Received March 15, 1770.

XXIII. *On the late Tranſit of* Venus: *By* Nathan Pigott, *Eſq*; *to Dr.* Bevis, *F.R.S.*

Caen, Lower Normandy, Feb. 9th, 1770.

Dear Sir,

Read April 26, 1770. I TAKE the opportunity of Capt. Hue's ſailing from this place, to ſend you the obſervations of the laſt tranſit of Venus over the Sun, made here, and which I would have remitted ſooner, if an opportunity had offered. I ſhould be obliged to you, if you would communicate theſe obſervations to the Royal Society. I have added thoſe of other obſervers, which have been ſent to me, from different places, and reduced the ſame to the obſervatory of Paris, keeping an account only of the difference of meridians, as inſerted in the *Connoiſſance des tems*, and omitting the ſmall correction of the parallax, ſuitable to the different ſituation of theſe places, becauſe, I preſume, the longitude of ſome of them, is not known with ſufficient preciſion, to admit here of this very ſmall equation.

TABLE of OBSERVATIONS reduced to the Meridian of the R. Obſervatory, at Paris.

Places of obſervations	Obſervers	External contact	Internal contact	Focus of inſtruments	Mag. powers	External contact reduced to Paris	Internal contact reduced to Paris
	Meſſ.	h ′ ″	h ′ ″			h ′ ″	h ′ ″
Greenwich	Maſkeline	7 10 55	7 29 23	teleſcope 2 feet	140	7 20 11	7 38 39
	Hitchens	7 10 54	7 28 57	teleſcope 6 feet	90	7 20 10	7 38 13
	Hirſt	7 11 11	7 29 18	teleſcope 2 feet	55	7 20 27	7 38 34
	Horſeley	7 10 44	7 29 28	achro. 10 feet	50	7 20 00	7 38 44
	Dun	7 10 37	7 29 48	achro. $3\frac{1}{2}$ feet	140	7 19 53	7 39 4
	Dollond	7 11 19	7 29 20	achro. $3\frac{1}{2}$ feet	150	7 20 35	7 38 36
	Nairne	7 11 30	7 29 20	teleſcope 2 feet	120	7 20 46	7 38 36
Kew	Bevis	7 10 2	7 28 17	teleſcope $3\frac{1}{2}$ feet	120	7 20 27	7 38 42
Caen		7 9 20	7 27 43	teleſcope 12 inches		7 20 7	7 38 30
Obſ. of Paris							7 38 11,5
Ditto	Duke of Chaulnes						7 38 58
Paris	Meſſier						7 38 45
	Baudouin						7 38 51
	Turgot						7 38 50
	Zanoni						7 38 41
St. Hubert	Le Monier		7 34 56	achro. $10\frac{1}{2}$ feet			7 36 52.5
Ditto	Chabert		7 35 32	refractor 18 feet			7 37 28,5
Miſſion	Rochefort		7 27 7,5	achro. 3 feet			7 37 54,5
	My Son		7 26 55,5	teleſcope 18 inches	55		7 37 42,5
	Self	7 9 38,5	7 26 24,5	achro. 6 feet	30	7 20 25,5	7 37 11,5

The

The place at Kew, where you obſerved, being 1′ 9″ to the Weſt of the obſervatory at Greenwich, is of courſe 10′ 25″ Weſt of that at Paris.

The obſervations in the table, joined by a ſtroke of the pen, were made together in the ſame place. You will perceive, in comparing the obſervations of the internal contact, how little the five laſt agree with the others. I am wholly ignorant in what light, the able aſtronomers, who obſerved at St. Hubert, conſider their obſervations.

Monſieur le Monnier, in communicating them to me, adds no remarks, no more than in the letters he has wrote to me ſince. I come therefore to thoſe made at the houſe called *La Miſſion*, ſituated in the neighbourhood of *Allemagne*, a village near this town. This houſe is about 500 toiſes South-Eaſt of my obſervatory at Caen, and their difference of meridians about 200 toiſes. I preferred this ſituation, from whence I could ſee the ſun almoſt in the horizon, to that of my obſervatory; the adjacent houſes of which, I foreſaw, would deprive me of the ſight of it, ſoon after the ingreſs of Venus.

