Received June 19, 1769.

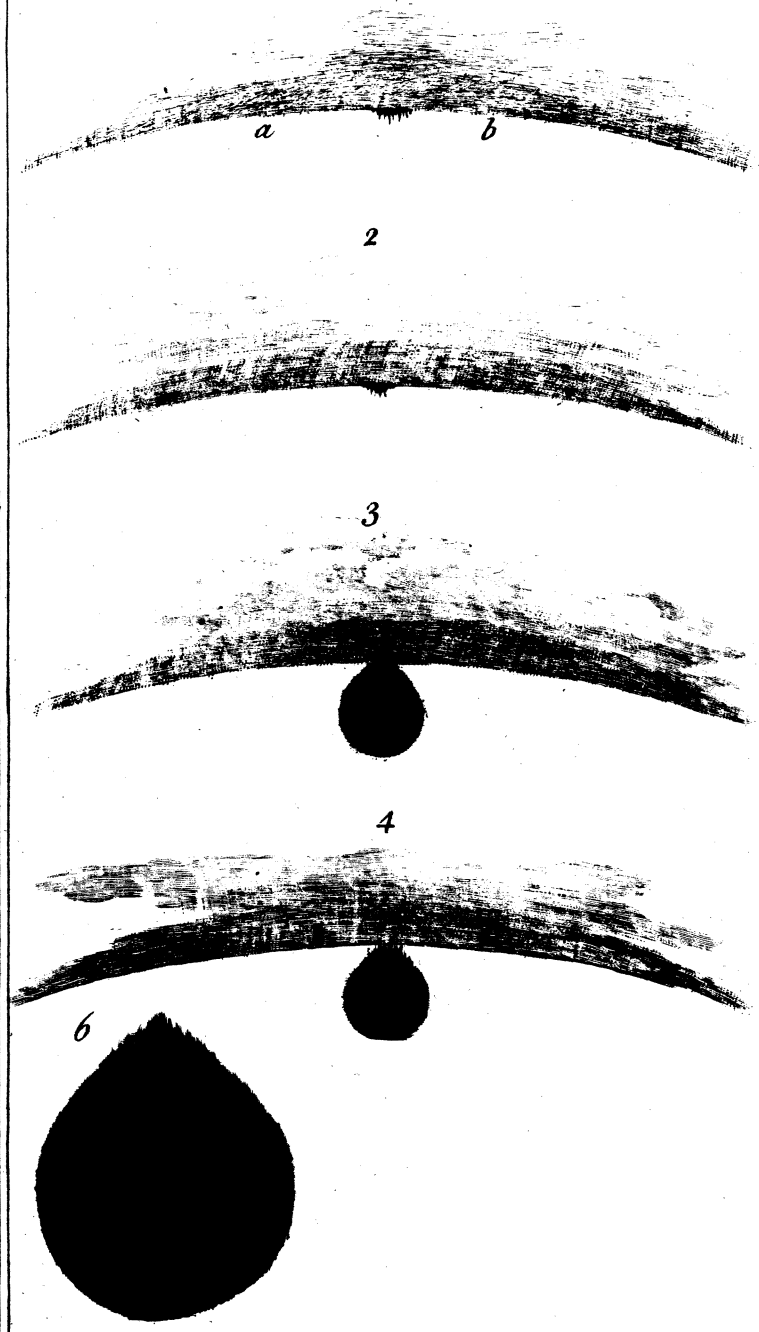
XXXI. *Account of ſeveral Phænomena obſerved during the Ingreſs of* Venus *into the Solar Diſc. By the Reverend* W. Hirſt, *F. R. S. in a Letter to the Aſtronomer Royal.*

Inner Temple, June 12, 1769.

DEAR SIR,

Read Nov. 16, 1769. AGREEABLY to your deſire, I now ſend you a particular account of all the phænomena I obſerved during the ingreſs of Venus into the ſolar diſc; but, before I do this, I look upon myſelf as obliged in gratitude to return you many thanks for the kind manner in which you accommodated me with the apparatus neceſſary for the obſervation. The teleſcope I uſed, as you well know, belonged to Mr. Dunn, and was a reflector two feet in length, and magnified 55 times. Expecting the planet to enter the ſolar diſc at or near the zenith, I kept my eye conſtantly fixed at that part of the Sun a conſiderable time before the beginning of the tranſit. The firſt intimation which I had of the near approach of the planet, was by the ſudden appearance of a violent corruſcation, ebullition,

Fig. 1.



tion, or agitation of the upper edge of the Sun, as in TAB. X. and XI. fig. 1. when I called out to my good friend, governour Vanſittart, who was ſo kind to give himſelf the trouble of taking the time for me, and deſired him to take care. I had not taken this precaution above five or ſix ſeconds, when I plainly ſaw a black notch breaking in upon the Sun's limb, and which ſeemed a portion of a much leſs ſphere than that of Venus, as in fig. 2. Inſtantly I deſired Mr. Vanſittart, by the word *Now*, to mark the time, which was $11^h\ 57'\ 35''$ ſidereal time, by Dr. Halley's little clock, belonging to the royal obſervatory. The laſt-mentioned time, allowing for the neceſſary corrections, and reduced to apparent time, is $7^h\ 11'\ 11''$

As I imagined, from the inſtructions of Dr. Halley, that the preciſe and accurate time of obſerving the internal contact is, when the thread of light ſhould break in between the concave edge of the Sun and the convex edge of Venus, as in fig. 6. I waited till that particular period, which was when Dr. Halley's clock marked $12^h\ 15'\ 45''$, ſidereal time, or $7^h\ 29'\ 18''$, apparent time, the difference being $18'\ 7''$ of apparent time.

