

XXIII. *An Account of the Observations of the Transit of Venus and of the Eclipse of the Sun, made at Shirburn Castle and at Oxford. By the Reverend Thomas Hornsby, M. A. F. R. S. and Savilian Professor of Astronomy in the University of Oxford.*

Read June 15,
1769. **T**HE weather, on the morning of the 3d of June, was so very unfavourable, both at the observatory of the Earl of Macclesfield and also here at Oxford, that there was very little reason to expect that we should be able to make any observation. But here, a few minutes before noon, the clouds began to break, and I was enabled to observe the transit of the Sun's consequent limb over the meridian. At one o'clock in the afternoon, the sky was again overcast, and it rained for some time; but towards three o'clock, the clouds were dispersed, the Sun shone out clearly, and at five o'clock there was hardly a cloud to be seen. The preceding evening was also so very favourable, that the several persons who proposed to make observations of the transit, had an opportunity of adjusting their instruments.

The Right Honourable the Earl of Macclesfield made use of an excellent refracting telescope of $3\frac{1}{2}$ feet,

feet, made by Mr. Dollond, with a treble object-glass, magnifying 150 times; and at $7^{\text{h}} 7' 49'' \frac{1}{2}$ apparent time, was certain that the planet had sensibly advanced upon the Sun's disk, having seen a small impression upon the zenith part of the Sun's limb near a minute sooner. At $7^{\text{h}} 23' 13''$ mean time, or $7^{\text{h}} 25' 28'' \frac{3}{4}$ apparent time (as reduced from fidereal time), his Lordship determined the internal contact, which he judged to happen when the dark penumbra, which was so sensibly perceived between the limbs of the Sun and Planet, was lost upon the completion of the thread of light. His Lordship observed at a small distance from the observatory, by means of a stop-watch, which was let go at the instant he judged the total ingress to happen, and immediately compared with the observatory clock.

Mr. Bartlett, a very excellent observer, who has been constantly employed in the observatory for many years, observed with a 14 feet refractor on the north side of the observatory, within hearing of the clock, the seconds of which were counted by Mr. Phelps, the other assistant observer. At $7^{\text{h}} 7' 4''$ apparent time, Mr. Bartlett first saw Venus upon the Sun; and at $7^{\text{h}} 23' 10'' \frac{1}{2}$ mean time, or $7^{\text{h}} 25' 26''$ apparent time, he judged the ingress to happen, the telescope magnifying near 60 times.

Lady Macclesfield was also pleased to attend to the observation; and at $7^{\text{h}} 25' 16'' \frac{1}{2}$ apparent time, judged the second internal contact to happen, with a refracting telescope of 6 feet, through which the penumbra before mentioned was hardly to be distinguished.

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The sky, though free from clouds, was charged with vapour, which occasioned a constant undulation of the limbs of the Sun and Planet; and the wind sometimes blew so hard as to incommode the observers.

On the next morning the sky was very favourable to observation, and Mr. Phelps determined the eclipse of the Sun to begin at $18^{\text{h}} 32' 45''$, 7 mean time, or $18^{\text{h}} 34' 56''$, 7 apparent time, and to end at $20^{\text{h}} 17' 23''$, 5 mean time, or $20^{\text{h}} 19' 33''$, 8 apparent time. The Earl of Macclesfield observed the end to happen one second later, making use of Mr. Dollond's refractor.

The latitude of the observatory at Shirburn Castle is $51^{\circ} 39' 22''$, as determined by observations of the Pole Star, at several different times; and is $3' 57''$ of time west of Greenwich, and $1' 6''$ to the east of Oxford, as appears by computing the difference of meridians between Mr. Short's house, Shirburn Castle, and Oxford, as they result from the observations of the Sun's eclipse on April 1, 1764.

I proposed to observe the transit of Venus and the Sun's eclipse in the upper room of the tower of the Schools, which, though the floor of it be very unsteady, yet from its elevated situation afforded me the clearest view of the north-west part of the horizon, and is indeed the best place for making occasional observations in different parts of the heavens, and at different altitudes, which this place at present affords. The clock, furnished with a compound pendulum, was for some time carefully compared with another
clock

clock of the same construction, which is fixed in a small observatory in the house where I live, and which I had altered from sidereal to mean solar time, for the easier comparison of those clocks, which several gentlemen had procured, in order to observe this rare and curious phenomenon. The time was determined by meridional transits of the Sun, taken with a transit instrument made by Mr. Bird, and placed very exactly in the plane of the meridian, the focal length of the object-glass being 43 inches. The motion of both clocks was perfectly even and regular.

