TRANSACTIONS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY,

HELD AT

PHILADELPHIA,

FOR PROMOTING

USEFUL KNOWLEDGE.

VOLUME I.

THE SECOND EDITION CORRECTED.

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PROTHONOTARY's OFFICE, Philadelphia county.

I DO certify that on this 29th day of April, 1789, *a Book entitled* “Tranſactions of the American Philoſophical Society, held at Philadelphia, for promoting uſeful Knowledge,” *vol.* I. *the ſecond edition corrected, printed at Philadelphia, by* R. Aitken & Son, *at Pope's Head, in Market-Street, was entered in my office, by* Robert Aitken.

JAMES BIDDLE, PROT.

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OF

VOLUME I.

An

TRANSACTIONS

OF THE

American PHILOSOPHICAL SOCIETY, &c.

SECT. I.

MATHEMATICAL *and* ASTRONOMICAL PAPERS.

A deſcription of a new ORRERY, *planned and now nearly finiſhed by* DAVID RITTENHOUSE, *A. M. of Norriton, in the county of Philadelphia. Communicated by Dr.* SMITH.

Read 21ſt Mar. 1768.

THIS *machine* is intended to have three *faces*, ſtanding perpendicular to the horizon: That in the front to be four feet ſquare, made of ſheet braſs, curiouſly poliſhed, ſilvered and painted in proper places, and otherwiſe ornamented. From the center ariſes an axis, to ſupport a gilded braſs ball, intended to repreſent the *ſun*. Round this ball move others, made of braſs or ivory, to repreſent the *planets*: They are to move in elliptical orbits, having the central ball in one focus; and their motions to be ſometimes ſwifter, and ſometimes ſlower, as nearly according to the true law of an equable deſcription of areas as is poſſible, without too great a complication of wheel-work. The orbit of each planet is likewiſe to be properly inclined to thoſe of the others; and their *Aphelia* and *Nodes* juſtly placed; and

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their velocities ſo accurately adjuſted, as not to differ ſenſibly from the tables of aſtronomy in ſome thouſands of years.

For the greater beauty of the inſtrument, the balls repreſenting the planets, are to be of a conſiderable bigneſs; but ſo contrived, that they may be taken off at pleaſure, and others, much ſmaller, and fitter for ſome purpoſes, put in their places.

When the machine is put in motion, by the turning of a winch, there are three indexes, which point out the hour of the day, the day of the month and the year, (according to the *Julian* account) anſwering to that ſituation of the heavenly bodies which it then repreſented; and ſo continually, for a period of 5000 years, either forward or backward.

In order to know the true ſituation of a planet, at any particular time, the ſmall ſett of balls are to be put each on its reſpective axis, then the winch to be turned round 'till each index points to the given time; then a ſmall *Teleſcope*, made for the purpoſe, is to be applied to the central ball, and directing it to the planet, its longitude and inclination will be ſeen on a large braſs circle, ſilvered, and properly graduated, repreſenting the *Zodiac*, and having a motion of one degree in 72 years, agreeable to the preceſſion of the *Equinoxes*: So likewiſe by applying the teleſcope to the ball repreſenting the *Earth*, and directing it to any planet, then will both the longitude and and latitude of that planet be pointed out (by an index, and graduated circle) as ſeen from the earth.

The two leſſer *Faces* are four feet in heighth, and 2 feet 3 inches in breadth: One of them repreſents and exhibits all the appearances of *Jupiter*, and his ſatellites, their eclipſes, tranſits and inclinations: Likewiſe all the appearances of *Saturn*, with his ring and ſatellites. And the other repreſents all the phænomina of the *Moon*, particularly the exact time, quantity, and duration of her eclipſes, and thoſe of the *Sun*, occaſioned by her interpoſition; with a moſt

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moſt curious contrivance for exhibiting the appearance of a *Solar Eclipſe* at any particular place on the earth: Likewiſe the true place of the *Moon* in the ſigns, with her latitude, and the place of her *Apogee* and *Nodes*, the *Sun*'s declination, equation of time, &c. It muſt be underſtood that all theſe motions are to correſpond exactly with the celeſtial motions, and not to differ ſome *Degrees* from the truth, as is common in orreries.

The whole may be adjuſted to, and kept in motion, by a ſtrong *Pendulum Clock*, neverthelefs, at liberty to be turned by the winch, and adjuſted to any time, paſt or future.

N. B. The above machine is to be ſupported by a mahogany caſe, adorned with foilage, and ſome of the beſt enrichments of ſculpture. The part containing the mechanical aſtronomy of the *Moon*, has been ſometime finiſhed, and is found perfectly to anſwer, by many trials already made of it. The remainder of the work is now almoſt completed. The clock part of it may be contrived to play a great variety of *Muſic*.

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The following CALCULATIONS *and* PROJECTIONS *of the* Tranſit *of* Venus *were laid before the Society agreeable to their Dates, and claim a Place here, as it may be of Uſe, in various Reſpects, to compare them with the* actual Obſervations *of the* Tranſit, *afterwards made in this Province; and from thence to collect the Differences between Computation and Obſervation, together with the Cauſes of thoſe Differences.*

Read 21ſt June. 1768. PROJECTION *of the enſuing* TRANSIT *of* VENUS *over the* SUN, *which is to happen* June 3d, 1769. *By* David Rittenhouſe, *A. M.*

ELEMENTS *from* Halley's *Tables, for Lat.* 40° *N.* & *Long.* 75 *W. from* Greenwich.

Communicated by Revd. Dr. Smith.