The ſame phænomenon of a protuberance, which I obſerved at Madras, in 1761, *at both internal contacts, I obſerved again at this laſt tranſit: at both times, the protuberance of the upper edge of Venus diminiſhed nearly to a point before the thread of light between the concave edge of the Sun, and the convex edge was perfected, when the protuberance inſtantaneouſly

* Philoſ. Tranſ. vol. LII. part i. 1761, p. 396.

broke

broke off from the upper edge of the Sun, but Venus did not aſſume its circular form till it had deſcended into the ſolar diſc, at leaſt to the diſtance, by eſtimation, from the upper edge of the Sun, as deſcribed in fig. 7.

Although at the time of the contacts the atmoſphere was remarkably clear, yet, as the Sun deſcended towards the horizon, the atmoſphere grew more and more hazey, ſo that the edge of the Sun, as well as the edge of the Planet, began to grow more and more tremulous, and cauſed the Planet to aſſume, in appearance, different configurations, reſembling ſometimes a prolate and ſometimes an oblate ſpheroid, till we loſt ſight of the Sun by its being intercepted by a dark cloud, or rather fog-bank, ſome time before the calculated time of Sun-ſet. Although theſe laſt phænomena are entirely optical deceptions, owing to the ſtate of the air at that particular time, or to horizontal vapours, yet I beg it may be here very carefully remarked, that, at the times of the contacts, the air, as you can bear me witneſs, was perfectly clear and favourable, ſo that our obſervations were then certain, and not ſubjected to any fallacy in viſion. The following circumſtance is a proof of this aſſertion. The firſt warning which I had of the near approach of Venus to the Sun's external edge was, as I have before ſaid, by the ſudden appearance of a violent corruſcation, ebullition, or agitation of the upper edge of the Sun, five or ſix ſeconds before the edge of Venus broke in upon the Sun; where alone I obſerved the violent agitation, the edge on each ſide remaining perfectly quieſcent, as *a*, *b*, fig. 1. If this appearance had been owing to the ſtate of *our* atmoſphere only, then

then would the edge of the Sun be univerſally fluctuating or trembling; but as this was not the caſe, the undulation muſt be imputed to ſome other cauſe, not improbably to an atmoſphere about Venus. I am the more minute on this circumſtance, becauſe you yourſelf, Sir, in a late * publication, have taken notice, that when I took the obſervation of the tranſit of Venus at Madras, in the year 1761, I ſaw *a kind of penumbra or duſky ſhade, which preceded the firſt external contact two or three ſeconds of time, and was ſo remarkable, that I was thereby aſſured the contact was approaching, which happened accordingly.*

Upon your foregoing paragraph I muſt beg leave to make the following remark, that in the tranſit of this preſent year I did not take notice of the ſame phænomenon as I did of the tranſit of Venus in India, in the year 1761; but I muſt here again inſiſt upon it, that ſuch penumbra or duſky ſhade I then actually ſaw, but I do not recollect I then ſaw the leaſt undulation, ebullition, or corruſcation, as happened in the tranſit of this preſent year. Yet both phænomena were conducive to the ſame purpoſe, and ſerved to give me notice of the near approach of the planet Venus to the ſolar diſc, the event, in both inſtances, juſtifying the preſage; and both appearances might be the conſequences of the ſame cauſe; which cauſe, as I have before obſerved, might be nothing leſs than the atmoſphere of Venus. I ſay *might be*, for I would not be underſtood to aſſert here any

* Inſtructions relative to the obſervation of the enſuing tranſit of the planet Venus over the Sun's diſc, on the 3d of June 1769. By the Rev. Nevil Maſkelyne, Aſtronomer Royal, p. 32.

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thing dogmatical, preſerving at this time the ſame diffidence in expreſſion as I made uſe of when I obſerved the tranſit of Venus in India, where I was apprehenſive, that *to* * *be able to diſcern an atmoſphere about a planet at ſo great a diſtance as Venus may be regarded as chimerical:* yet I may venture to ſay, that my obſervation of the tranſit of the preſent year ſeems to corroborate my aſſertion, in the account of the tranſit obſerved in India, in 1761; however, I ſhall not here peremptorily aſſign the cauſe, leaving ſuch remarks to be made by others.