June the firſt, I ſent to the abovementioned houſe a ſix feet achromatic refractor, with its micrometer made by Dollond, magnifying 30 times: an excellent teleſcope of 18 inches focus magnifying from 55 to 200 times made by Short, and a clock.

June 2d, I took twenty altitudes of the ſun, in the morning, to determine the going of a good compound pendulum, made by Le Paute, at Paris, which was to remain in the obſervatory at Caen, and to give the true times of the obſervations of the next day; and from correſponding ones in the afternoon, I

concluded by a mean, which agreed with the reſt to leſs than one ſecond, that it was ſlow on mean time at noon 2′ 21″,8; and that ſince the 25th of May, it had loſt at the rate of 3″ a day on the mean motion of the ſun.

I then went to the *Miſſion*, to prepare for the operations of the next day; it had been more or leſs rainy from ſun riſing; but about ſix in the evening, the clouds diſperſed and the ſun ſet in the moſt auſpicious manner.

June 3d, I took the following correſponding altitudes of the ſun's ſuperior limb; light clouds being troubleſome.

A. M.			Alt.	P. M.			Noon by clock.		
h	′	″		h	′	″	h	′	″
8	43	20,0	44.00	15	7	25,0	11	55	22,5
	46	35,0	44.30		4	12,0		55	23,5
	48	12,0	44.45		2	33,0		55	22,5
	49	45,0	45.00		1	00,0		55	22,5
	51	24,0	45.15	14	59	23,0		55	23,5
	53	3,0	45.30		57	42,0		55	22,5
	57	55,0	46.15		52	49,0		55	22,0
	59	33,0	46.30		51	12,0		55	22,5
9	1	13,0	46.45		49	32,0		55	22,5
						Mean	11	55	22,5+
						Correction		—	4,3
						Clock at true noon	11	55	18,2
						Mean time at ditto	11	57	43,7
						Clock ſlow on mean time		2	25,5

Theſe correſponding altitudes being taken, I went, as the day before, about four o'clock to *La Miſſion*; where I met Monſieur de Rochfort, a gentleman of Caen,

Caen, and my ſon. It rained by intervals, as it had done the whole day; the quickſilver in the barometer at noon being at 29,9 Engliſh inches, and Fahrenheit's thermometer in the obſervatory at 62°, the wind varying from the Weſt to the North.

I compared the going of the clock I had with me, with that which remained in the obſervatory by ſignals repeated five times, and which agreed perfectly together: the ſame was done after ſun ſet.

At half an hour paſt five, the clouds diſperſed entirely: the ſun ſhewed itſelf in all its ſplendor, and continued ſo the remaining part of the day.

About ſeven we all placed ourſelves at our inſtruments; Monſieur de Rochfort made uſe of a three feet achromatic refractor: my ſon of the 18 inch refractor: and I of the ſix feet achromatic refractor made by Dollond, and at $7^h\ 4'\ 58'',5$ of the clock, or $7^h\ 9'\ 38'',5$ apparent time, I perceived the external contacts of the Sun's and Venus's limbs.

As the impreſſion on the Sun's limb ſeemed conſiderable when I perceived it, I concluded this obſervation too late, which I judged to be occaſioned by a motion of undulation, with which the ſun was ſtrongly affected; for this reaſon, in two letters wrote to Paris the 11th of June and the 14th of July, and communicated to the Academy of Sciences there, I do not heſitate to declare this obſervation inſufficient; it agrees nevertheleſs very well with yours made at Kew, and is nearly a mean between thoſe of Greenwich, as may be ſeen by the table. However, I prepared myſelf with all poſſible care, for the obſervation of the internal contacts; and though the Sun's limb moved continually up and down with a quick motion,

motion, I judged the internal contacts at $7^h\ 21'\ 44{,}5''$ by the clock, or $7^h\ 26'\ 24{,}5''$ apparent time, and $3''$ or $4''$ later, I ſaw a thread of light ſeparate the planet from the Sun,

	h	′	″	
Internal contacts, by M. de Rochfort	7	27	7,5	ap. time
By my ſon	7	26	55,5	ap. time

I find, by my regiſter, that Monſieur de Rochfort judged his obſervation ſome ſeconds too late.