The atmosphere was so loaded with vapour, and the limb of the Sun was in such a constant state of undulation, that I determined to observe the external contact with a refractor of 12 feet, furnished with a system of eye-glasses, and magnifying 68 times. I had found, by a previous computation, that the Planet would make the first impression upon the Sun's upper limb, about nineteen minutes of a degree to the right hand of a vertical circle passing through the Sun's center. I therefore kept my eye constantly fixed upon that part, and at $7^h 5' 58''$ apparent time, I perceived that a small part of the Planet's diameter had certainly entered upon the Sun's disk; the impression, which I had observed for a few seconds before, having continued upon that part. While the Planet was passing over the Sun's edge, I determined, with the old micrometer applied to the 12 feet glass, the following differences of declination between the northern limb of the Sun, and the southern limb of Venus, with as much accuracy as the unsteadiness of the floor would permit.

Mean

		Mean Time.				
		h	'	"		
At	7	8	48	3	35,2	
	7	11	37	3	44,5	
	7	13	28	3	46,4	
	7	14	57	3	50,1	
	7	15	42	3	53,6	

But as the time of the internal contact began to draw nigh, I directed a refractor of $7\frac{1}{2}$ feet, with a double object-glass, to the Sun, made by Mr. Dollond, and magnifying 90 times; and soon after $7^h 21'$ mean time, perceived that the Planet appeared to be wholly entered upon the Sun, though the limbs of the Sun and Venus were not actually separated; that part of the Sun's edge, where the ingress happened, being very sensibly obscured by a penumbra, and the limbs appearing to be united, by a kind of ligament of a considerable breadth. This ligament became narrower and narrower, and was at length reduced to a point, and actually broken at $7^h 21' 57''\frac{1}{2}$ mean time, or $7^h 24' 13''\frac{1}{4}$ apparent time. At $7^h 24' 23''$ apparent time, the thread of light between the edges of the Sun and Venus, which was before compleated, now appeared to me of a very sensible breadth, and to equal $\frac{1}{10}$ th of the Planet's diameter. If I have estimated this breadth properly, the true internal contact must have happened considerably more than a minute sooner. The Swedish astronomers have described this appearance very nearly as I saw it; but according to the ac-

count * given by Mr. Mallet, the interval of time between the true and apparent ingress, when the limbs appeared perfectly to coincide, and when the ligament was observed to be broken, did not exceed $53''$, according to Mr. Melander's observation, and amounted to $56''$, according to Mr. Wargentin. This appearance, in all probability, is occasioned by the refraction which the rays of the Sun suffered in passing through the high and dense atmosphere of the Planet, and was perhaps rendered more sensible by the vapours near the horizon; as a similar appearance was observed at the second internal contact, in 1761, at very considerable altitudes, though in a smaller degree. But it will, I fear, occasion a much greater uncertainty in the quantity of the Sun's parallax deducible from these observations, than was reasonably expected.

By a mean of six observations, I found the Planet's diameter $= 58'',1$; being not greater than $59'',0$ from four of the observations, all agreeing precisely to the same part of a second; nor less than $56'',9$ by the least of the other two.

About fifteen minutes after the internal contact, a very thick and black cloud, which moved towards the east, with a slow motion, along the skirts of the horizon, prevented any further observations.

The next morning, the sky being perfectly clear, and the limb of the Sun undulating but in a small degree, I made the following observations of the Sun's eclipse.

* Phil. Transf. 1766, p. 77.

App. Time.			
	h	'	"
At 18	33	45	Beginning of the eclipse.
	36	4	The double spot (<i>a</i>) immerges.
	36	15	covered.
	46	circ.	A large irregularity on the Moon's edge appeared on the Sun's disk.
	54	44	The Moon touches the haziness surrounding the largest spot (<i>b</i>).
	55	15	Nucleus of the spot (<i>b</i>) immerges.
	56	11	D° covered.
18	57	7	Haziness of (<i>b</i>) covered.
19	5	12	The Moon touches the haziness surrounding the spot (<i>c</i>).
	6	14	The nucleus immerges.
	6	38	covered.
	8	14	The spot (<i>d</i>) covered.
	10	14	The spot (<i>f</i>) covered.
	10	28	The spot (<i>g</i>) covered.
	16	8	The spot (<i>b</i>) immerges.
19	16	32	The spot (<i>b</i>) covered. ' "
19	17	51	Lucid parts measured 15 15,7
	18	37	15 12,7
	19	11	15 9,5
	19	58	15 1,5
	20	52	14 53,0
	21	28	14 49,7
	22	12	14 44,5
	22	48	14 41,3
	23	38	14 40,4
	24	28	14 39,5
			App.