1769, June 3d, at 3 h. P. M. Sun's place, $2^{s}.\ 13^{\circ}.\ 21'.\ 37''$
Heliocentric place of ♀ in ecliptic, $8.\ 13.\ 18.\ 11$ Lat. ♀ N. $4'\ 29''$

♀ à ⊖ $3'\ 26''$

At 8 Hours P. M. Sun's place, $2^{s}.\ 13^{\circ}.\ 33'\ 35''$
Place of Venus $8.\ 13.\ 38\ .2$ Lat. ♀ N. $3'\ 18''$

⊖ à ♀ $4.\ 27$

Log. ⊖ à ⊙ 5.006568 Diſtance 10152385
Log. ♀ à ⊙ 4.861095 Diſt. 7262652
Log. ♀ à ⊖ 4.460858 Diſt. 2889733

Diff. Log. .400237

Apparent Semidiameter of ⊙ $15'.\ 51'' = 15',\ 85$
Apparent Semidiameter of ♀ - - $0',\ 5719$
Diminiſh'd [*] Semidiam. of ⊙ $6',3065$ } in Ratio of 7262 to 2889.
Diminiſh'd Semidiam. of ♀ $0',2276$ }

Beginning of the Tranſit, 2h. 16′
End, 8. 50

But ſuppoſing the Sun's horizontal Parallax but 8 Seconds, then for the above Lat. and Lon.

Firſt External Contact will be at 2h. 11min.

See the *Projection; Plate* I.

The

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[*] *The Diameters were diminiſhed to anſwer the Scale to which the Lat. of Venus was ſet off in the Projection.*

PLATE, I

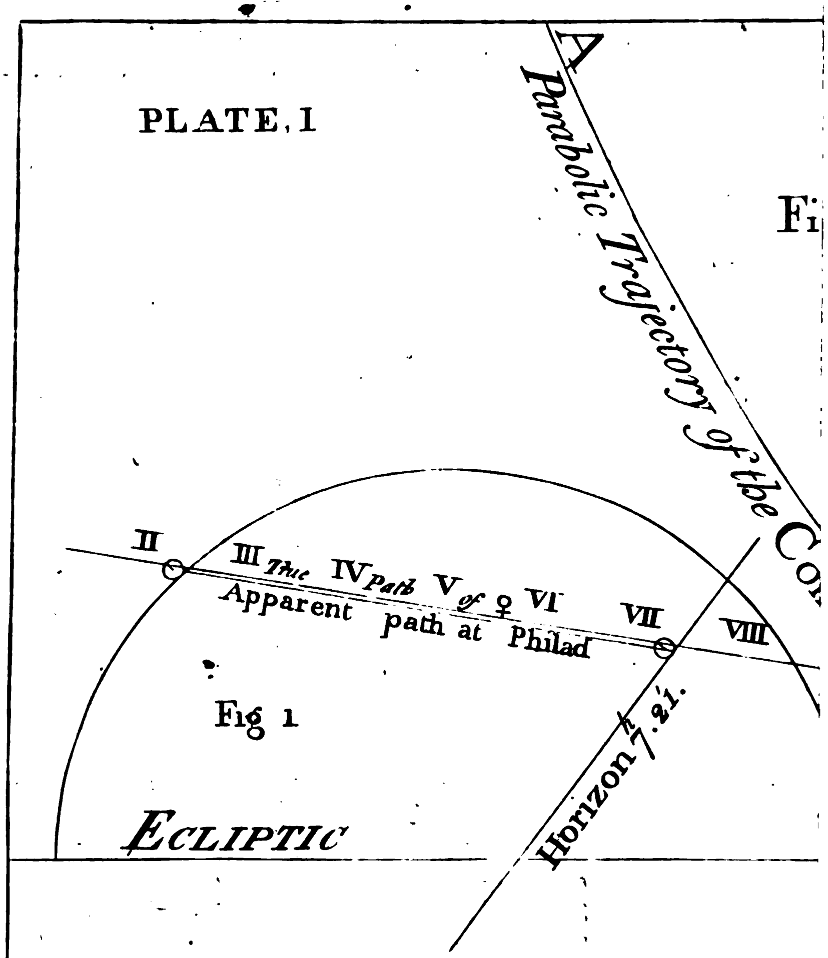

Fig 1

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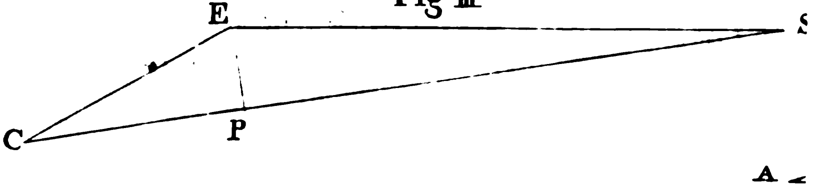
Fig III