On my return from India, I was glad to find I was not particular in remarking the ſtrange phænomenon of the oblongation of the orb of Venus at the time of both the internal contacts. It was with ſenſible pleaſure I have ſeen, in the † Philoſophical Tranſactions, that four aſtronomers at Upſal, in Sweden, as well as ‡ Mr. Dunn, in England, took notice of the ſame or ſimilar circumſtances. The appearance of this protuberance or ligament muſt now be univerſally confirmed, eſpecially by all obſervers of the tranſit of the preſent year, at leaſt by all ſuch who have viewed it through teleſcopes of ſufficient magnifying powers, and who have ſenſe enough to believe their own eyes, or candour enough to embrace and acknowledge conviction, *malgré* all prejudice and preconceived opinion.

Fig. 1. repreſents the firſt preſage I had of the approach of Venus to the Sun's external diſc. Fig. 2. is the appearance of the black notch, when I noted

* Philoſ. Tranſ. vol. LII. part i. 1761, p. 396.
† Ibid. p. 227. and vol. LVI. 1766, p. 72.
‡ Ibid. p. 184.

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the time of the firſt external contact. Fig. 3. is the body of the planet within the ſolar diſc, adhering to the Sun's upper edge, the thread of light not yet formed. Fig. 4 the protuberance forming, and the undulation at, *c*, *d*, very violent, better ſeen in fig. 8. Fig. 5. the undulation decreaſing, and the protuberance forming itſelf into a point, the luminous filaments darting between the edges of the Sun and the planet. Fig. 6. the luminous filaments ceaſe to move, and the upper edge of the planet is well defined. Its whole orb more opaque, but not yet diveſted of its oval appearance, the thread of light at *c*, *d*, is formed; and at this period I marked down the time of the internal contact. Fig. 7. the planet is reſtored to its circular figure.

I ſhall conclude this account with a few remarks I think it neceſſary to make on the manner in which my obſervation of the tranſit in India, in 1761, was inſerted in the Philoſophical Tranſactions. I am very much grieved, that the obſervations of the equal altitudes and meridional tranſits for regulating my time-keeper were altogether omitted. Had this not been the caſe, every one might have judged of the care and pains I took in that diſtant part of the world, as well in making ſeveral of my inſtruments myſelf, as in uſing them when made. What degree of confidence was to be given to my obſervations might be eaſily ſeen. Monſieur Pingré* would have had no occaſion to lament that I did not acquaint *the world in what manner I obſerved the equal altitudes to determine the paſſage either of a fixed ſtar, or of the Sun over the*

* Philoſ. Tranſ. vol. LIV. 1764, p. 156.

meridian, &c. If theſe particulars had been inſerted, there would have been no occaſion likewiſe to alter my numbers reſpecting the periods of the tranſit, ſince every aſtronomer, from the previous obſervations, might draw his own concluſions. Obſervations ought not to be rejected or ſtifled becauſe they do not entirely ſuit any adopted ſyſtem, or favourite parallactic angle. If I declared I ſaw an oblongation of the planet Venus, it ought not to be diſcredited becauſe another did not ſee it. If I gave reaſons for ſuggeſting that Venus had an atmoſphere, but had not a ſatellite, the report ſhould have been impartially ſtated, though another ſhould be of a contrary opinion.

I ſhall beg leave to extract the following paragraph from my original letter from India to Lord Macclesfield, on the ſubject of the tranſit of Venus, in the year 1761, which, for what good reaſon I know not, was ſuppreſſed, and had not the honour of a place in the Philoſophical Tranſactions; but which I am the more deſirous ſhould now be inſerted, as it tends to elucidate a matter of fact, and to render indiſputable an aſtronomical truth, only to be eſtabliſhed by thoſe who had the opportunity of ſeeing as I did, the entire paſſage of Venus over the ſolar diſc. The paragraph is as follows:

" Looking over the Philoſophical Tranſactions,
" ſome time before the tranſit, I found Mr. Short
" had obſerved a ſmall ſtar near Venus, which had
" the ſame phaſis as that planet. This gave ſuſpicion
" that Venus was attended with a ſatellite. A cor-
" roborating circumſtance was added, *viz*, M. Caſ-
" ſini, in his *Elements d'Aſtronomie*, mentions a like
" obſervation. This I regarded as a favourable

" opportunity,

" opportunity, concluding, that if Venus had a ſatel-
" lite, it muſt be ſeen at its tranſit over the Sun's diſc;
" accordingly, I gave notice of this to Captain Barker,
" of the Company's Artillery" (now Colonel Sir Robert Barker), " who took the obſervation at Pondicherry. I alſo mentioned it to the Jeſuits, who
" obſerved at the Great Mount, about $7\frac{1}{2}$ miles S.
" 50° W. of Madras, but neither of them ſaw any
" appearance in the leaſt like a ſatellite. I alſo ſpoke
" of it to Governour Pigot" (now Lord Pigot) " and
" Mr. Call, who with myſelf ſaw not the leaſt ſpeck
" attending that planet; whence we may now ven-
" ture to affirm, *That Venus has not a Satellite.*"

I am,

with great reſpect,

DEAR SIR,

Your affectionate, humble ſervant,

W. Hirſt.