C. *The Obſervations of the internal Contact of* Venus *with the* Sun's *Limb, in the late Tranſit, made in different Places of* Europe, *compared with the Time of the ſame Contact obſerved at the* Cape of Good Hope, *and the Parallax of the* Sun *from thence determined. By* James Short, *A. M. F. R. S.*

Read Dec. 9, 1762.

IN the ſummer of the year 1760, the Royal Society reſolved to ſend ſome proper perſons to proper places of the globe, in order to obſerve the tranſit of Venus, which was to happen on the 6th of June, 1761. In conſequence of this reſolution, they appointed meſſieurs Maſkelyne and Waddington to go to the iſland of St. Helena, and meſſieurs Maſon and Dixon to go to Bencoolen, a ſettlement belonging to the Eaſt India Company, on the iſland of Sumatra. Two reflecting teleſcopes of 2 feet focal length each, with an object glaſs micrometer of 40 feet focus adapted to one of them, an aſtronomical clock, and an equal-altitude inſtrument were ordered, by the ſociety, for each of thoſe places. The munificence of his late and preſent Majeſty, patrons of the Royal Society, defrayed the expence.

Mr. Maſkelyne and his aſſiſtant arrived at St. Helena in the month of April 1761; but Mr. Maſon and his aſſiſtant, being detained at Plymouth by an accident, on their arrival at the Cape of Good Hope in the month of April 1761, found it was too late

to

to reach Bencoolen, and therefore resolved to stay at the Cape, and to make their observations there; and it was extremely fortunate they did so, for, by reason of cloudy weather, Mr. Maskelyne was hindered from making the proper observations, and in that case, the observation of the internal contact at the egress at Bencoolen, when compared with the same observation at Greenwich, could have determined nothing with regard to the parallax of the Sun.

To determine the parallax of the Sun, by means of the observations of the internal contact of Venus with the Sun's limb, made at two different places, it is absolutely necessary that the difference of longitude between these two places be exactly determined. For this purpose Mr. Mason applied himself assiduously to observe the eclipses of Jupiter's satellites, and Mr. Green, the assistant observer at Greenwich, observed as many of the same eclipses, as the unfavourable season would allow. Dr. Bevis and myself likewise observed the same eclipses in Surry-Street, London. The insufficiency of these sort of observations in determining the longitude of places, where accuracy is required, is well known to those who have the practice of them.

By comparing the observations of the first and second satellites made at the Cape with those made in Surry-Street *, the difference of longitude between Greenwich and the Cape, comes out, on a mean, $= 1^h\ 13'\ 30''$, and rejecting those of the second satellite, which are always more uncertain than those of the first, I fix the difference of longitude between Greenwich and the Cape of Good Hope $= 1^h\ 13'\ 35''$, which I have made use of in the following computations.

* Vid. Phil. Transf. vol. LII. part I.

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In order to aſcertain the Sun's parallax, with more certainty, I have compared the obſervation of the internal contact at the egreſs at the Cape, with the obſervations of the ſame contact made at fifteen different places in Europe. But, before I proceed any farther, I ſhall mention the times of ſuch obſervations, from whence I had them; and the longitudes of thoſe places, and from whence I likewiſe had thoſe.

Internal Contact at	h	′	″			h	′	″	
Greenwich - at -	8	19	0	from Phil. Tranſ.	Longitude from the Cape =	1	13	35	W. from Phil Tranſact.
Shirburn Caſt. at	8	15	10	from ditto - - - - -	from Greenwich =	0	4	1	W. from ditto.
	8	15	14						
Savile-Houſe - at	8	18	22	from ditto - - - - -	from Greenwich =	0	0	30	W. from ditto.
Leſkeard - - at	8	0	21	from ditto - - - - -	from Greenwich =	0	18	32	W. from ditto.
Paris - - - at	8	28	25	from ditto - - - - -	from Greenwich =	0	9	10	E. from Conn. des Tems.
	8	28	29						
Bologna - - at	9	4	54	from ditto - - - - -	from Paris - - =	0	36	5	E. from ditto.
	9	5	0						
Rome - - - at	9	9	36	from a private letter - - -	from Paris - - =	0	40	37	E. from ditto.
Drontheim - at	9	1	49	from a private letter - - -	from Greenwich =	0	43	58	E. from a private letter.
Upſal - - - at	9	28	3	from Phil. Tranſ. - - -	from Paris - - =	1	1	10	E. from Phil. Tranſ.
	9	28	9						
Stockolm - - at	9	30	8	from ditto - - - - -	from Paris - - =	1	3	10	E. from Conn. des Tems.
	9	30	11						
Hernoſand - at	9	28	52	from Swediſh acts - - -	from Paris - - =	1	2	12	E. from Phil. Tranſ.
Calmar - - at	9	23	40	from ditto - - - - -	from Stockolm =	0	6	27	W. from Swediſh acts,
Abo - - at *	9	45	59	from Phil. Tranſ. - - -	from Paris - - =	1	19	17	E. from Phil. Tranſ.
Tornea - - at	9	54	8	from ditto - - - - -	from Paris - - =	1	27	28	E. from ditto.
Cajaneburg - at	10	8	59	from Swediſh acts - - -	from Stockolm =	0	39	20	E. from Swediſh acts.
Cape of G. Hope at	9	39	48	from Phil. Tranſ. - - -	from Greenwich =	1	13	35	E. from Phil. Tranſ.
	9	39	52						