The following Paper by the Revd. Mr. EWING, *was alſo communicated.*

GENTLEMEN,

Read June 21, 1768. AS you have taken under conſideration, the propoſal which I made to you the 19th of April laſt, of obſerving the enſuing Tranſit of Venus over the diſk of the Sun, which will be on the 3d of June, 1769; permit me to lay before you a projection of the Tranſit, as ſeen from Philadelphia, together with the elements of the projection, deduced from as accurate a calculation as I could make from Dr. Halley's Tables. I find from the obſervations made on the laſt Tranſit in June, 1761, that the mean motion of Venus, for the year 1769, ſhould be 21″ more than theſe tables make it, and that the place of the nodes of Venus, as ſtated in theſe tables, needs the following correction. At the time of the ecliptical conjunction of the Sun and Venus in June 1761, their place was 2^{s} 15° 36′ 33″, and her geocentric latitude was 9′ 44″ .9 ſouth. Then ſay, as 72626.3 the diſtance of Venus from the Sun : 28894.9 the diſtance of Venus from the earth :: 584″.9 her geocentric latitude : 3′ 52″.71 her heliocentric latitude at that time. Then ſay, as the tangent of the inclination of her orbit with the ecliptic, is to rad. ſo is the tangent of her heliocentric latitude to the ſine of her diſtance from the node; *i. e.* as T, 3° 23′ 20″ : rad. :: T, 3′ 52″.71 : S, 1° 5′ 14″, which deduct from her place June 6, 1761, at the time of the tranſit, viz. at 5^{h} 57′ 20″ at Greenwich; and the remainder viz. 2^{s} 14° 31′ 19″ is the place of her aſcending node at that time. The motion of her nodes, as ſtated by Dr. Halley, is 31″ per annum; therefore, for 8 years, add 4′ 8″ to the abovementioned place of her node and the ſum, viz. 2^{s} 14° 35′ 27″ is the place of the node in the year 1769, June 3d. With theſe corrected elements, and others, as in the tables, the following calculations are made.

The

The apparent time of the ecliptical conjunction of the Sun and Venus, as ſeen from the center of the earth, 1769, June 3d, 5^h. 4′ 43″, as reckoned at Philadelphia, 5^h. 0′ 32″ weſt from Greenwich. The place of the Sun and Venus, at the time of the tranſit, is 2^s 13° 26′ 32″. The place of her deſcending node is 8^s 14° 35′ 27″ at that time. The geocentric latitude of Venus at that time is 10′ 16″.295 The Sun's ſemidiameter is 15′ 45″.65. The ſemidiameter of Venus 0′ 29″. Their ſum 16′ 14″.65; Their difference is 15′ 16″.65. Venus's horary motion from the Sun 3′ 57″.43. The angle made by the axis of the earth and ecliptic, as ſeen from the Sun, 7° 3′ 16″. The angle made by the axis of Venus's viſible path and the axis of the ecliptic, is 8° 34′ 17″; the angular point or node being 1° 8′ 55″ weſt of the Sun. The angle made by the earth's axis and the axis of Venus's viſible path is equal to the ſum of theſe, 15° 37′ 35″. The horizontal parallax of the Sun on the day of the tranſit is 8″.5204, when his diſtance from the earth is 101521.2, his parallax at his mean diſtance 100000 being ſuppoſed to be 8″.65, as found at the laſt tranſit, 1761. The horizontal parallax of Venus on the day of the tranſit 29″.9348, when her diſtance from the Sun 72626.3, her mean diſtance being according to her periodic time 72333. The difference of theſe, viz. 21″.4144, is the horizontal parallax of Venus from the Sun on the ſaid day. The tranſit begins, as ſeen from the earth's center, at 2^h, 17′ 20″.48, and ends at 8^h. 41′ 46″.72. The total ingreſs at 2^h. 36′ 31″.38; the beginning of egreſs at 8^h. 22′ 35″.82; ſo that the whole duration between the internal contacts will be 5^h, 46′ 4″.44. But theſe times will be conſiderably altered by the parallaxes of Venus in longitude and latitude, as obſerved from different parts of the earth. The whole effect of the parallaxes of longitude and latitude at the time of the external contact to haſten it, being 3′ 31″, the time of it, as ſeen from Philadelphia, is at 2^h, 13′ 49″ 28‴ P. M. And the time of total ingreſs at Philadelphia is

2h. 32′ 27″; the total effect of theſe parallaxes to accelerate the internal contact being 4′ 4″.

Theſe times depend upon the longitude of Philadelphia, weſt of Greenwich, which in this calculation is ſuppoſed to be 5h, 0′ 32″, which is as near as I have yet been able to aſcertain it, by comparing a number of obſervations made on the eclipſes of the firſt ſatellite of Jupiter, with Mr. Emmerſon's tables. But theſe cannot be depended upon for the longitude, within a minute or two of time, which will by no means anſwer the deſign of aſcertaining the diſtances of the Sun and planets by the enſuing tranſit. I would therefore beg leave to propoſe to the Society, that proviſion be made, without loſs of time, for erecting a ſmall obſervatory in ſome convenient place that the occultations of ſome known ſtars by the Moon, and the eclipſes of Jupiter's ſatellites, may be noted, and compared with the correſponding obſervations made at Greenwich and other places: And that ſome proper perſons be appointed to make the obſervations, at the expence of the Society, that our longitude may be aſcertained with the preciſion that is neceſſary. It would be proper, that at leaſt two ſetts of obſervers be appointed to view the tranſit in this city, in order to guard againſt the fatal accident of loſing the Sun out of the field of the teleſcope, in the critical and important moment; which I find happened to a good aſtronomer in the Eaſt-Indies, at the time of the laſt tranſit. It is very difficult to preſerve a celeſtial object in the field of a teleſcope, that magnifies conſiderably.

The expence of making theſe obſervations, with ſufficient accuracy, muſt be conſiderable; but it is hoped that an opportunity will not be neglected on this account, which, for its importance to the intereſts of aſtronomy and navigation, has juſtly drawn the attention of every civilized nation in the world, and which will not be preſented again for more than a century to come.

Theſe things are ſubmitted, with all humility and deference to the judgment of this reſpectable Society, by

Their very humble Servant,

Philadelphia, June 14, 1768. *JOHN EWING.*

N. B. The difference between ſome of theſe Numbers and thoſe printed in the American Magazine, was occaſioned by neglecting the 21″ of correction in the place of Venus, as inconſiderable, the effect of which is here taken into the computation, and the reſult is ſet down above. See the projection, plate 2.

An Account of the TRANSIT OF VENUS *over the* SUN'*s* DISK, *as obſerved at* NORRITON, *in the County of* Philadelphia, *and Province of* Pennſylvania, June 3d, 1769.

