

- II. *A Letter from Mr. John Winthrop, Hollisian Professor of Mathematics and Astronomy at Cambridge in New-England, to C. Mortimer, M. D. Sec. R. S. concerning the Transit of Mercury over the Sun, April 21. 1740. and of an Eclipse of the Moon, Dec. 21. 1740.*

S I R,

Read Nov. 3.
1743.

THOUGH I have not the Honour to be known to you, I flatter myself you will excuse the Freedom of this Letter, since the Design of it is to lay before you an Observation which, I hope, may be of some Use in Astronomy. In Confidence of this, I take the Liberty to inform you, that, on the 21st of *April* 1740. I had an Opportunity to observe *Mercury*, then near his descending Node, transiting the Sun's Disk. Being advertised by the Calculations of that excellent Astronomer Dr. *Halley*, that the former Part of this Transit would be visible in our Horizon, I was resolved to observe it in the best manner I could, with those few Instruments I was furnished with; which were only those I had received from my Predecessor Mr. *Isaac Greenwood*, and are the same that are mentioned by the late Mr. *Thomas Robie* in *Philosophical Transactions* N^o 382. being a 24 Foot Telescope, another of Eight Foot, and a brass Quadrant of Two Foot Radius, fitted with telescopic Sights, and having cross Hairs fixed in the *Focus* of the Glasses. All these I got in

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Readiness, being the more desirous to make this Observation, because *Mercury* had never as yet been seen entering upon or going off the Sun's Limb at his descending Node, and this *Transit* ought to be invisible to *Europe*. The better to observe *Mercury's* Ingress on the Sun, I determined to make use of my 24 Foot Tube, while an Assistant I had with me used that of Eight Foot: After which I proposed, in order to find out *his* Path in the Sun, to observe the Passages of *Mercury* and the Sun's Limbs by an horizontal and vertical Hair in the Telescope of the Quadrant; and I chose rather to deduce *Mercury's* Right Ascensions and Declinations by Calculation from hence, than to observe them immediately in the common way of placing one of the cross Hairs parallel to the Equator, &c. because, as the Sun was likely to be low before *Mercury* made his Entrance, Refraction would have caused considerable Errors in the Places of *Mercury* determined in this Manner. Having no Clock, I was obliged to make use of my Pocket-Watch, which I know to be a good one; and by this it was easy to distinguish Time to a Quarter of a Minute, which would have served pretty well for the Ingress of the Planet. But as it was by no means sufficient for those other Observations I designed to make, I procured another Watch, which shewed Seconds; and both these Watches I adjusted to the apparent Time, by several Altitudes of the Sun taken with the Quadrant before the *Transit* began; and by Altitudes taken the next Day, I found that the Watches had kept time exactly enough. I expected that the Centre of the Planet would enter upon the Sun at 5^h 2'; but, being apprehensive that he might

be earlier than the Calculation, I, for some time before that, with my 24 Foot Tube directed to the Sun, kept my Eye fixed on that Part of his Limb where the Planet was to enter, as steadily as I could for the Wind, which then blew fresh. This Precaution was not needless; for, at 4^h, 54', 59'', I perceived that *Mercury* had made an Impression on the Sun's Limb; by the Quantity of which I concluded, that almost One quarter of his Diameter might be entered. After I had beheld this very plainly about a Minute, a small Cloud covered the Sun near 3'; which then clearing off, and the Sun shining very bright, as before, I had again a distinct View of the Planet, and saw much more than half his Body on the Sun. I continued to see him till 5^h 0' 40'', at which time he seemed to be gotten almost wholly within the Sun; for he appeared now very near round, though I could not yet discern the Sun's Light behind him. By the shaking of the Tube, I unfortunately missed the Moment of his interior Contact with the Sun's Limb, but am certain it could be but very little later than this; for I presently after saw him fairly within the Sun. Upon which, I repaired to my Quadrant; but this being at my Lodgings, at some Distance from the long Telescope with which I observed the Ingress, and which I had no Convenience for raising nearer Home, almost half an Hour slipped away before it was possible for me to begin my Observations. I began them as soon as I could, and continued them till Sun-set, excepting when I was interrupted by the Clouds; and I observed sometimes one and sometimes the other Limb of the Sun, as I found it most convenient. It will be needless, I
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suppose, to give a Detail of all the Observations I made; I shall therefore select Two or Three, which I look upon as most exact, and most suitable to my present Purpose. One was as follows:

	h.	'	''.
The Sun at the Horizontal	5.	37.	59.
The Sun at the Vertical		39.	1.
<i>Mercury</i> at the Vertical		39.	16.
<i>Mercury</i> at the Horizontal		40.	1.

This Observation gave me the *Azimuth* and Altitude of *Mercury* at his Passage by the vertical Hair; from whence I computed his Right Ascension and Declination, and from thence his Longitude and Latitude. The Method of obtaining which being sufficiently known, I shall say nothing upon it, but only mention the Result of the Numbers, which was, that at 5^h, 39', 16'', when *Mercury* passed the Vertical, his Longitude was 120°, 43', 5'', 8; and the Sun being then in 12°, 42', 27'' of that Sign, *Mercury* was, in consequence of the Sun's Centre, 38'', his Latitude at the same time being 15', 2'' North. Another Observation was thus:

	h.	'	''.
The Sun at the Horizontal	6.	47.	37.
The Sun at the Vertical		48.	17.
<i>Mercury</i> at the Vertical		48.	25.
<i>Mercury</i> at the Horizontal		49.	24.