As there were ſeveral obſervers at ſome places, I have therefore ſet down the two extreme obſervations, that I may afterwards take the mean of them.

One reaſon, I apprehend, why the obſervers, even at the ſame place, differ ſome ſeconds in the time of the contact, may ariſe from this, that ſome of them

* In the Phil. Tranſactions it is at $9^h\ 46'\ 59''$, but that this is a miſtake, in writing down the minutes, may be eaſily proved.

judged

judged of the contact when there was no light between the limb of Venus and that of the Sun, others did not imagine the contact to happen, till they lost a part of the circumference of Venus: I shall therefore set down the difference between the observers, at the same place, that an estimate may be formed of the limit of this error.

Observers at Greenwich	3	Difference in observation	= 0″.
at Bologna	4		= 6.
* at Paris	6		= 16.
at Sherburn Castle	2		= 4.
at Cambridge	2		= 7.
at Stockolm	2		= 3.
at Upsal	3		= 6.
at Tornea	2		= 14.
at Cape of G. Hope	2		= 4.
at Carlscrona	2		= 6.

The mean, therefore, of all these comes out to be $= 6''$, 6, an error that may be committed in judging of the contact, even at the same place.

After having computed the parallaxes of longitude and latitude, on the supposition that the Sun's parallax was $= 8''\frac{1}{2}$, for each of the above places, I compared the observation at each place with the observation at the Cape of Good Hope, and deduced the Sun's parallax from each, as may be seen more fully in the following table.

* M. de la Lande, in a letter to Mr. Maskelyne, says that M. de la Caille observed with a Telescope of Mr. Dolland's construction, which was not well fitted up; it may, therefore, be presumed that there is some mistake in the observation of M. Maraldi, because his observation is later than that of M. de la Caille, and differs so considerably from the rest.

I.

1.

h ′ ″		′ ″		
9 39 50	Cape	6 8	Cape.	
1 13 35	= D. M.	1 11	Greenwich.	
8 26 15		7 19		
8 19 0	Greenwich			− 4″
7 15				

Sun's parallax = 8″, 42

2.

h ′ ″		′ ″		
9 39 50	Cape	6 8	Cape.	
1 17 36	= D. M.	1 12	Shirburn.	
8 22 14		7 20		
8 15 12	Shirburn			− 18″
7 2				

Sun's parallax 8″, 15

3.

h ′ ″		′ ″		
9 39 50	Cape.	6 8	Cape.	
1 14 5	= D. M.	1 11	Savile-house.	
8 25 45		7 19		
8 18 22	Savile-house			+ 4″
7 23				

Sun's parallax = 8″, 57

4.

h ′ ″		′ ″		
9 39 50	Cape	6 8	Cape.	
1 32 7	= D. M.	1 4	Leskeard.	
8 7 43		7 12		
8 0 21	Leskeard			+ 10″
7 22				

Sun's parallax = 8″, 69

5.

h ′ ″		′ ″		
9 39 50	Cape	6 8	Cape.	
1 4 25	= D. M.	54	Paris.	
8 35 25		7 2		
8 28 27	Paris			− 4″
6 58				

Sun's parallax = 8″, 42

6.

h ′ ″		′ ″		
9 39 50	Cape	6 8	Cape.	
0 28 20	= D. M.	29	Bologna.	
9 11 30		6 37		
6 4 57	Bologna			− 4″
6 33				

Sun's parallax = 8″, 41

7.

h ′ ″		′ ″		
9 39 50	Cape	6 8	Cape.	
0 23 48	= D. M.	13	Rome.	
9 16 2		6 21		
9 9 36	Rome			+ 5″
6 26				