By WILLIAM SMITH, *D. D. Provoſt of the College of* Philadelphia, JOHN LUKENS, *Eſq; Surveyor-General of* Pennſylvania, DAVID RITTENHOUSE, *A. M. of* Norriton, and JOHN SELLERS, *Eſq; Repreſentative in Aſſembly for* Cheſter *County*——

Being the Commitee *appointed for that Obſervation, by the* AMERICAN PHILOSOPHICAL SOCIETY, *held at* Philadelphia, *for promoting uſeful Knowledge.*

Communicated to the SOCIETY, July 20*th*, 1769, *by Direction, and in Behalf of, the* Committee; *by Dr.* SMITH.

GENTLEMEN,

AMONG the various public ſpirited deſigns, that have engaged the attention of this *Society*, ſince its firſt Inſtitution; none does them more honor than their early reſolution to appoint COMMITTEES, of their own Members, to take as many obſervations, in different places, of that *rare Phænomenon*, the TRANSIT OF VENUS over the SUN'*s* DISK, as they had any probability of being able to defray the expence of, either from their own funds, or the public aſſiſtance they expected.

As

The above letter was occaſioned by a ſhort account I had ſent to Mr. Penn four days after the tranſit, informing him of the ſucceſs of our obſervations, the times of the contacts, and a few other circumſtances attending them; which he communicated to Mr. Maſkelyne. Since that, Mr. Maſkelyne has received full ſatisfaction on all the points mentioned in his letter, as complete copies of our different obſervations have been tranſmitted to Dr. Franklin, to communicate to him, and ſuch other aſtronomers as he may think proper among his correſpondents in Europe. The particular circumſtances which I mentioned relative to the firſt entrance of Venus, was the duſky tremulous ſhadow or atmoſphere that ſeemed to precede her body, and the light that ſurrounded that part of her limb not entered on the Sun, which was alſo obſerved by the gentleman at Philadelphia, and by Mr. Biddle at the Capes. Which of theſe, or whether both, may be the curious circumſtance, or circumſtances, obſerved here, which Mr. Maſkelyne ſays the low altitude of the Sun did not permit him to obſerve, we cannot tell; as his account of the Greenwich obſervations has not yet come to hand. W. S.

An Account of the Obſervations *on the* Tranſit of Venus *over the* Sun, *on the 3d of June*, 1769, *by the* Committee *appointed to obſerve it at* Philadelphia; *drawn up, and preſented to the* American Philoſophical Society, *held at Philadelphia, for promoting uſeful Knowledge*.

By JOHN EWING.

GENTLEMEN,

IT doubtleſs muſt appear ſtrange to many, that the parallax of the Sun, which is ſo important and fundamental an article in aſtronomy, has not been ſettled by aſtronomers long ago, as ſo many things in that uſeful ſcience depend upon it. But this ſurpriſe is leſſened by conſidering, that the ſmallneſs of the parallactic angle has eluded their moſt careful reſearches in all ages, as it is but about 8 or

9 ſeconds

9 ſeconds of a minute; ſo that the ſubtenſe of it, were it much larger than it is, muſt be inviſible to the naked eye at the diſtance of 6 inches, and it is hardly poſſible to diſtinguiſh 10 ſeconds by inſtruments, let them be ever ſo ſkilfully made. Many methods have been deviſed by aſtronomers, which ſhew the ingenuity of the inventors; but the diſadvantage of them all was, that they depended upon obſervations to be made with a preciſion, which no inſtruments hitherto conſtructed could poſſibly accompliſh. The tranſits of Venus alone afford an opportunity of determining this problem with ſufficient certainty, and theſe, from the ſtrict laws of her motion, happen ſo ſeldom, that there cannot be more of them than two in one century, and in ſome centuries none at all. Three only have been obſerved ſince the creation, and the firſt of them by two perſons only. The peculiar advantage of this phœnomenon for determining the parallax of the Sun with a preciſion which is not to be expected from any other method, conſiſts in its being deduced from the abſolute time that elapſes between the inſtants of the contacts with the Sun's limb, as ſeen from different parts of the earth; or from the difference of total durations as noted by diſtant obſervers, properly ſtationed for that purpoſe. A ſecond of time being eaſily diſtinguiſhed by a well regulated clock, if the aforeſaid abſolute difference of time be carefully noted, in places where it will amount to 24 minutes, it will give the parallax, ſmall as it is, within the hundreth part of a ſecond of a degree, and conſequently the diſtance of the Sun and planets within the ſeven hundredth part of the whole. In ſome tranſits this difference of time will be greater, and in others leſs, in certain places on the earth, which renders thoſe that happen on the northern part of the Sun's diſc, in general, more favourable to our purpoſe, than thoſe that happen on the ſouthern hemiſphere. Hence it is, that although much was done in this matter by the ſedulity and care of aſtronomers at the tranſit in the year 1761, when Venus paſſed ſouth of the Sun's center, yet our

our expectations could not be fully anſwered by the obſervations that were then made; as it was eaſily foreſeen that much greater preciſion might be attained, from the advantageous circumſtances that would attend the tranſit in 1769. The great proficience, which the aſtronomers made in ſettling this fundamental element, beyond what was ever known before, has only raiſed their expectations and engaged their attention to improve every advantage, that can be derived from a careful obſervation of this tranſit. If they have not been diſappointed by unfavourable weather, we hope for the utmoſt certainty that can be gained in this matter, from the obſervations they have made, when they ſhall be compared together. But after all, we muſt ſit down with the diſagreeable aſſurance that the diſtance of the Sun cannot be determined by them, let them be made with ever ſo great accuracy, within many thouſand miles; which will not appear ſtrange, when we conſider that his diſtance is upwards of 94 millions of miles, and that an error of a ſingle ſecond in his parallax will give an uncertainty of 10 or 11 millions of miles in his diſtance.

