LXIX. *Obſervations of the Tranſit of* Venus *over the* Sun, June 3, 1769; *made by Mr.* Owen Biddle *and Mr.* Joel Bayley, *at* Leweſtown, *in* Pennſylvania. *Communicated by* Benjamin Franklin, *LL. D. F. R. S.*

Read Dec. 21, 1769. ON the 26th of May, 1769, Joel Bayly and myſelf arrived at Leweſtown (on Cape Hinlopen at the mouth of Delaware Bay), being ordered there, by the American Philoſophical Society, held at Philadelphia, for promoting uſeful knowledge, to take an obſervation of the enſuing tranſit of Venus over the Sun's diſc; and immediately ſet about fixing our time-piece, in a houſe (which we hired) on the ſouth ſtreet of the town, where we were moſt likely to be free from interruption, and had an open view of the Sun and ſtars for our obſervations. We ſet a ſtrong oak poſt in the ground, to which we ſcrewed our clock caſe, reſting the baſe of it on the ground, the face of it fronting a door which opens to the ſouthward, ſo as to be convenient for us to hear the beat of the clock, where we intended to fix our teleſcopes and inſtrument for taking equal altitudes. We then ſet a poſt in the ground for the equal altitude inſtrument, which was not

not ſo good as I wiſhed, but much better than a Hadley's quadrant, as we found by experience, and the beſt we could procure in time for our purpoſe. It was a theodolite, with teleſcopic ſights, in which there were croſs hairs; it had a ſpirit level to adjuſt the plain of the inſtrument horizontally; and alſo one applied to the teleſcope parallel with its axis, and at right angles to the other ſpirit level. By means of theſe two levels and adjuſting ſcrews, we found we could adjuſt it very nearly, the inſtrument being a very good one of the kind. With this we ſet our clock, by taking equal altitudes of the Sun, which we corrected by the tables publiſhed in a pamphlet, intitled, Inſtructions relative to the enſuing Tranſit of Venus, &c. by the Rev. Mr. Nevil Maſkelyne. The 27th, we got ſome good correſponding altitudes of the Sun, by which we ſet our clock; and took equal altitudes of ſome of the fixed ſtars, to prove the rate of our clock. After this it continued cloudy, with rain at times, and a high wind at north-eaſt, till the 31ſt, when the clouds broke a little. During this time, we employed ourſelves in meaſuring the diſtance of our place of obſervation from the ſtone fixed at the beginning, or eaſt end, of the eaſt and weſt line, which is the boundary between the three lower counties and Maryland, and is ſituate on Fenwick's Iſland; the latitude and longitude of this place being accurately determined by Meſſieurs Dixon and Maſon.

The meridional difference of the latitude of the place of our obſervation, north from Fenwick's Iſland, at the beginning of the eaſt and weſt line, as before deſcribed, being the eaſternmoſt end of the ſouthern boundary

boundary between the lower counties and Maryland, is 19′ 41″ 24‴; and the meridional difference of longitude of the place of our obſervation, weſt from the point aforeſaid, in Fenwick's Iſland, 5′ 45″ of a degree. Theſe data, with the latitude and longitude of Station Point, will determine exactly the place of obſervation.

June 2, the weather being clear, had good correſponding obſervations of the Sun.

June 3, the weather being remarkably fine, had good obſervations to ſet our clock. About 12 o'clock began to direct our glaſſes to the Sun, keeping it continually in the field from then to the time the obſervation was paſt. We agreed to watch our teleſcope one minute in turn, till about ſeven or eight minutes before the contact was expected, leſt, by too ſteady an attention to the glaſſes, our ſight ſhould be impaired, ſo as to diſable us from diſcerning the contact clearly. I had left my teleſcope the minute preceding the contact, intending to apply myſelf ſteadily to it, from the next minute, until the obſervation was paſt; and when the 48th ſecond was called, I applied myſelf to the glaſs, and by the time three ſeconds were elapſed, I perceived, on that part of the Sun's limb where I expected the contact, a ſmall impreſſion, which proved to be the limb of Venus in contact with the Sun. All the limb of the Sun, which appeared at that time in the field of the teleſcope, had a ſmall undulatory motion, which, I apprehend, was owing to denſe vapours, which aroſe at that place, being near the ſea. At Venus's firſt appearance to me, it was only like one of thoſe waves on the limb or border of the Sun, increaſed in

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ſo ſmall a proportion, that I remained doubtful for ſeveral ſeconds, whether it was any thing elſe; thus it continued, making a deeper impreſſion, with that tremulous motion, for about ten ſeconds, when the tremor where Venus was in contact ceaſed, and the indenture was truly circular, with an even termination.

My abſence from the teleſcope, juſt before the contact occurred, deprived me of an opportunity of judging whether there was any appearance of an atmoſphere preceding the weſtern limb of Venus in contact; but when Venus had entered nearly one half of its diameter into the Sun's diſc, my companion and myſelf ſaw a luminous creſcent, which enlightened that part of Venus's circumference which was off the Sun, ſo that the whole of her circumference was viſible, but did not continue ſo until the internal contact; and at the time of the firſt internal contact, the eaſtern or external limb of Venus ſeemed to be united to the Sun's limb by a black protuberance or ligament, which was not broke by the entrance of the thread of light, till four ſeconds after that the regular circumference of Venus ſeemed to coincide with the Sun's.