Sun's parallax = 8″, 61

8.

h ′ ″		′ ″		
9 39 50	Cape	6 8	Cape.	
0 29 32	= D. M.	2 38	Drontheim.	
9 10 18		8 46		
9 1 49	Drontheim			− 17″
8 29				

Sun's parallax = 8″, 23

9.

h ′ ″		′ ″		
9 39 50	Cape	6 8	Cape.	
0 3 15	= D. M.	2 21	Upsal.	
9 36 35		8 29		
9 28 6	Upsal			− 0″
8 29				

Sun's parallax = 8″, 50

10.

h ′ ″		′ ″		
9 39 50	Cape	6 8	Cape.	
0 1 15	= D. M.	2 18	Stockolm.	
9 38 35		8 26		
9 30 10	Stockolm			− 1″
8 25				

Sun's parallax = 8″, 48

11.

h ′ ″		′ ″		
9 39 50	Cape	6 8	Cape	
0 2 13	= D. M.	2 26	Hernosand.	
9 37 37		8 34		
9 28 52	Hernosand			+ 11″
8 45				

Sun's parallax = 8″, 68

12.

h ′ ″		′ ″		
9 39 50	Cape	6 8	Cape.	
0 7 42	= D. M.	1 59	Calmar.	
9 32 8		8 7		
9 23 40	Calmar			+ 21″
8 28				

Sun's parallax = 8″, 86

13.

h ′ ″		′ ″		
9 39 50	Cape	6 8	Cape.	
0 14 52	= D. M.	2 30	Abo.	
9 54 42		8 38		
9 45 59	Abo			− 5″
8 43				

Sun's parallax = 8″, 58

14.

h ′ ″		′ ″		
9 39 50	Cape	6 8	Cape	
0 23 3	= D. M.	3 5	Tornea.	
10 2 53		9 13		
9 54 8	Tornea			+ 28″
8 45				

Sun's parallax = 8″, 07

15.

h ′ ″		′ ″		
9 39 50	Cape	6 8	Cape.	
0 38 5	= D. M.	2 59	Cajaneburg.	
10 17 55		9 7		
10 8 59	Cajaneburgh			+ 11″
8 56				

Sun's parallax = 8″, 33

 I shall

I ſhall explain this table by the example of the obſervation at Greenwich compared with the obſervation at the Cape, which is the firſt in the table.

9^h 39′ 50″ is the mean of the times of the internal contact obſerved at the Cape, 1^h 13′ 35″ is the difference of longitude between Greenwich and the Cape, this being ſubſtracted from the time of the obſerved contact at the Cape, leaves 8^h 26′ 15″ for the time the obſervers at Greenwich ſhould have ſeen the contact, if there had been no parallax of Venus; ſubtracting therefore the time of the obſerved contact at Greenwich from this time, the remainder, 7′ 15″ is the effect of the parallaxes of longitude and latitude at the two places of obſervation. But the effect of theſe two parallaxes at the Cape, on the ſuppoſition of the Sun's parallax being = 8″ $\frac{1}{2}$, is = 6′ 8″, by which quantity of time the obſervers at the Cape ſhould have ſeen the internal contact later than at the center of the earth: and the effect of the ſame parallaxes at Greenwich is = 1′ 11″, by which quantity of time the obſervers at Greenwich ſhould have ſeen the internal contact ſooner than at the center of the earth. The ſum therefore of theſe two quantities is = 7′ 19″, by which quantity of time the obſervers at Greenwich ſhould have ſeen the internal contact ſooner than the obſervers at the Cape in abſolute time, had the Sun's parallax been = 8″ $\frac{1}{2}$. But the difference in abſolute time as found by obſervation, as above, is only = 7′ 15″, therefore the Sun's parallax, by ſuppoſition, viz. 8″, 5, is to the parallax of the Sun found by obſervation, as 7′ 19″ is to 7′ 15″, which gives 8″, 42 for the Sun's parallax, on the day of the tranſit, by this obſervation, which

which numbers and refult are fet down in number 1ft. and fo of all the reft in the table.

By taking a mean of the refults of thefe fifteen obfervations, the parallax of the Sun, on the day of the tranfit, comes out = 8″, 47, and by rejecting the 2d, the 8th, the 12th, and 14th refults, which differ the moft from the reft, the Sun's parallax, on the day of the tranfit, by the mean of the eleven remaining ones is = 8″, 52.

