

XLVI. *Observations of the Transit of Venus over the Sun, June 3, 1769. In a Letter to the Reverend Nevil Maskelyne, F. R. S. Astronomer Royal, from John Winthrop, Esquire, F. R. S. Hollifian Professor of Mathematics at Cambridge, in New England.*

Cambridge, New-England, Sept. 5, 1769.

REVEREND SIR,

Read Dec. 7, 1769. I BEG leave to lay before you my observation of the late transit of Venus, the beginning of which I observed, in this place, with all the care I was capable of. Our situation on this North American coast, I am sensible, was not the most favourable, as we could see only the first part of the transit; yet, I presume, careful observations, wherever made, will have their use in determining the grand problem of the Sun's parallax; at least, may serve as collateral evidences to the capital observations.

Our apparatus having been wholly destroyed by fire, about five years ago, we have since procured a new set of astronomical instruments, made by some of the most eminent hands in London. A clock, by
Mr.

Mr. Ellicott, with the pendulum of his invention, having the bob supported by levers. An astronomical quadrant, of 2 feet radius, made by Mr. Siffon; and an equal altitude instrument, by Mr. Bird; each having three horizontal wires in the telescope. A reflecting telescope, of four feet focus; another of two; and another of 1 foot; fitted with an object glass micrometer, of $21\frac{1}{2}$ feet focus; all three made by the late Mr. James Short.

I was obliged to remove the clock to another apartment, for the sake of the transit, which I did on the 23d of May, when I took some equal altitudes. By reason of an almost continual succession of cloudy weather till the end of that month, I could make but few material observations afterwards for regulating the clock. But, happily, the weather cleared up on the 1st of June, about noon, and continued fine for several days. As the precise knowledge of the true time is of the utmost consequence in the present case, I suppose a particular account of the observations made for this purpose, within a few days of the transit, will be most satisfactory to you; and this must be my apology for the prolixity of the detail.

Observations for regulating the clock.

1769
June

24 1 Very cloudy till noon; the Sun hardly visible for a minute at a time; so that I could make only the following sparse observations.

Equal altitudes of the Sun's limbs.

Morning.	I.	Afternoon.	Middle Times	☉ on the meridian.
h ' "	h ' "	h ' "	h ' "	h ' "
7 55 13		4 0 6	11 57 39,5	
			equation—4,2	
	II.		11 57 35,3	☉ on the meridian
8 13 36		4 ^I 43		
14 6		3 41 13	—11 57 39,5	
			equation—3,9	
	III.		11 57 35,6	☉ on the meridian
8 21 21		3 33 57		
			11 57 39	
			equation—3,8	
			11 57 35,2	☉ on the meridian

☉ on the meridian.
h ' "
I. 11 57 35,3
II. 35,6
III. 35,2
Mean 11 57 35,4
or, true time of noon
by the clock.

2 2

		I.		
☉'sup. limb	1 } 8 3 39	5 ^I 49	44	
	2 } 4 49	5 ⁰ 38	43,5	
	3 } 6 0	49 28	44	
low limb	1 } 6 30	48 58	11 57 44	
	2 } 7 41	47 46	43,5	
	3 } 8 52	3 46 35	43,5	
Mean		11 57 43,75		
Equation		—3,77		
☉ on meridian		11 57 40		

		II.		
☉'sup. limb	1 } 8 11 47	43 41	44	
	2 } 12 58	42 31	44,5	
	3 } 14 9	41 19	11 57 44	
low limb	1 } 14 39	40 49	44	
	2 } 15 50	39 38	44	
	3 } 17 1	3 38 27	44	
Mean		11 57 44,1		
Equation		—3,7		
☉ on meridian		11 57 40,4		
		Z z		

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	Morning.			Afternoon.			Middle times.		
	h	'	"	h	'	"	h	'	"
☉'s up. limb	1	8	35	42	19	45			43,5
	2		36	54	18	33			43,5
	3		37	25	18	2	11	57	43,5
low. limb	1		38	37	16	51			44
	2		39	48	3	15	40		44
	3								
Mean							11	57	43,7
Equation									-3,3
☉ on meridian							11	57	40,4

IV.

☉'s up. limb	1	8	41	49	13	37			43	☉ on the meridian. h ' "
	2		43	1	12	25			43	
	3		44	13	11	14	11	57	43,5	
low. limb	1		44	45	10	43			44	
	2		45	57	9	30			43,5	
	3		47	10	3	8	17		43,5	
Mean							11	57	43,4	Mean of all 11 57 40,3 or, true time of noon by the clock.
Equation									-3,2	
☉ on meridian							11	57	40,2	

I.

☉'s up. limb	1	7	46	28	9	12			
	2		47	39	8	1			
	3		48	9	7	31	11	57	50
low. limb	1		49	20	4	6	20		equat. -3,8
	2								
	3								
☉ on meridian							11	57	46,2

II.