This approximation, however, is ſo much greater than could be expected, from any other method, that has ever been propoſed, that it has deſervedly engaged the attention of every civilized nation in the world; and it muſt redound to the honor of our ſociety, that they have taken ſuch effectual care to have proper obſervatories erected, to furniſh them with the neceſſary inſtruments, and to appoint proper perſons, to uſe them on that occaſion.

As the credit of our obſervations, and the ſtreſs that will be laid upon them, in determining the parallax of the Sun, will greatly depend not only on the care and ſkill of the perſons that made them, but alſo on the goodneſs of the inſtruments, with which we were furniſhed; it has been judged proper to give the public the following account of our apparatus, and of the pains we have taken to have it in the beſt order.

As the Society were pleaſed to appoint *Joſeph Shippen*, Eſq. Dr. *Hugh Williamſon*, Mr. *Charles Thomſon*, Mr. *Thomas Prior*, and *myſelf*, as a committee to obſerve the tranſit at the obſervatory, which they had erected in this city, we ſpared neither time nor labour to have every thing neceſſary for the obſervation in readineſs. We were provided with an excellent ſector of 6 feet radius, made by the accurate Mr. Bird, and an equal altitude and tranſit inſtrument, both belonging to the honourable Proprietaries of this province, which the Governor very generouſly lent to the ſociety on this occaſion. Our teleſcopes were, a large reflector of 4 feet focus and 7 inches aperture, which magnified from 100 to 400 times with an excellent micrometer of Mr. Dollond's conſtruction fitted to it, which the aſſembly of the province had ordered over at the requeſt of the ſociety; a refracting teleſcope of 24 feet focus, belonging to Miſs Norris; two reflecting teleſcopes of 18 inches focus, one the property of Mr. Hamilton, the late Governor of this province, and the other of Mr. Prior, together with another reflector of 12 inches focus. With theſe, and a good time-piece, we promiſed ourſelves the pleaſure of making accurate obſervations, if the weather ſhould prove favourable. For this purpoſe we met frequently before the day of the tranſit, to adjuſt our inſtruments, and to remove every local obſtruction that might hinder our obſervations.

Some of us gave particular attention to the regulation of the time-piece, and therefore took the paſſage of the Sun's limbs over the croſs hairs of the tranſit inſtrument, both forenoon and afternoon for many days before and after the tranſit, and particularly on that day. As it had three horizontal hairs fixed in the focus, it afforded us ſix ſets of correſponding altitudes, which generally agreed in giving the time of apparent noon within 2 ſeconds of each other; ſo that by comparing them together daily, and applying the proper equations for correſponding altitudes, on account of the Sun's change of declination between the

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forenoon and afternoon obſervations, we were aſſured of the rate of our clock's going and the time of apparent noon to a ſingle ſecond. We did not think it neceſſary to burden our minutes, with the great number of obſervations of this kind, that we made. Let us ſuffice to ſay, that they were made with the utmoſt care, and that our time-piece was fixed to a large poſt ſunk into the ground four or five feet, ſecured from ſhaking by a brick wall at the bottom, and no ways communicating with the ſides of the building.

The long expected day of the tranſit came, ſo favourable to our wiſhes, that there was not the leaſt appearance of a cloud in the whole horizon from morning 'till night, and the ſky was uncommonly ſerene. The committee aſſembled in the morning at the obſervatory, examined the adjuſtment of their teleſcopes anew, and appointed two aſſiſtants to obſerve the clock, one to count the ſeconds with an audible voice, and the other to write down the minutes as they were compleated, to prevent a miſtake in that article.

Every obſerver being fixed at his teleſcope, at leaſt half an hour before the beginning of the tranſit; we obſerved the contacts of the limbs of Venus and the Sun at the times mentioned in the following accounts, as they were drawn up ſeparately by the obſervers themſelves, and are here inſerted in their own words.

Account of the CONTACTS, *by* JOSEPH SHIPPEN, ESQ.

" I obſerved this very uncommon and curious phœnomenon with a new reflecting teleſcope, made by Mr. George Adams, whoſe tube is two feet and half an inch long, its aperture 4,15 inches diameter, and its magnifying power about 90 times. After having well adjuſted its focal diſtance, the Sun's limb appeared ſo well defined, that the leaſt obſcuration of it might be clearly diſcerned by a good eye.

" In

" In order to diſcover the firſt external contact, as near the preciſe time of its happening as poſſible, I kept conſtantly in the field of the teleſcope, but a ſmall arch of the Sun's limb, and only that part of it, where it was expected the planet would enter; by which means I believe I ſaw the obſcuration on the limb of the Sun as near the exact time of its beginning as the power of the teleſcope would admit of.

" The firſt alteration which I perceived in the Sun's diſk, was *a jagged like appearance* on a ſmall arch of the limb; as if a ſhadow had been caſt on it with *an irregular notched edge*, which at every ſecond, ſeemed to increaſe with a kind of waving and tremulous motion. I firſt perceived this change at 2ʰ. 13′. 47″ apparent time, though I was not then convinced that that appearance was, either the phœnomenon we looked for, or cauſed by the planet's near approach to the Sun's limb; but imputed it rather to ſome duſt that might accidentally have fallen on the large mirror of the teleſcope, as I expected the contact would have ſhewn itſelf by one ſmall arched *indent* on the Sun's limb. And it was not 'till after twelve ſeconds more had paſſed, that I was certain the contact had happened; for then, viz. at 2ʰ. 13′. 59″ apparent time, I could plainly diſtinguiſh a ſingle impreſſion, or indent, in the Sun's limb; yet it was exceedingly ſmall, and without any of the *jagged appearance* before mentioned.