App. Time.			
	h	' "	' "
At	25	8	14 44,6
	25	44	14 48,3
	26	31	14 49,8
	27	19	14 50,5
	28	19	14 54,5
	28	58	14 59,1
	29	38	15 1,9
	30	15	15 4,7
19	52	37	The spot (c) totally uncovered.
	55	17	(b) begins to emerge.
	55	39	(b) totally uncovered.
20	15	30	(i) totally uncovered.
20	18	36	Eclipse nearly ended.
20	18	42 $\frac{1}{2}$	Eclipse ends.

The spots are marked with letters in the order in which they were covered by the Moon.

Many irregularities were observable upon the Moon's limb; though none of them were so pointed as some which I observed in the eclipse of the Sun, on August 16, 1765.

Towards the end of the eclipse, the sky began to be hazy; which haziness increased, and was very considerable at ten o'clock in the morning.

On the top of New College Tower, the Reverend Mr. Lucas, Fellow of New College, with an excellent acromatic telescope of 6 feet, magnifying 60 times, was certain that the external contact of Ve-

nus with the Sun was passed at $7^{\text{h}} 6' 12''$ apparent time, having perceived a small impression upon the Sun's edge several seconds sooner; and the Reverend Mr. Clare, Fellow of St. John's College, with the same instrument, judged the thread of light to be completed at $7^{\text{h}} 24' 28''$, having observed the limbs to be in contact several seconds sooner.

The next morning Mr. Lucas observed the beginning of the Sun's eclipse at $18^{\text{h}} 33' 47''$, and the end at $20^{\text{h}} 18' 37''$.

Mr. Sykes, of Brazen Nose College, with an acromatic refractor of $3\frac{1}{2}$ feet, made by Mr. Dollond, first saw Venus upon the Sun at $7^{\text{h}} 6' 0''$, and observed the thread of light to be completed at $7^{\text{h}} 24' 22''$.

Mr. Shuckburgh, of Balliol College, observed there the external contact of Venus with the Sun at $7^{\text{h}} 6' 8''$ apparent time, and the internal contact at $7^{\text{h}} 24' 25''$; though at $7^{\text{h}} 23' 16''$, he judged that the center of the Planet was removed more than its own semi-diameter from the Sun's limb, or that the true internal contact was then actually past. He is of opinion that the observation of the completion of the thread of light could not be made nearer than to $8''$ or $10''$, on account of the undulation of the limbs: and he farther adds, that when Venus was wholly entered upon the Sun, he could no longer perceive the penumbra that attended the Planet before the apparent contact; but that in the room of it there appeared a small circle of light, somewhat more luminous than the surrounding parts of the Sun. Mr. Shuckburgh also observed the beginning of the eclipse at $18^{\text{h}} 33' 51''$,
and

and the end at $20^h 18' 38''$, with the appulse of the Moon to several of the spots.

In an unfurnished room of the Hospital, that commanded the north-west part of the horizon, Mr. Nikitin of St. Mary Hall, and inspector of the Russian gentlemen sent here for their education by the Empress of Russia, and Mr. Williamson, of St. Alban Hall, both well versed in the Mathematics, made the following observations of the transit, with a reflector of 10 inches, and a refractor of 8 feet :

	1st ext. cont.			Ingrafs.		
	h	'	"	h	'	"
Mr. Nikitin	7	6	44	7	24	$15\frac{1}{2}$
Mr. Williamson	7	6	29	7	24	$10\frac{1}{2}$

The transit and the eclipse were also observed here by the Reverend Mr. Horsley, F. R. S. and Mr. Cyril Jackson, A. B. and student of Christ Church. But as Mr. Horsley proposes to lay the observations before the Society, I have only to add, that I believe them to have been made with all the accuracy and care that the circumstances of the time and place would permit; and that those gentlemen are not less distinguished by their zeal for astronomical and mathematical inquiry, than for their extensive knowledge and erudition.

The latitude of Oxford is $51^{\circ} 45' 15''$, as determined by myself, from several observations of the Pole Star, both above and below the Pole, with an excellent mural quadrant, of 32 inches, made by Mr. Bird; the focal length of the telescope being 34 inches.

34 inches. I am the rather induced at present to mention this, as the latitude of Oxford, given by Mr. De la Lande in the *Connoissance des Temps*, and attributed to me, was determined by the late Professor Blifs, from observations made with a smaller and less perfect instrument. The longitude of Oxford is $5' 3''$ or $5' 4''$ to the west of Greenwich, the former quantity being deduced from a comparison of the Sun's eclipse, observed by myself, with Mr. Short's observation, an allowance being made in the computation for the figure of the earth, in the effect of the Moon's parallax.

Oxford, June 14,
1769.

Thomas Hornsby.