☉'s up. limb	1	7	51	38	4	2			50
	2		52	48	2	51			49,5
	3		53	59	1	40	11	57	49,5
low. limb	1		54	29					
	2		55	40	4	0	0		50
	3		56	50					
Mean							11	57	49,75
Equation									-3,74
☉ on meridian							11	57	46

1769
June
h 3

		Morning.			Afternoon.			Middle times.				
		III.										
		h	'	"	h	'	"	h	'	"		
☉'s up. limb	1	7	58	51	56	46				48,5	☉ on the meridian.	
	2	8	0	2	55	35				48,5	I. 11 57 46,2	
	3		1	13	54	34		11	57	48,5	II. 46	
low. limb	1				53	55				50	III. 45,5	
	2	2	54		52	46				50	Mean of all 11 57 45,9	
	3	4	5		3 51	35				50	or, true time of noon by the clock.	
		Mean									At 4 ^h 15' thermometer 85 $\frac{1}{4}$.	
		Equation									☉ on meridian 11 57 45,5	

☉ 4

		I.										
		h	'	"	h	'	"	h	'	"		
☉'s up. limb	1	7	45	1	10	51				56		
	2		46	12	9	40				56		
	3		47	23	8	29		11	57	56		
low. limb	1		47	53	7	59				56		
	2		49	4	6	48				56		
	3		50	14	4 5	37				55,5		
		Mean									☉ on meridian 11 57 52,4	
		Equation										
		II.										
		h	'	"	h	'	"	h	'	"		
☉'s up. limb	1	7	52	32	3	20				56		
	2		53	42	2	9				55,5		
	3		54	12	1	40		11	57	56		
low. limb	1		54	12	4	0	29			56		
	2		55	23	3	59	18			56		
	3		56	34						56		
		Mean									☉ on meridian 11 57 52,5	
		Equation										
		III.										
		h	'	"	h	'	"	h	'	"		
☉'s up. limb	1	7	57	38	58	11				54,5	☉ on the meridian.	
	2		58	50	57	0				55	I. 11 57 52,4	
	3	8	0	2	55	49		11	57	55,5	II. 52,5	
low. limb	1		0	32	55	19				55,5	III. 51,7	
	2		1	42	54	8				55	Mean of all 11 57 52,2	
	3		2	43	3 52	57				55	or, true time of noon by the clock.	
		Mean									☉ on meridian 11 57 51,7	
		Equation									Z z 2	
											Observation	

Observation of the TRANSIT of VENUS.

I chose to observe the transit with the 2 feet telescope, as I supposed most of the observations in other parts would be made with telescopes of that size; and I used a power that magnified 90 times, which gave a very distinct view of the spots then on the Sun. Soon after two o'clock, I began to look on the Sun's upper limb, where the Planet was to enter. The first impression I perceived was at $2^h 27' 51''$, by the clock, the Sun being then perfectly clear. I then rested my eye, which was pretty much fatigued, to prepare it for the total ingress or interior contact. At $2^h 45' 15''$, I began to be doubtful whether the internal contact was not formed; but at $20''$ was satisfied that it was past, the Sun's limb being restored to its integrity, in the place where it had been interrupted by the Planet. During this interval of near $5''$, there seemed to be a duskiſhneſs in the place of contact; my idea of which is well represented by Mr. Dunn's figure of what he calls the grey contact, in Phil. Trans. Vol. LII. Tab. VII. p. 190.

By the foregoing equal altitudes it appears, that the clock was now $2' 13''$ + too slow. I therefore state the observation as follows:

	Apparent time.
	h ' "
First visible impression of Venus upon the Sun	2 30 4
Internal contact	47 30

This time of internal contact, I think, cannot differ above $2''$ from the truth, and perhaps may not differ

differ $1''$. But about $4''$ of Venus's diameter must have entered upon the Sun before I perceived the impression. At nine in the morning, I observed the Sun's diameter, in the horizontal direction, to be $1\ 21\ 1$ parts of the micrometer, = $31' 33'', 2$. At $5^h\ 34' 23''$, the Sun's north limb was distant from Venus's south limb $9\ 3$ of the micrometer, = $6' 16'', 2$. At $5^h\ 37' 23''$, I found no sensible difference; and the Sun's north limb was then distant from Venus's north limb $7\ 14\frac{1}{2}$ of the micrometer, = $5' 17'', 6$. This gives Venus's diameter $58'', 6$; and the least distance of centers $9' 59'', 7$. Hence, the true duration of the ingress should be $18' 56''$; but this being here contracted $15''$, by parallax, is reduced to $18' 41''$. So that the first contact, strictly so called, happened $1\frac{1}{4}$ before the impression was discovered; and the central ingress was at $2^h\ 38' 5''$. The nearest approach was nearly, I suppose, at $5^h\ 37'$.

After Venus was entered upon the Sun, I viewed her attentively several times, with a power of the great telescope which magnified 260 times, but could perceive no such duskiſhness round her as I saw at the internal contact, nor that imperfect light upon her disk, especially near the centre, which Mr. Dunn speaks of; neither could I discover any satellite. Soon after six, the western sky began to be over-cast, so that for a considerable time before sun-set the Sun was hid.

I made observations for determining some other positions of Venus upon the Sun; but as they can be of no service in the grand problem of the parallax, I think it needless to swell this letter, very long already, with them. I therefore only add, that the latitude of
this

this place is nearly $42^{\circ} 25'$ N. and the difference of meridians west from London about $4^{\text{h}} 44'$. But this may be farther ascertained by the following emerfions of Jupiter's fatellites, which I observed with the 2 feet reflector.

Emerfions of Jupiter's first fatellite.

Apparent time.				h ' "		h ' "	
1768	April 25	9	13	52	1769	May 14	10 19 7
	May 18	9	27	27		Aug. 23	7 31 50
	June 10	9	37	25	<hr/>		
	July 3	9	45	54	Emerfion of μ 's second fatellite.		
					June 7 9 1 15		

I submit the foregoing observations to your candid acceptance; and am, with great respect,

REVEREND SIR,

Your most obedient humble servant,

John Winthrop.