I perceived that Venus, before ſhe ſeparated from the Sun, was conſiderably ſtretched out towards his limb, which gave the planet nearly the form of a pear; and even after the ſeparation of the limbs, Venus was twelve or more ſeconds before ſhe reſumed her rotundity.

	Clock			Ap. time			
	h	′	″	h	′	″	
At	7	30	27,0	7	35	7,0	Venus quite round.
	7	38	25,0	7	43	5,0	Venus's limb indented.
	7	45	8,0	7	49	48,0	Venus of a very irregular form, and ſtrongly affected by an odd twiſting motion.

I endeavoured to take the difference of right aſcenſion of the Sun and Venus; but I would not make the former deſcribe the æquatorial wire of the micrometer.

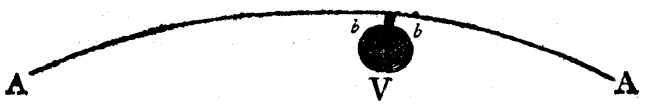
I cannot but repent having quitted my obſervatory, for the houſe in which I was; it is true indeed, as I have ſaid, that I had the advantage of ſeeing Venus till ſun ſet; but, in giving the preference to this ſituation, I unfortunately did not take notice, that I had

I had a river and a meadow between the Sun and me; the exhalations which riſe from ſuch places, eſpecially towards the evening, produced, no doubt, that undulatory motion of the Sun, which muſt render obſervations made in ſuch circumſtances more or leſs dubious.

In ſhort, I ſhall make two remarks on our obſervations: the firſt, that it ſeems odd, that the obſervation of the external contacts, which, for the reaſons beforementioned, I judged had been made too late, agrees nevertheleſs both with yours and thoſe of Greenwich: ſecondly, that although the internal contacts be marked by us ſooner than by any other obſervers, except thoſe of St. Hubert; we kept, nevertheleſs, the moſt ſcrupulous ſilence, nor did any motion indicate to the others, the times each wrote down; moreover, we were all three convinced that Venus and the Sun were ſeparated, when we began to count the clock. However, I can but conſider it as a misfortune, to have left my obſervatory, where the Sun's limb appeared perfectly well determined, even after the internal contacts, and not in the leaſt affected by any motion or undulation, which were ſo troubleſome to us; luckily I left a perſon in it, who did not neglect theſe favourable circumſtances; and the obſervations there made are the more intereſting, as the weather did not permit the external contacts to be obſerved, in any place from Caen to Breſt, no more than at Paris nor in its environs.

Obſervations of the contacts of the Sun and Venus, made in my obſervatory at Caen, with a 17 inch refractor with $2\frac{3}{4}$ inches aperture.

Clock			App. time			
h	′	″	h	′	″	
7	4	40,0	7	9	20,0	Sun well determined: a very ſmall impreſſion appeared on its ſuperior limb: it ſeemed even doubtful whether the contacts were formed.
7	4	52,0	7	9	32,0	The contacts very certain: this obſervation excellent, and it is thought the contacts could not have been ſeen ſooner than $7^h\ 9'\ 20''$.
7	20	33,0	7	25	13,0	The following limb of Venus ſeemed to touch that of the Sun: the planet appeared quite round; but ſoon after ſeemed to ſtretch itſelf out, and to form the tail, mentioned underneath: this obſervation is thought leſs certain than the others.
7	23	3,0	7	27	43,0	Internal contacts: by internal contacts muſt be underſtood the inſtant, when a ſort of tail, ſuch as is repreſented in the figure, and which joined Venus to the Sun's limb, ſeparated from it ſo ſuddenly, that it is impoſſible there could have been an error of one ſecond. There appeared inſtantly a conſiderable diſtance between the limbs; that diſtance was not meaſured, but it might be $\frac{1}{200}$ of the Sun's diameter; and that diſtance was concluded from the compariſon of the apparent length of this tail, to the diameter of Venus.