We have received from Sweden feveral obfervations of the total duration of the tranfit from the internal contact at the ingrefs to the internal contact at the egrefs, and alfo the obfervation of the fame duration by M. Chappe at Tobolfk in Siberia, and by feveral perfons in the Eaft Indies: but the differences between thefe durations are too fmall to determine with any accuracy, the Sun's parallax from them, by comparing the duration at one place with the duration at another place. The greateft difference between them, and the duration at Tobolifk (which is the leaft) amounting only to 2′ 50″, and the leaft difference amounting only to 1′ 4″: in which fmall quantities the unavoidable errors of obfervation muft bear a confiderable proportion, and yet by comparing fifteen total durations obferved at different places with the total duration obferved at Tobolfk, I find the following refults of the Sun's parallax from each of them.

Cajaneburg

		″		
Cajaneburg	=	9	50	
Calmar - -	=	9	00	
Calcutta - -	=	9	50	
Hernosand	=	9	50	
Abo - - -	=	8	75	
Stockolm -	=	11	00	—
Stockolm -	=	10	75	—
Upsal - - -	=	7	25	
Upsal - - -	=	6	70	
Upsal - - -	=	9	00	
Tornea - -	=	12	00	—
Tornea - -	=	14	00	—
Madrass -	=	9	70	
G. Mount -	=	8	50	
Tranquebar	=	8	75	

The mean of these fifteen results gives the Sun's parallax $= 9'', 56$; and if we reject four of them, which differ the most from the rest, the mean, of the remaining eleven, gives the sun's parallax $= 8'', 69$.

However, on calculation by another method, I find so great an agreement between them, on the supposition that the Sun's parallax is $= 8'' \frac{1}{2}$, that I have determined the Sun's parallax from them also, as a corroboration of the Sun's parallax being very nearly the same as found by the observations of the internal contact; and this is done in such a manner that each observation of the total duration, at any one place, determines the Sun's parallax independent of any observation of the same duration made at any other place, and in which an exact knowledge of the longitude, of the latitude, and of the time at the place of observation is not required; all that is necessary to be known is the time of duration from the internal contact at the ingress, to the internal contact at the egress, and that the clock moved equably during the interval of the contacts, and that the leaſt diſtance of the centers of the Sun and Venus, as ſeen from the center of the earth, is alſo known.

The method I have followed, in this enquiry, was by finding the total duration at the center of the earth: in order to find this, it was neceſſary to know the leaſt diſtance of the centers of the Sun and Venus as ſeen from the center of the earth. By the meaſurements of the diſtance of the limb of Venus from the Sun's limb taken at Savile-Houſe, and alſo by the like meaſurements taken by Mr. Haydon at Leſkeard, I found, on the above ſuppoſition of the Sun's parallax, that the leaſt diſtance of the centers, as ſeen from the center of the earth, was $= 9' 32''$. The total duration, therefore, at the center of the earth was $5^h 58' 1''$. I have compared the ſeveral obſervations of the total duration with this central duration, and from each I have determined the Sun's parallax, as may be ſeen more fully in the following table. I have inſerted in this table the alteration of duration by one ſecond of the Sun's parallax at each place, by which may be ſeen the quantity of error in the determination of the Sun's parallax ariſing from any quantity of error in the obſervation.

The times of the total duration at thoſe different places I have taken from the Phil. Tranſactions; only thoſe of Calmar and Cajaneburg I have taken from the Sweediſh acts; the internal contact at the ingreſs at Cajaneburgh, in thoſe acts, is at $4^h 18' 5''$, whereas it ſhould be at $4^h 19'' 5''$, as may be eaſily proved, this being an error in writing down the minutes, which has happened more than once in theſe obſervations, occaſioned by the hurry of writing down the times of the obſervations. The obſervations in the

East

East Indies I have taken from letters sent by the East India Company to the Royal Society. I have also been obliged to make a correction of the minutes in the observation at Tranquebar and at the Grand Mount, a place about 8 miles to the S. West of Madrass.