" I cannot well account for theſe different appearances in ſo ſmall a ſpace of time, but by ſuppoſing that the firſt was occaſioned by an atmoſphere around the body of Venus, which might have obſcured in a ſmall degree, part of the Sun's limb, a few ſeconds before the contact; and that after Venus herſelf had actually entered on the Sun's limb, the brilliancy of the ſolar rays might have ſo far illuminated the atmoſphere of Venus, as to cauſe the obſcuration at firſt perceived to diſappear, and leave only the well defined form of the planet on the Sun's diſk.

" On

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"On conſidering the matter in this view, I am inclined to think that the firſt external contact did not really happen 'till at leaſt three ſeconds after I firſt perceived the jagged obſcuration on the Sun's limb; and then it would be at $2^h. 13'. 50''$ apparent time.

"But if aſtronomers agree to fix the time of the firſt contact at the beginning of that obſcuration, I think it is probable the contact may have happened two or three ſeconds before I diſcerned that obſcuration: In which caſe, the contact may be ſaid to take place at $2^h. 13'. 44''$ apparent time.

"In determining on the manner in which I ſhould judge of the *internal contact*, I conſidered that after Venus ſhould move on the Sun's diſk with half her diameter, the horned points occaſioned thereby in the Sun's limb would appear more acute, and approach nearer to each other as the planet proceeded till the points ſhould actually unite. From this reflection I was induced to think, that the inſtant of the cloſing of thoſe points ought to be fixed on as the preciſe time of the internal contact; becauſe Venus muſt then have paſſed the Sun's limb with her whole diameter, and both their circumferences, or limbs, might be ſaid to coincide.

"I therefore carefully obſerved the progreſs of the planet, and ſaw very diſtinctly, as ſhe moved onwards, that the illuminated points of the Sun's limb became better defined; and when they approached ſo near each other as to be within about 8 ſeconds of touching, which was at $2^h. 31'. 26''$ ap. time, I heard one of the obſervers call out, *contact*; but as his obſervation did not ſeem to agree with the manner which I had fixed for judging of the contact, I continued viewing with the cloſeſt attention, in order to fix the time of contact according to the idea I had formed of it; and at $2^h. 31' 34''$. ap. time I could ſcarcely diſtinguiſh the illuminated points of the Sun's limb to be any longer ſeparate; for in two ſeconds more they appeared to be ſo far cloſed as to form a ſingle thread of light on that part of the Sun's limb, which a few ſeconds before had been eclipſed.

I therefore

I therefore conclude that the *apparent* firſt internal contact of Venus happened at 2^{h}. 31′. 34″ ap. time. Yet it is not improbable that her *real* contact may have happened a few ſeconds ſooner, if it be certain that ſhe has an *atmoſphere*; becauſe *that* might have obſcured the Sun's limb a few ſeconds after Venus was entirely immerſed within the diſk; in the ſame manner as I judged with reſpect to the external contact, that the beginning of the obſcuration of the Sun's limb was occaſioned by the intervention of the atmoſphere of Venus a few ſeconds before her body actually came in contact with the Sun."

Account of the CONTACTS, *by Dr.* WILLIAMSON.

"I made uſe of a refracting teleſcope 24 feet long, which magnifies ninety times. The glaſſes were in very good order, and the air uncommonly ſerene, ſo that the Sun's limb appeared very diſtinct and well defined, whence I promiſed myſelf the pleaſure of fixing the external contact to a ſecond, but the event convinced me that I had promiſed too much. A duſky appearence once and again drew my attention to a particular part of the Sun's limb, but I could ſee no ſuch dark ſpot there as I thought Venus muſt produce, and it was not till 2^{h}. 11′. 31″ mean time, or 2^{h}. 13′. 46″ apparent time, that I determined to ſtop a watch which I had in my hand, to aſcertain the time of my obſervation, leaſt ſome accident ſhould prevent my hearing the aſſiſtant, who ſtood at 5 or 6 yards diſtance by the clock counting ſeconds. At that very time I was doubtful, whether the appearance on the limb of the Sun was certainly occaſioned by the interpoſition of the body of Venus; for though the darkneſs was of ſome extent along the Sun's limb, yet the impreſſion was not proportionably deep, ſuppoſing that it was made by a circle ſo ſmall as Venus compared with the diameter of the Sun, nor was the darkneſs equally perfect; yet the ſubſequent progreſs of the darkneſs ſoon convinced me that I had not been much too haſty in noting the time of the external contact.

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" When Venus had advanced with a little more than half her body on the Sun, her whole eaſtern limb appeared faintly illuminated: This light ſeemed to encreaſe as ſhe advanced farther on the Sun, till near the time of the internal contact. By this time I was convinced that Venus is ſurrounded by a denſe atmoſphere of a conſiderable height, which doubtleſs had prevented my fixing the external contact, with that accuracy I had expected, and had occaſioned that inequality in the darkneſs, which I had obſerved on the Sun's limb.

" In determining the internal contact, which I apprehend was done with great exactneſs, I attended to the inſtant, when there was a prefect coincidence of the limb of Venus with the limb of the Sun, as when two circles touch internally. This appeared at 2h. 31′. 24″ apparent time. I expected by the time the aſſiſtant had counted another ſecond, to have ſeen light diſtinctly round the eaſtern limb of Venus; not ſuch a radiance as had for 7 or 8 minutes rendered that part of the planet viſible; but a certain narrow portion of the Sun's limb which had a very diſtinguiſhable appearance from the light I have mentioned. The edge of the Sun did not appear ſo ſoon; nevertheleſs I fixed upon 2h. 31′. 25″ for the preciſe time of the internal contact, being certain, that no part of Venus was then off the Sun. One or two ſeconds more were counted before the Sun appeared diſtinctly without the limb of Venus. But then it was obvious that Venus did not then touch the Sun's limb in any part, ſo that the contact was certainly over."