A A repreſents the Sun's ſuperior limb.

V Venus entirely upon the Sun only joined to his limb by the tail *b b*, which decreaſed in breadth till the inſtant of ſeparation: the length of this tail ſeemed equal to $\frac{1}{6}$ of Venus's diameter.

The calculation of this tranſit of Venus over the Sun, was made from tables corrected by that of the 6th June 1761; and, compared to obſervation, give the following differences.

	Calculation			Obſervation			Difference		
	h	′	″	h	′	″		′	″
External contacts	7	3	33,0	7	9	20,0	+	5	47
Internal contacts	7	22	27,0	7	27	43,0	+	5	16
Interval of contacts	0	18	54,0	0	18	23,0	−	0	31

June 4th light clouds flying and Fahrenheit's Thermometer at 60° I took the following equal altitudes of ☉ ſuperior limb.

A. M.			Alt.		P. M.	Noon by clock
h	′	″	°	′		
9	44	6,0	53	00		
	45	58,0	53	15		
	47	49,0	53	30	Cloudy	
	49	40,0	53	45		
	51	36,0	54	00		
	53	29,0	54	15		

June 5th cloudy

June 6th, I took the following altitudes of Sun's ſuperior limb.

A. M.			Alt.		P. M.	Noon by clock
h	′	″	°	′		
8	53	27,0	45	45		
	58	18,5	46	30		
	59	57,5	46	45		
9	1	38,5	47	00		
	4	53,5	47	30		
	8	14,5	48	00	Cloudy	
	11	37,5	48	30		
	13	16,5	48	45		
	14	58,5	49	00		
	16	40,5	49	15		
	18	23,0	49	30		

June 7th, cloudy.

June 8th, ditto.

June 9th, Fahrenheit's thermometer at 63°; I took the following correſponding altitudes of the Sun s ſuperior limb. Weather hazy.

A. M.			Alt.		P. M.			Noon by clock		
h	′	″	°	′	h	′	″	h	′	″
9	10	38,5	48	30	14	48	41,0	11	56	9,75
	17	23,5	49	30		34	57,0		56	10,75
	19	5,0	49	45		33	16,0		56	10,5
	20	46,0	50	00		31	35,0		56	10,5
	58	46,0	55	15		53	32,0		56	9,0
	Mean							11	56	10,1
	Correction								—	2,7
	Clock at true noon							11	56	7,4
	Mean time at true noon							11	58	47,6
	Clock ſlow on mean time								2	40,2
	Ditto, June 3d								2	25,5
	Loſt on mean time in 6 days									14,7
	Hence loſt on ditto, per day									2,45

It

It was from the correſponding altitudes of the Sun, taken the 3d and 9th of June, that I got the apparent times of the obſervations made at Caen; theſe times may be eaſily verified, by the altitudes taken in the mornings of the 4th and 6th; but I can ſufficiently depend on the clock to diſpenſe with that trouble.

I return you, dear Sir, many thanks for your obſervations of the tranſit, which you was ſo kind to ſend me; it is the moſt circumſtantial and compleat of any I have ſeen. What ſeems odd to me is, that neither M. le Monnier, as appears by his letters to me on this occaſion, nor any of the obſervers at Paris, ſaw Venus ſtretched out as I did, nor any kind of tail: by your deſcription of this tail, there muſt have been ſome little difference in its appearance, to that ſeen by the perſon in my obſervatory here.

If you think it will be acceptable to the Royal Society, I will take an opportunity of forwarding ſome other obſervations; and among the reſt, an account of a very remarkable degree of cold, and its effects on different liquids in the beginning of the year 1768, to which I attended with great attention. In the mean time, I am,

DEAR SIR,

Your moſt obedient

humble ſervant,

Nath. Pigott.