITUDE BETWEEN FOSTER, QUE., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	r.	
1908.	m. s.	m. s.	s.	s.	m. s.	m. s.	m. s.	s.	s.
Aug. 17	13 34·669	13 34·598	+8·408	−33·484	12 52·777	12 52·706	12 52·742	·011	·036
" 18	13 36·332	13 36·250	+8·413	35·147	12 52·772	12 52·690	12 52·731	·000	·041
" 19	13 37·618	13 37·546	+8·529	36·332	12 52·757	12 52·685	12 52·721	−·010	·036

Observers: West—C. C. Smith, D. B. Nugent.
East—F. A. McDiarmid.

	h.	m.	s.
$d\lambda$		12	52·731
λ Ottawa	5	02	51·797
λ Foster	4	49	59·066

DIFFERENCE OF LONGITUDE BETWEEN BOIESTOWN, N.B., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	v.	
1 08.	m. s.	m. s.	s.	s.	m. s.	m. s.	m. s.	s.	s.
Aug. 20	37 27·414	37 27·220	+8·569	−08·003	37 10·842	37 10·648	37 10·745	−·044	·097
" 21	37 27·398	37 27·220	+8·610	−07·916	37 10·872	37 10·694	37 10·783	·006	·089
" 23	37 29·741	37 29·560	+8·642	−10·154	37 10·945	37 10·764	37 10·854	·065	·090
" 24	37 30·028	37 29·882	+8·718	−10·464	37 10·846	37 10·700	37 10·773	·016	·073

	h.	m.	s.
$d\lambda$		37	10·789
λ Ottawa	5	02	51·797
λ Boiestown	4	25	41·008

Observers: West—D. B. Nugent, C. C. Smith, R. M. Stewart.
East—W. C. Jaques.

DIFFERENCE OF LONGITUDE BETWEEN WOODSTOCK, N.B. AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	v.	
1908.	m. s.	m. s.	s.	m. s.	m. s.	m. s.	m. s.	s.	s.
Aug. 23	28 32·513	28 32·280	+8·642	+4 09·028	32 32·899	32 32·666	32 32·783	·005	·117
" 24	28 33·234	28 33·028	+8·717	+4 08·377	32 32·894	32 32·688	32 32·791	·013	·103
" 25	28 33·843	28 33·620	+8·778	+4 07·806	32 32·871	32 32·648	32 32·760	·018	·112

Observers: { West—R. M. Stewart, C. C. Smith, D. B. Nugent.
{ East—F. A. McDiarmid.

	h.	m.	s.
d λ		32	32·778
λ Ottawa	5	02	51·797
λ Woodstock	4	30	19·019

DIFFERENCE OF LONGITUDE BETWEEN ST. HYACINTHE, QUE. AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	v.	
1908.	m. s.	m. s.	s.	m. s.	m. s.	m. s.	m. s.	s.	s.
Aug. 27	12 37·653	12 37·580	+8·804	1 21·387	11 07·462	11 07·389	11 07·426	·031	·037
" 28	12 38·816	12 38·748	+8·807	1 22·530	11 07·479	11 07·411	11 07·445	·012	·034
" 30	12 42·103	12 42·036	+8·837	1 25·733	11 07·533	11 07·466	11 07·499	·012	·033

Observers: { West—D. B. Nugent, C. C. Smith, R. M. Stewart.
{ East—F. A. McDiarmid.

	h.	m.	s.
$d\lambda$		11	07·457
λ Ottawa	5	02	51·797
λ St. Hyacinthe	4	51	44·340

DIFFERENCE OF LONGITUDE BETWEEN FREDERICTON, N.B., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	ϵ.	
1908.	m. s.	m. s.	s.	s.	m. s.	m. s.	m. s.	s.	s.
Aug. 28	36 24·603	36 24·438	+8·807	+2·544	36 18·340	36 18·175	36 18·258	·040	·083
" 29	36 25·485	36 25·327	+8·822	+1·597	36 18·260	36 18·102	36 18·181	·037	·079
" 30	36 26·489	36 26·370	+8·837	+0·615	36 18·267	36 18·148	36 18·207	·011	·059
" 31	36 27·449	36 27·300	+8·876	0·335	36 18·238	36 18·089	36 18·164	·054	·075
Sept. 1	36 28·746	36 28·598	+8·914	1·469	36 18·363	35 18·215	36 18·289	·071	·074
" 3	36 31·437	36 31·304	+8·989	4·171	36 18·277	36 18·144	36 18·211	·007	·067