Mr. Prior made his obſervations with his own reflecting teleſcope, whoſe magnifying power he does not certainly know, but ſuppoſes it to be at leaſt an hundred times. He gave the following account of his obſervation of the contacts, viz.

" The uncertainty where Venus would touch the Sun's limb made me take the following method. From 8 or 9 minutes paſt two o'clock I made it a rule to paſs my eye from the lower edge of the field of my teleſcope to the upper,

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per, many times in a minute, and examine the limb of the Sun ſtrictly, in hopes of diſcovering the atmoſphere of Venus approach, ſo as to give an opportunity of taking the contacts of the limbs to a great certainty. In paſſing my eye along the limb of the Sun, I diſcovered a ſmall imperfection, which I thought muſt be the ſtroke of the atmoſphere, but in four ſeconds I diſcovered it to be the limb of Venus, the atmoſphere not being viſible on the Sun. The time therefore that I note for my external contact is, when I firſt diſcovered that imperfection on the Sun's limb, which was at 2^h. 13′. 42″ apparent time. When the body of Venus was ſomething more than one third on the Sun, I ſaw her eaſtern atmoſphere very diſtinctly reflecting the light of the Sun ſo ſtrongly on the limb of Venus, as to ſhew it well defined; but as it came on the Sun, it was entirely loſt. The time, I note for my internal contact, was, when the thread of light was diſtinctly ſeen all round the body of Venus, which was at 2^h. 31′. 28″ apparent time."

Mr. James Pearſon, having obſerved the external contact at 2^h. 13′. 50″ apparent time, with a ſmall teleſcope, belonging to the honorable proprietaries of this province, whoſe magnifying power is about 60 times; Mr. Charles Thompſon obſerved the internal contact with the ſame teleſcope, of which he gave the following account, viz.

"At 2^h. 29′. 11″ mean time, or 2^h. 31′. 26″. apparent time, I ſaw ſome tremulous rays of light paſs from the upper or eaſtern limb of the Sun to the eye, acroſs, and ſo as juſt to touch the upper limb of Venus. Marking that down therefore as the time of contact, I counted four ſeconds, at which time I ſaw a continued thread of light, like a ſilver lace, but ſtill with a tremulous motion, round the eaſtern limb of Venus, whereby it appeared to me that the whole body of Venus was then within the diſk of the Sun. The tremulous appearance of the rays of light, I at firſt attributed to my teleſcope reſting againſt the ſide of the obervatory, but afterwards apprehended might be owing to their paſſing through the atmoſphere of Venus." The

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The committee having deſired me to uſe the large reflector mentioned above, I choſe that power which magnifies the diameters of objects 300 times; with which I obſerved at $2^{h}.\ 13'.\ 48''$. apparent time, an obſcuration on the north-eaſtern limb of the Sun, gradually advancing forwards with a tremulous motion, which, from its irregular and duſky appearance, I concluded was occaſioned by the refraction on the Sun's rays through the atmoſphere of Venus, which atmoſphere ſoon afterwards became very obſervable to us all. From this I was led to conclude that the contact did not happen till about 15 or 16 ſeconds afterwards, when there was a large and evident impreſſion made on the limb of the Sun; but as the preciſe moment of the external contact cannot be noted by an obſerver, the body of Venus not yet being interpoſed between the Sun's limb and the eye; this contact muſt have happened about the time that her atmoſphere made the abovementioned obſcuration, and therefore I am of opinion that the true time of the contact ſhould be accounted at $2^{h}.\ 13'.\ 48''$, or it may be 3 or 4 ſeconds ſooner, when nothing but the atmoſphere of Venus, which preceded her body, appeared on the limb of the Sun. About the time that the center of Venus approached the Sun's diſk, I ſaw the whole body of Venus, her eaſtern edge being ſurrounded with a faint light which was doubtleſs occaſioned by her atmoſphere refracting the Sun's rays. At $2^{h}.\ 29'.\ 11''$ mean time, or $2^{h}.\ 31'.\ 26''$ apparent time, I ſaw the internal contact, when the whole body of Venus was introduced within the diſk of the Sun, and the thread of light had compleatly ſurrounded her, although not as bright as it became in two ſeconds afterwards.

From what has been ſaid, it appears that the apparent times of the contacts may be repreſented at one view in the following table, as they were noted by the different obſervers.

	1ſt Exter. Contact. h. m. ſec.	1ſt Inter. Contact. h. m. ſec.	Magnifying Powers.
Joſeph Shippen, Eſq.	2. 13. 47 Ap. T.	2. 31. 34 Ap. T.	80 times.
Dr. Williamſon,	2. 13. 46	2. 31. 25 to 27	90 times.
Mr. Pearſon,	2. 13. 50	- - - -	60 times.
Mr. Thompſon,	- - - -	2. 31. 26 to 30	
Mr. Prior,	2. 13. 42	2. 31. 28	100 times.
Myſelf,	2. 13. 48	2. 31. 26	300 times.
A well-defined black dent in ⊙'s limb, at	2. 14. 3		

After the obſervation of the contacts, I applied myſelf to the micrometer to meaſure the diameters of the Sun and Venus, and the diſtance of their limbs at ſundry times during the tranſit. I had indeed frequently meaſured the equatorial diameter of the Sun before the day of the tranſit, and always found it to be 6 ſeconds leſs than what is given in the nautical almanac. The mean of 6 meaſures on that day is 31′. 31″.6, which differs but 0″,3 or three-tenths of a ſecond from what is given in the ſaid almanac leſſened as above. Therefore I have ſtated it at 31′. 31″.3 in the following reductions and calculations.