1. Cajaneb.	2. Calmar.	3. Calcutta.	4. Hernos.	5. Abo.	6. Tobolsk.	7. Stockolm	8. Stockolm	
′ ″	h ′ ″	h ′ ″	h ′ ″	h ′ ″	h ′ ″	h ′ ″	h ′ ″	
5 58 1	5 58 1	5 58 1	5 58 1	5 58 1	5 58 1	5 58 1	5 58 1	= Duration at the centre of the earth.
8 5	7 21	7 30	7 36	7 46	9 3	7 34	7 34	= Effect of parallaxes, from a parallax of 8″, 5.
5 49 56	5 50 40	5 50 31	5 50 25	5 50 15	5 48 58	5 50 27	5 50 27	= Duration from a parallax of 8″, 5 of the Sun.
5 49 54	5 50 39	5 50 36	5 50 26	5 50 9	5 48 50	5 50 45	5 50 42	= Duration observed.
— 2	— 1	+ 5	+ 1	— 6	— 8	+ 18	+ 15	= Diff. of observation and a parallax of 8″, 5.
9° 48′	0° 44	39° 30′	4° 4′	5° 43′	26° 50′	3° 24′	3° 24′	= altitude of the Sun at ingress without refraction.
57″	52′	53,	54″	55″	64″	54″	54″	— Alteration of Duration by 1″ of ☉s parallax.
8″, 53	8″, 52	8″, 40	8″, 48	8″, 61	8″, 63	8″, 16	8″, 22	— Parallax of the sun from the observation.

9. Upsal.	10. Upsal.	11. Upsal.	12. Tornea.	13. Tornea.	14. Madrass.	15. G.Mount	16. Tranqueb	
h ′ ″	h ′ ″	h ′ ″	h ′ ″	h ′ ″	h ′ ″	h ′ ″	h ′ ″	
5 58 1	5 58 1	5 58 1	5 58 1	5 58 1	5 58 1	5 58 1	5 58 1	— Duration at the center of the earth.
7 33	7 33	7 33	8 7	8 7	6 33	6 33	6 24	— Effect of parallaxes, from a parallax of 8″, 5.
5 50 28	5 50 28	5 50 28	5 49 54	5 49 54	5 51 28	5 51 28	5 51 37	— Duration from a parallax of 8″, 5 of the sun.
5 50 7	5 50 2	5 50 26	5 50 9	5 50 21	5 51 43	5 51 20	5 51 33	— Duration observed.
— 21	— 26	— 2	+ 15	+ 27	+ 15	— 8	— 4	— Diff. of observation and a parallax of 8″, 5.
3° 29	3° 29′	3° 29′	9° 33′	9° 33′	29° 27′	29° 25′	28° 44′	= Altitude of the ☉ at ingress without refraction.
54″	54″	54″	57″	57″	46″	46″	45″	= Alteration of duration by 1″ of ☉s parallax.
8″, 89	8″, 98	8″, 54	8″, 24	8″, 03	8″, 17	8″, 67	8″, 59	= Parallax of the Sun from the observation.

This table explains itself. If we, therefore, take the mean of the Sun's parallax arising from each of those sixteen total durations, it will be found = 8″, 48, and if we reject the observations of number 7th, 8th, 9th, 10th, 12th, 13th, and 14th, which differ the most from the rest, the mean of the nine remaining ones gives the Sun's parallax = 8″, 55, agreeing, to a surprizing exactness, with that found

 by

by the obſervations of the internal contact at the egreſs.

The obſervations at Tobolſk and Cajaneburg I look upon as very good ones, they differing in the total duration only ſix ſeconds; this error in obſervation, from what is gone before, may be very eaſily allowed. The obſervation of the internal contact at the ingreſs at Stockolm is, I believe, too ſoon, and the uncertainty of this obſervation may be eaſily granted, when it is conſidered, that the Sun was only 3 or 4 degrees above the horizon at that time, and we find a difference of 22″ between the obſervers at Upſal, where the ſun was about the ſame altitude. This, I apprehend, was owing to the undulation on the limb of the Sun, occaſioned by the vapours near the horizon: but the ſame reaſon cannot be given for the obſervation at Tornea, where the Sun was about 10^d degrees high, at the time of the internal contact at the ingreſs, unleſs there was an undulation at that altitude alſo, which may have been the caſe, though not mentioned. I have reaſon to believe that the error of obſervation at Tornea is at the egreſs, where indeed the two obſervers differ conſiderably.

The parallax of the Sun being thus found, by the obſervations of the internal contact at the egreſs, = 8″, 52 on the day of the tranſit, the mean horizontal parallax of the Sun is = 8″, 65.