From hence I concluded, that at 6^h, 48', 25'', *Mercury* was in Antecedence of the Sun 3', 57'', with 14', 20'' North Latitude. I made another Observation after this; but the Sun being then very near the Horizon, his Limbs were not well defined, so that I look upon this Observation as much preferable to that. I

shall set down only Two more, which were made about the Middle between these Two; and were made by the Sun's upper Limb.

	h.	'.	''.
The Sun at the Vertical . . .	6.	6.	56.
<i>Mercury</i> at the Vertical . . .		7.	8.
<i>Mercury</i> at the Horizontal . . .		8.	42.
<u>The Sun at the Horizontal . . .</u>		9.	45.
	h.	'.	''.
The Sun at the Vertical . . .	6.	17.	18.
<i>Mercury</i> at the Vertical . . .		17.	29.
<i>Mercury</i> at the Horizontal . . .		18.	26.
The Sun at the Horizontal . . .		19.	32.

At the former of these Observations, *viz.* 6^h, 7', 8'', I computed the Longitude of *Mercury* to be in 12°, 42' 17'' 8, which being taken from the Sun's Place in 12°, 43', 35'' 8, leaves 1', 18'' for the Difference of Longitude between the Sun and *Mercury*; and his Latitude was then 14', 47''. At the latter Observation, the Difference of Longitude was 1', 55'', and the Latitude of *Mercury* 14', 42''.

From these Places of *Mercury* it appears, that his horary Motion in Longitude from the Sun was now 3', 58''; according to which, if we suppose the central Ingress to have been at 4^h, 57', we shall find the Difference of Longitude at that time 3', 20''; and the Semidiameter of the Sun being 15', 57'', the Latitude of *Mercury* must be 15', 36''. Now the Angle of *Mercury's* visible Way with the Ecliptic being, by the Theory of his Motion, 10°, 23', we must conclude the former of the observed Latitudes about 4'' too small, and the latter as much too large;—an Error very inconsiderable in this kind of Observations.

tions. From these things we may gather by an obvious Computation, that *Mercury* was in Conjunction with the Sun, in respect of Longitude, at $5^{\text{h}}, 47'$, with $14', 59''$, North Latitude; and that his nearest Distance to the Centre of the Sun was $14', 44''$; and when he was at his nearest Distance, the Difference of his Longitude from the Sun's was $2', 39''$, which he passed over in $40'$ of Time, and consequently arrived at the Middle of his Course in the Sun at $6^{\text{h}}, 27'$: Whence the Semiduration of the central *Transit* was $1^{\text{h}}, 30'$, and the End at $7^{\text{h}}, 57'$, an Hour after Sun-set.

As to the Place of *Mercury's* Nodes, the Inclination of his Orbit to the Ecliptic, and the other Elements of his Theory, I pretend not to determine any thing from so short a Series of Observations as this. I content myself with the foregoing Determinations, which, I hope, are not far from the Truth, having taken all the Care I could, both in the Observations and Calculations.

I was in Hopes to have made a good Observation of the Lunar Eclipse, which happened last Week: But the Sky, which at the Beginning of the Eclipse was very clear, soon became overcast, which hindered me from making above One or Two Observations that I could depend upon; and they were as follows:

21 *December* 1740.

h. '.

- At 5. 24. A plain Penumbra.
 35. The true Shadow seems to enter.
 47. Touches *Palus Maræotis*.
 53. Reaches *Mount Sinai*.

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After this the Clouds thickened, and covered the Moon till the End of the Eclipse, which was about 8^h, 30', as near as I could guess through the Clouds.

The Night before the Eclipse, *viz.* 20 *December*, at 12^h, 14', I saw the Moon eclipse a Fixed Star, which, I think, is in the Heel of *Castor*.

These Two last Observations were made with an Eight Foot Telescope, my Watch being rectified to the apparent Time by correspondent Altitudes of the Sun, taken with the before-mentioned Quadrant for several Days together, before and after the Eclipse.

I must ask your Pardon for this long Trouble, and am,

S I R,

Your most humble Servant,

Cambridge in New-
England, Dec. 30.
1740.

John Winthrop.

III. *An Account of the Transit of Mercury over the Sun, Oct. 25. 1743. in the Morning, observed at Mr. Geo. Graham's House in Fleetstreet.*

Read Nov. 3. 1743. **T**HE Beginning could not be seen by reason of Clouds, but about 8^h, 45', *Mercury* was seen (through a reflecting Telescope Three Foot *Focus*, magnifying about 50 times) about Four or Five of his Diameters within the Sun's Limb.

At Mr. *Short's* House in *Surrey-street*, *Mercury* was seen just past the interior Contact 8^h, 30', 59'', through