Observers: West—C. C. Smith, D. B. Nugent, R. M. Stewart.
East—W. C. Jaques.

	h.	m.	s.
$d\lambda$		36	18·218
λ Ottawa	5	02	51·797
λ Fredericton	4	26	33·579

DIFFERENCE OF LONGITUDE BETWEEN SOREL, QUE., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	r.	
1908.	m. s.	m. s.	s.	s.	m. s.	m. s.	m. s.		s.
Aug. 31	10 35·736	10 35·677	+8·876	2·701	10 24·159	10 24·100	10 24·130	....	·030
Sept. 1	10 37·509	10 37·467	+8·914	4·473	10 24·122	10 24·080	10 24·101	....	·031
" 2	10 39·562	10 39·513	+8·951	6·494	10 24·117	10 24·068	10 24·093	....	·025
" 3	10 40·755	10 40·733	+8·989	7·661	10 24·105	10 24·083	10 24·094	....	·011

Observers: West—C. C. Smith, D. B. Nugent.
East—F. A. McDiarmid.

	h.	m.	s.
$d\lambda$		10	24·107
λ Ottawa	5	02	51·797
λ Sorel	4	52	27·690

DIFFERENCE OF LONGITUDE BETWEEN ST. JEROME, QUE., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	r.	
1908.	m. s.	m. s.	s.	s.	m. s.	m. s.	m. s.	s.	s.
Sept. 4	7 13·199	7 13·091	+ 9·052	−12·194	6 51·953	6 51·845	6 51·899	·084	·054
" 5	7 14·187	7 14·070	+ 9·078	−13·087	6 52·022	6 51·905	6 51·963	·020	·058
" 6	7 16·010	7 15·890	+ 9·081	−14·781	6 52 148	6 52·028	6 52·088	·105	·060

Observers: West—C. C. Smith, D. B. Nugent, R. M. Stewart.
East —F. A. McDiarmid.

	h.	m.	s.
$d\lambda$		06	51·983
λ Ottawa	5	02	51·797
λ St. Jerome	4	55	59·814

DIFFERENCE OF LONGITUDE BETWEEN RIVIERE DU LOUP STATION., QUE., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	v.	
1908.	m. s.	m. s.	s.	s.	m. s.	m. s.	m. s.	s.	s.
Sept 8	24 57·951	24 57·827	+ 9·192	− 03·086	24 45·673	24 45·549	24 45·611	− ·024	·062
" 9	24 58·218	24 58·117	+ 9·256	− 03·237	24 45·725	24 45·624	24 45·674	·039	·050
" 10	25 00·319	25 00·211	+ 9·320	− 05·236	24 45·763	24 45·655	24 45·709	·074	·054
" 11	25 01·650	25 01·557	+ 9·383	− 06·574	24 45·693	24 45·600	24 45·647	·012	·047
" 12	25 02·291	25 02·175	+ 9·388	− 07·258	24 45·645	24 45·529	24 45·587	− ·048	·058
" 13	25 03·561	25 03·428	+ 9·437	− 08·478	24 45·646	24 45·513	24 45·580	− ·055	·067

Observers: West — D. B. Nugent, C. C. Smith.
East — W. C. Jaques.

	h.	m.	s.
$d\lambda$		24	45·635
λ Ottawa	5	02	51·797
λ Rivière du Loup Station	4	38	06·162

DIFFERENCE OF LONGITUDE BETWEEN EDMUNDSTON, N.B., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	r.	
1908.	m. s.	m. s.	s	s.	m. s.	m. s.	m. s.	s.	s.
September 19	29 16·621	29 46 516	+9 680	03·297	29 33·647	29 33·539	29 33·593	·073	054
" 20	29 44·051	29 43·950	+9·627	-00·708	29 33·716	29 33·615	29 33·665	-001	·050
" 22	29 42·765	29 42·696	+9·664	+00·621	29 33·722	29 33·653	29 33·687	·021	034
" 23	29 42·736	29 42·645	+9·678	+00 706	29 33·761	29 33·673	29 33·718	052	·045

Observers: West—D. B. Nugent, R. M. Stewart, C. C. Smith.
East—W. C. Jaques.