I cannot help taking notice on this occaſion, of a method employed by ſome aſtronomers, of determining the diameter of Venus by the duration of the egreſs over the Sun's limb: for I am fully ſatisfied, that the beſt eye, aſſiſted by the beſt teleſcope, and in the beſt and cleareſt air, could not ſee the very

very laſt contact of Venus with the Sun's limb, but muſt have loſt ſight of it ſeveral ſeconds before ſhe really had left the Sun's limb; and this will the more plainly appear, when it is conſidered that every ſecond of the diameter of Venus took up about 19″ of time in paſſing over the Sun's limb. And to ſhew this further, and in a ſtronger light, I ſhall mention the following particulars. Mr. Canton meaſured the diameter of Venus, and found it = 58″, but by his duration of the egreſs, the diameter of Venus is = 57″, 8: the ſame diameter was meaſured by myſelf at Savile-houſe, and found = 59″, but by the duration of the egreſs obſerved there, the diameter of Venus is = 58″, 6. Mr. Maſon alſo at the Cape meaſured the diameter of Venus, which he found = 59″, $\frac{1}{4}$, but by his duration of the egreſs her diameter is found = 57″, 0: and therefore I muſt conclude that the diameter of Venus, found by the duration of the egreſs, muſt be always leſs than the true diameter for the reaſon given above. And, ſince I am upon this ſubject, I ſhall likewiſe mention the times of duration of the egreſs from ſeveral diameters of Venus. If the diameter of Venus is ſuppoſed = 57″, then the duration of the egreſs at London ſhould have been = 18′, 9″; if the diameter is = 58″, then the duration at London will be found = 18′ 28″; and if the diameter is = 59″, then the duration of the egreſs at London will be found = 18′ 47″. The diameter of Venus being = 59″, and the diameter of the Sun = 31′ 31″, the duration of the egreſs at Stockolm is = 18′ 43″, at Paris = 18′ 45″, at the Cape of Good Hope = 18′ 8″, and at Rome 18′ 38″. The duration of the egreſs at this laſt place was obſerved

ſerved = 18′ 31″, and if we ſuppoſe the diameter of Venus = 58″, and the diameter of the Sun = 31′, 33″, the duration of the egreſs at Rome will be found = 18′ 18″, which duration being leſs than the obſerved duration, it, therefore, follows that the diameter of Venus was more than 58″ on the day of the tranſit, and the duration of the egreſs at Paris, obſerved by M. de la Lande and P. Clouet, by Mr. Mallet and Mr. Bergman at Upſal, by M. Chappe at Tobolſk, and by myſelf at Savile-Houſe, prove the ſame thing.

Obſervations of the tranſit of Venus and Mercury over the Sun have been reckoned by aſtronomers (if the Sun's parallax is known) as very proper to determine the differences of the longitudes of the places of obſervation, even in many reſpects preferable to the obſervations of Jupiter's ſatellites. I ſhall therefore ſet down in the following table the longitudes from Greenwich obſervatory of the different places, where the late tranſit of Venus was obſerved, drawn from the ſaid obſervations.

Places.	Longitude in time				Latitude.			
	h	′	″		°	′	″	
Greenwich Obſervatory -	00	00	00		51	28	37	North.
Shirburn Caſtle - - -	0	3	47	Weſt.	51	39	22	N.
Leſkeard, Cornwal - -	0	18	47	W.	50	26	55	N.
Paris - - - - - - -	§0	9	10	Eaſt.	48	50	14	N.
Bologna, Italy - - -	0	45	15	E.	44	29	36	N.
Rome - - - - - - -	0	49	38	E.	41	53	54	N.
Drontheim, Norway - -	0	44	16	E.	63	26	10	N.
Upſal - - - - - - -	1	10	16	E.	59	51	50	N.
Stockolm - - - - - -	1	12	17	E.	59	20	30	N.
Hernoſand - - - - -	1	11	7	E.	60	38	0	N.
Calmar - - - - - - -	1	5	28	E.	56	40	30	N.
Abo - - - - - - - -	1	28	18	E.	60	27	0	N.
Tornea - - - - - - -	1	36	44	E.	65	50	50	N.
Cajaneburg - - - - -	1	51	47	E.	64	13	30	N.
Tobolſk, Siberia * - -	4	32	52	E.	58	12	22	N.
Madrid - - - - - -	0	13	26	W.	40	25	0	N.
St. John's, Newfoundl. †	3	31	12	W.	47	32	0	N.
Madraſs - - - - - -	5	20	10	E.	13	8	0	N.
Rodrigues - - - - - -	4	12	34	E.	19	40	40	South.
Cape of Good Hope - -	1	13	31	E.	33	55	42	S.
Calcutta, Bengall - -	5	53	44	E.	22	30	0	N.
St. Peterſburgh - - -	2	1	29	E.	59	56	0	N.
Tranquebar - - - - -	5	18	8	E.	10	56	0	N.
Pondicherry - - - - -	5	15	50	E.	11	56	30	N.
Kingſton, Jamaica ‡ - -	5	6	52	W.				
Port Royal, Jamaica - -	5	7	2	W.				