The teleſcope I made uſe of for viewing the tranſit, was a reflecting one, belonging to the Philadelphia Library Company, the ſpeculums of which are $2\frac{1}{2}$ feet apart, and the lenſes in the eye tube four inches apart; it was the leaſt magnifying power that I uſed, as I found the tremulous motion too much magnified by the other power. The ſmall one was in good order, and defined the Sun's limb, and ſpots on its diſc, very clearly. I had applied a polar axis

to it, and made ſome rack-work, by which I could keep the ſame part of the Sun's limb in the field with eaſe; my companion was not ſo well provided with a teleſcope, the one he uſed being of Dollond's refracting glaſſes of 4½ feet. This we fixed, with a ball and ſocket, to a poſt, by which it was eaſily directed to the Sun. Thus furniſhed, we found the contacts to take place as follows, reduced to mean time.

		h	′	″
Owen Biddle's	External contact at	2	11	53
	Internal one at	2	29	53
Joel Bayley's	External contact was loſt by an accident, but ſeen by him, after it had taken place, at	2	12	15
	Internal ditto	2	29	53

It muſt be noted, the internal contact, given by Owen Biddle, is at four ſeconds before the thread of light had broken the dark ligament or protuberance, by which Venus's limb was united to the limb of the Sun, that being the time he eſtimated the two limbs to be in contact.

The internal contacts, we think, may be relied on; the external happening ſooner than expected, occaſioned a doubt at its appearance, which made the exact ſecond of its appearance a little uncertain.

Signed,

Philadelphia,
June 9, 1769.

Owen Biddle.

Copy taken in haſte, but the times examined by
Owen Biddle.

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The times of the contacts of Venus with the limb of the Sun, as ſeen by Owen Biddle and Joel Bayley on Cape Hinlopen; with the true difference of latitude and departure of the place of their obſervation, from the Middle Point between Fenwick's Iſland and Cheſopeak Bay, are as follows, viz.

	h	′	″	
External contact at	2	11	53	mean time
Internal contact at	2	29	53	mean time

The difference of latitude of the place of obſervation, north of Middle Point.	21,93	miles
The meridian diſtance of the place of obſervation, eaſt of Middle Point.	30,6356	miles

The latitude and longitude of Middle Point were taken by Meſſieurs Dixon and Maſon, and, as we ſuppoſe, communicated to the Royal Society, but we are not yet acquainted with it.

N. B. As we are not acquainted with the exact meaſure of a degree of latitude, agreeable to the above gentlemen's meaſurement, we have ſent the difference of latitude and longitude in miles and decimal parts, as it may be reduced to greater certainty thereby.

Remarks by the ASTRONOMER ROYAL.

From the data given above, and the length of a degree of latitude, found by Meſſieurs Maſon and Dixon, in theſe parts = 68,896 Engliſh miles, the difference of latitude of Leweſtown and the Middle Point above mentioned (which is the ſame with the point A; ſee Meſſieurs Maſon's and Dixon's meaſure of a degree, Philoſ. Tranſact. vol. LVIII. p. 276) is 19′ 53″; but the latitude of the point A was found, by Meſſieurs Maſon and Dixon 38° 27′ 34″; therefore that of Leweſtown is 38° 47′ 27″ north; and the difference of its meridian, and that of the point A, or their difference of longitude, is 34′ 0″ = 2′ 16″ of time, Leweſtown being to the eaſt. But if the difference of longitude of Leweſtown eaſt of the Stones on Fenwick's Iſle be ſuppoſed truly given, in the former account, 5′ 45″ of a degree, then the difference of longitude of Leweſtown and the point A will come out about 1′ of a degree, or 4″ of time leſs; for Mr. Dixon acquaints me, that the diſtance of the Stone on Fenwick's Iſle, eaſt of the point A, is 35 Engliſh miles wanting 100 yards. Now this is equal to 30′ 26″ of a great circle = 38′ 51″ of longitude; from which ſubtracting 5′ 45″, there remain 33′ 6″ for difference of longitude of Leweſtown and Point A = 2′ 12″½ of time, or 3″½ leſs than found before; and this latter I take to be neareſt the truth. If this be ſo, Leweſtown is very nearly under the ſame meridian with the ſouthernmoſt part of the city of Philadelphia, or more accurately 13″ of longitude, anſwering

anſwering to 1″ of time, eaſt of it. For, by Meſſieurs Maſon's and Dixon's meaſure of a degree, the point N (ſee Philoſ. Tranſact. Vol. LVIII. p. 276) is 2′ 19″ of longitude weſt of the point A; and N, by meaſurement, is 31 Engliſh miles due weſt of the ſouthernmoſt part of the city of Philadelphia, anſwering to 35′ 12″ of longitude; from which ſubtracting 2′ 19″, there remain 32′ 53″, anſwering to 2′ 11″½ of time, for the difference of longitude of the ſouthernmoſt part of Philadelphia, eaſt of the point A. But Leweſtown is found above to be 33′ 6″ of longitude = 2′ 12″½ eaſt of the point A, and conſequently is 13″ of longitude, or about 1″ of time eaſt of the ſouthernmoſt part of the city of Philadelphia.

Nevil Maſkelyne.