	h.	m.	s.
$d\lambda$		29	33 666
λ Ottawa	5	02	51·797
λ Edmundston	4	33	18·131

DIFFERENCE OF LONGITUDE BETWEEN PERCÉ, QUE., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	v.	
1908.	m. s.	m. s.	s.	s.	m. s.	m. s.	m. s.	s.	s.
October 5	46 00·841	46 00·632	+10·060	+8·512	45 59·303	45 59·094	45 59·199	·017	·105
" 6	46 00·161	45 59·955	+10·072	+9·215	45 59·304	45 59·098	45 59·201	·019	·103
" 7	45 59·666	45 59·456	+10·078	+9·664	45 59·252	45 59·042	45 59·147	·035	·105

Observers: West—C. C. Smith, D. B. Nugent.
East—W. C. Jaques.

	h.	m.	s.
$d\lambda$		45	59·182
λ Ottawa	5	02	51·797
λ Percé	4	16	52·615

DIFFERENCE OF LONGITUDE BETWEEN CAMPBELLTON, N.B., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	r	
1908.	m s	m s	s	s	m s	m s	m s	s	s
Oct. 10	36 42·680	36 42·550	+ 42·351	+ 9·842	36 10·171	36 10·041	36 10·106	·057	·065
" 12	35 56·874	35 56·700	00·392	+ 13·711	36 10·193	36 10·019	36 10·106	·057	·087
" 13	35 54·320	35 54·149	00·407	+ 16·422	36 10·335	36 10·164	36 10·250	·087	·086
" 14	35 53·985	35 53·808	00·400	+ 16·753	36 10·278	36 10·101	36 10·189	·026	·088

Observers: West—C. C. Smith, R. M. Stewart, D. B. Nugent.
East.—W. C. Jaques.

	h	m	s
$d\lambda$		36	10·163
λ Ottawa	5	02	51·797
λ Campbellton	4	26	41·634

LONGITUDE AND LATITUDE OF STATIONS OBSERVED IN 1908.

Place.	Difference of Longitude.	To	Longitude.	Longitude	Latitude.
	h. m. s.		h. m. s.	° ′ ″	° ′ ″
Gateway	28 39·199	Seattle	7 40 41·075	115 10 16·13	48 59 58·45
Boundary (Waneta)	18 49·289	"	7 50 30·985	117 37 44·78	49 00 00·55
St. John	38 35·784	Dominion Observatory	4 24 16·013	66 04 00·20	45 16 35·04
Sprague	1 19 41·569	" "	6 22 33·366	95 38 20·49	49 02 05·10
Rainy River	1 15 24·072	" "	6 18 15·869	94 33 58·04	48 43 22·80
Moncton	43 42·053	" "	4 19 09·744	64 47 26·16	46 05 02·21
Fort Frances	1 10 44·697	" "	6 13 36·494	93 24 07·41	48 36 48·59
Truro	49 46·754	" "	4 13 05·043	63 16 15·65	45 21 47·32
North Lake	59 00·307	" "	6 01 52·104	90 28 01·56	48 08 28·77
Nipigon	50 11·299	" "	5 53 03·096	88 15 46·44	49 00 43·75
Jackfish	45 01·729	" "	5 47 53·526	86 58 22·89	48 47 44·84
Halifax	48 27·113	" "	4 14 24·684	63 36 10·26	44 40 07·52
Matheson	18 59·866	" "	5 21 51·663	80 27 54·95	48 32 07·23
Newcastle	40 33·746	" "	4 22 18·051	65 34 30·77	47 00 11·37
Megantic	19 19·725	" "	4 43 32·072	70 53 01·08	45 34 32·80
Black Lake	17 27·230	" "	4 45 24·567	71 21 08·51	46 02 44·59
Foster	12 52·731	" "	4 49 59·066	72 29 45·99	45 17 14·63
Boiestown	37 10·789	" "	4 25 41·008	66 25 15·12	46 27 18·52
Woodstock	32 32·778	" "	4 30 19·019	67 34 45·29	46 08 33·28
St. Hyacinthe	11 07·457	" "	4 51 44·340	72 56 05·10	45 37 15·28
Fredericton	36 18·218	" "	4 26 33·579	66 38 23·69	45 57 41·30
Sorel	10 24·107	" "	4 52 27·690	73 06 55·35	46 02 19·59
St. Jerome	6 51·983	" "	4 55 59·814	73 59 57·21	45 46 33·29
Riviere du Loup Station	24 45·635	" "	4 38 06·162	69 31 32·43	47 49 23·48
Edmundston	29 33·666	" "	4 33 18·131	68 19 31·97	47 22 06·65
Percé	45 59·182	" "	4 16 52·615	64 13 09·23	48 30 52·05
Campbellton	36 10·163	" "	4 26 41·634	66 40 24·51	48 00 31·33

LOCAL POSITIONS OF ASTRONOMICAL STATIONS.