§ If the obſervation at Savile-Houſe is compared with the obſervation of M. de la Lande at Paris, the difference of longitude between the royal obſervatories at Greenwich and Paris is $= 9' \ 16''$.

* The latitude of this place was ſent to the Royal Society, but no longitude of it, and therefore the internal contact at Tobolſk could not be compared with that

that at the Cape of Good Hope for the purpose of the Sun's parallax.

† Mr. professor Winthrop went, at the expence of the province of Massachuset's-Bay, to St. John's in Newfoundland, to observe the transit of Venus, which he did with great care, and as much exactness as the low situation of the sun at that time would permit. The internal contact happened there at $4^h\ 47'\ 17''$. He had no other way of determining his longitude from Greenwich, at that time of the year, but by taking the distance of a star from the Moon, which gave him $3^h\ 20'\ 56''$ for his longitude from Greenwich, and therefore his observation of the internal contact could not be compared with the same observation at the Cape.

‡ The longitude of Kingston in Jamaica is determined by the observation of the transit of Mercury over the Sun on the 25th of October 1743 O. S. mentioned in the Phil. Transactions: the effect of the parallaxes is considered, and here included.

The longitudes of Tornea and Madrass are determined from the contact at the egress, because I have good reason to believe that the observation at the egress at these two places was not correct, and the observation of the contact at the ingress is more certain than that of the egress, and the observers at the ingress at these two places agree to 2″.

The elements I made use of in the preceding calculations are

		°	′	″
The Sun's diameter - - - - - - -	=	0	31	31
The diameter of Venus - - - - -	=	0	0	59
The horary motion of Venus in her path - - - - - - - - - - -	=	0	3	59, 8

 The

		°	′	″
The angle of the orbit of Venus with the ecliptic - - - - - - - -	=	8	30	10
The diſtance of the centers of the Sun and Venus as ſeen from the center of the earth - - - - - -	=	0	9	32
The difference of the parallaxes of the Sun and Venus - - - -	=	0	0	21, 35

I ſhall now give the method I followed in theſe calculations.

In Tab. XIX. Fig. 1ſt. Let F G repreſent the horizon, ZVH a vertical circle paſſing thro' the center of Venus, PVR a circle of declination, BV a circle of latitude, E C the ecliptic, O V N the orbit of Venus, VL the parallax of altitude, VN the parallax of lo gitude, LN the parallax of Latitude, ZVP the angle of the vertical with the circle of declination, BVP the angle of the equator with the ecliptic, Z V B the angle of the vertical with the circle of latitude, E V O the angle of the orbit of Venus with the ecliptic, ZVO the angle of the orbit of Venus with the vertical, ZP the complement of the latitude of the place, V P the complement of the declination of the planet, ZPV the horary angle or diſtance of the planet from the meridian, ZV the complement of the altitude of the planet.

In the triangle ZPV, the ſides Z P and P V and the angle Z P V are given, therefore the angle ZVP may be found, and alſo the ſide Z V, and as the parallax of altitude is to the horizontal parallax as the coſine of the apparent altitude is to the radius, therefore L V is found. B V P added to or ſubtracted from ZVP, as the nature of the caſe requires, leaves the angle

Fig. 1.