Gateway.—The pier is on the international boundary line 189·4 feet due east of boundary monument No. 244, and is 541·3 feet west of United States survey post No. 25104 on boundary line.

Boundary (Waneta).—The pier is 24·5 feet due east of monument No 181 on the international boundary line.

St. John.—The pier is 82 feet north and 174 feet west of the northeast corner of Lombard and Southwork streets. Reference point is southeast corner of I.C.R. grain elevator. Reference angle 188°·44 right from meridian at centre of pier to reference point. Distance, 196·8 feet.

Sprague.—The pier is 670·7 feet west and 1·4 feet north of the southwest corner of the Canadian Northern Railway station house.

Rainy River.—The pier is 111.2 feet north, and 51·3 feet west of the southwest corner of 3rd street and Atwood ave.

Moncton.—Reference point is the northwest corner of the Intercolonial Railway blacksmith shop. N. 52° 16′ E. from meridian through centre of pier. Distance, 1·378 chains.

Fort Frances.—The pier is 9·7 feet north and 189·2 feet east of the northeast corner of 4th street and Cornwall ave.

Truro.—The pier is 49·49 feet east and 64·13 feet south of gas-pipe marking the boundary of the I.C.R. yard at head of Miller street and Mr. Fraser's gate.

North Lake.—The pier is 272·5 feet east and 15·5 south of 'frog' lying between the Port Arthur and Duluth Railway main line and the southwest leg of the 'Y.'

Nipigon.—The pier is 47·8 feet west and 82·4 feet north of the northwest corner of the Canadian Pacific Railway station house.

Jackfish.—The pier is 228·5 feet north and 82·9 feet west of the southwest corner of the Canadian Pacific Railway station house.

Halifax.—The pier is 127·26 feet east and 90·38 feet north of the southeast corner of Creighton & Co.'s grocery store. It is also 63·23 feet east and 54·04 feet south of the gas pipe marking the boundary of the I.C.R. yard. Direction of said pipe from pier being 54° 15′ from the meridian measured from the north through the west.

Matheson.—The pier is on the right of way of the Timiskaming and Northern Ontario Railway, and is 153·5 feet south and 178·0 feet east of the northeast corner of 5th ave. and Railway street.

Newcastle.—The pier is 14·16 feet east and 90·66 feet south of the intersection of Station and Gene streets.

Megantic.—The pier is 172·5 feet east and 72·6 feet north of the southwest corner of Maple ave. and McCauley street.

Black Lake.—The pier is 111·1 feet east and 190·8 feet north of the northwest corner of Whitney ave. and the private way of the American Asbestos Company.

Foster.—The pier is 181·5 feet north and 480·3 feet west of the middle point of the crossing of the Boltôn Road and the Canadian Pacific Railway main line (Foster crossing). The pier is about 80 feet north of the Canadian Pacific Railway station house.

Boiestown.—The pier is 41·63 feet east and 90·87 feet north from the northeast corner of T. Lynch & Co.'s supply store.

Woodstock.—The pier is 432·5 feet east and 100 feet south of the northeast corner of George and Main streets.

St. Hyacinthe.—The pier is 85 feet east and 546 feet north of the middle point of the crossing of Broadway Road and the Canadian Pacific Railway main line, and is about 400 feet from the station house.

Fredericton.—The pier is on the river front 52·15 feet north and 67·0 feet west of the northwest corner of Lamont's furniture warehouse at the corner of Regent and Campbell streets.

Sorel.—The pier is 194·9 feet west and 34·2 feet north of the southeast corner of Ray and Victoria streets.

St. Jerome.—The pier is 412·0 feet east and 102·4 feet south of the southeast corner of St. Antoine and St. Anne streets. It is on the Canadian Pacific Railway right of way about 400 feet south of the station house.

Rivière du Loup Station.—The pier is 511·5 feet from the southeast corner of the I.C.R. machine shop. Angle from the north through the west 41° 54′.

Edmundston.—The pier is 148·30 feet east and 12·04 feet north of the northeast corner of Temiscouata Railway station.

Percé.—The pier is 84·63 feet west and 72·28 feet south of the southwest corner of Abraham Lenfesty's house.

Campbellton.—The pier is 18·27 feet east and 12·41 feet south of the southeast corner of the post office building.

Dominion Observatory.—The reference point of the longitudes observed in 1908 is a temporary transit house, the meridian of which is $0^s{\cdot}12$ east of the centre of the dome of the Observatory.