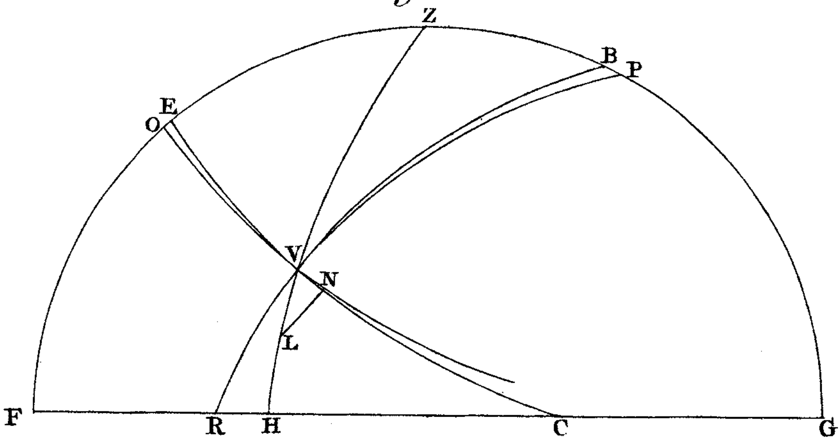
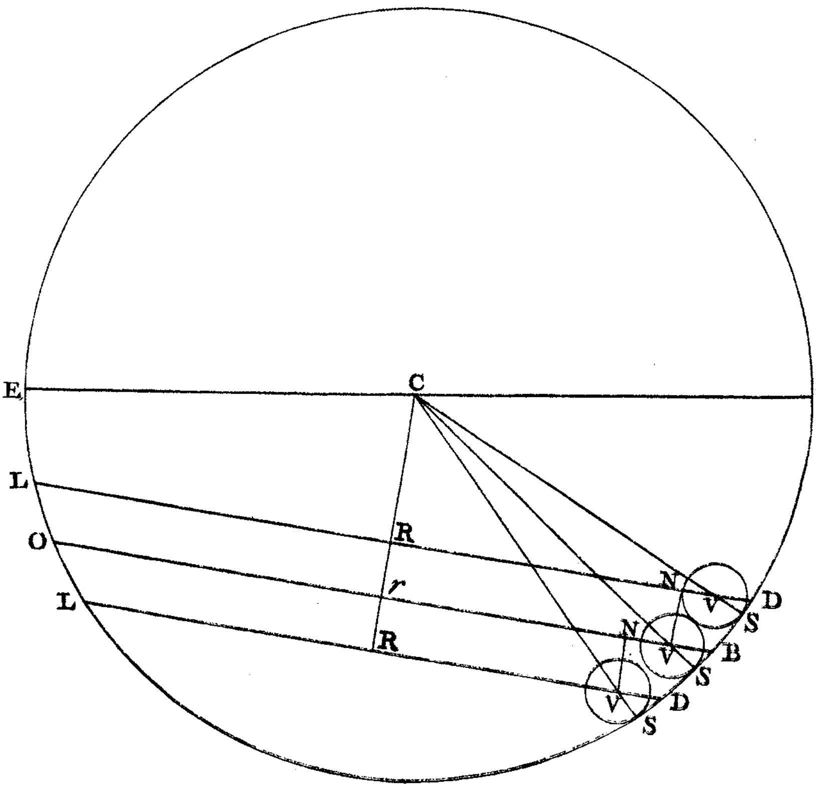


Fig. 2.



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angle ZVB; the angle ZVB ſubtracted from BVO leaves ZVO = to the angle of the orbit of Venus with the vertical, ZVO = LVN. Therefore in the right-angled triangle LNV, the angle LVN being given, and the ſide LV, the ſide VN, = the parallax of longitude, and the ſide LN, = to the parallax of latitude, may be found. The parallax of longitude is reduced to time by knowing the horary motion of Venus in her orbit or path. Thus the value of one ſecond of longitude is known in time. But to reduce the parallax of latitude to time, in Fig. 2d. Let ECP repreſent the ecliptic, O*r* B the path of Venus over the Sun as ſeen from the center of the earth, LRD the path of Venus as affected by parallax at any one place, C*r* the neareſt diſtance of the centers of the Sun and Venus as ſeen from the center of the earth, CR the neareſt diſtance of the ſame centers as ſeen from the place of obſervation, R*r* or NV the parallax of latitude, CS the Sun's ſemidiameter, VS the ſemidiameter of Venus, N*v* the difference of the ſemichords *rv* and RV, CV and C*v* = the difference of the ſemidiameters of the Sun and Venus.

In the right-angled triangles C*rv* and CRV, two ſides are given, therefore the other ſides *rv* and RV may be found the difference of theſe two ſides N*v* being reduced to time, by the horary motion of Venus in her path, will give the time anſwering to the parallax of latitude. The parallax of longitude being added to or ſubtracted from the Parallax of latitude, as the caſe requires, will give the retardation or acceleration of the contact at the place of obſervation,

after

after or before the contact as ſeen from the center of the earth.

In all the above calculations, I have conſidered the place of Venus, with reſpect to the center of the Sun, both in right aſcenſion and declination; and I have neglected the fractions of ſeconds in the reſults of the parallaxes of longitude and latitude, and I have always taken the ſecond that was neareſt to the fractional part.

I take this opportunity of acquainting the Royal Society, that I have, by means of an achromic object-glaſs micrometer of 40 feet focus adapted to a reflecting teleſcope of two feet focal Length, meaſured the leaſt and greateſt diameters of the Sun, and I find the apogeal diameter $= 31' \; 28''$, and the perigeal diameter $= 32' \; 33'$.