Six meaſures of the diameter of Venus on the Sun made it 58 ſeconds. I attempted to meaſure it both ways, with the beginning of the diviſions of the vernier advanced on the ſcale of the micrometer and the contrary, that the error of adjuſtment might have been thereby taken away. But the micrometer did not admit of it, the diameter of Venus being a ſmall matter too large for this operation. However I took ſome meaſures this way, but they gave the diameter no more than 55″.4, which appearing too ſmall were therefore rejected.

About 20 minutes after the contacts, I began to meaſure the neareſt diſtance of the limbs of Venus and the Sun, and continued untill the Sun was ſo low, that the meaſures could not be made with ſufficient accuracy any longer. Some of the meaſures appear to diſagree too much with the others, and therefore ſhould not be depended on; but I could not prevail upon myſelf to neglect the inſerting of them; leaſt the unuſual agreement among ſo great a number ſhould raiſe a ſuſpicion, in the minds of aſtronomers, that they had not been honeſtly tranſcribed from our minutes; eſpecially as there are enough, to anſwer all the purpoſes deſigned by them, which agree in giving the neareſt diſtance of the centers with ſufficient preciſion. Although theſe meaſures are ſet down in the following table with the parts of a ſecond, we would not therefore be ſuppoſed to affect an impoſſible accuracy in them; but they are ſuch as the micrometer has given them when properly reduced.

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No. of Obſerv.	M. Time. 1769. *June 3d,*			Ap. Time.			Neareſt diſtance of the limbs of ☾ and ♀		Neareſt diſtance of their centers.		Par. of ♀ in the Vertical.	Par. of ♀ in her Path.	Par. of ♀ perpendic. to her path.
	h.	m.	ſec.	h.	m.	ſec.	m.	ſec.	m.	ſec.	ſec.	ſec.	ſec.
1	2.	53.	43	2.	55.	59	1.	8,46	14.	8,19	13,95	13,20	4,56
2	3.	5.	51	3.	8.	7	1.	48,23	13.	57,42	14,60	13,9	4,64
3	3.	11.	32	3.	13.	48	2.	4,49	13.	12,16	14,92	14,20	4,68
4	3.	14.	17	3.	16.	33	2.	10,4	13.	6,25	15,05	14, 3	4,70
5	3.	22.	7	3.	24.	23	2.	24,77	12.	33 07	15,50	14,70	4,78
6	3.	25.	45	3.	28.	0	2.	33,25	12.	34,3	15,70	14,90	4,86
7	3.	27.	37	3.	29.	52	2.	38,46	12.	29,09	15,75	15,02	4,90
8	3.	44.	31	3.	46.	46	3.	18,86	11.	57,89	16,55	15,80	5,02
9	4.	2.	31	4.	4.	46	3.	53,64	11.	23,01	17,38	16,56	5,30
10	4.	3.	41	4.	5.	56	3.	55,6	11.	21,05	17,45	16,62	5,31
11	4.	8.	39	4.	10.	54	4.	8,54	11.	8,11	17,63	16,64	5,32
12	4.	10.	9	4.	12.	24	4.	13,85	11.	2,8	17,60	16,80	5,35
13	4.	14.	53	4.	17.	8	4.	15,81	11.	0,84	17,83	17,01	5,44
14	4.	22.	5	4.	24.	20	4.	22,10	10.	53,55	18,10	17,20	5,52
15	4.	25.	37	4.	27.	52	4.	30,36	10.	46,29	18,20	17,30	5,56
16	4.	29.	47	4.	32.	2	4.	35,92	10.	40,73	18,40	17,50	5,68
17	4.	41.	57	4.	44.	12	4.	50,14	10.	26,51	18,80	17,90	5,90
18	4.	44.	0	4.	46.	15	4.	51,96	10.	24,69	18,94	17,98	5,97
19	4.	51.	18	4.	53.	33	4.	58,62	10.	18,03	19,14	18,10	6,06
20	4.	52.	16	4.	54.	31	5.	1,23	10.	15,42	19,16	18,16	6,09
21	4.	53.	27	4.	55.	42	5.	1,23	10.	15,42	19,20	18,20	6,12
22	4.	54.	52	4.	57.	7	5.	3,18	10.	13,47	19,26	18,26	6,17
23	4.	56.	30	4.	58.	45	5.	5,14	10.	11,51	19,30	18,30	6,20
24	4.	58.	29	5.	0.	44	5.	6,44	10.	10,21	19,36	18,35	6,24
25	5.	1.	35	5.	3.	50	5.	5,14	10.	11,51	19,44	18,43	6,30
26	5.	9.	29	5.	11.	44	5.	5,79	10.	10,86	19,55	18,52	6,46
27	5.	11.	52	5.	14.	7	5.	9,05	10.	7,6	19,68	18,74	6,50
28	5.	18.	29	5.	20.	44	5.	12,96	10.	3,69	19,95	18,85	6,69
29	5.	20.	29	5.	22.	43	5.	14,26	10.	2,39	20,05	18,90	6,76
30	5.	24.	17	5.	26.	31	5.	14,26	10.	2,39	20,14	18,98	6,90
31	5.	25.	59	5.	28.	13	5.	9,7	10.	6,95	20,19	18,99	6,91
32	5.	28.	33	5.	30.	47	5.	8,4	10.	8,25	20,20	19,01	6,96
33	5.	33.	39	5.	35.	53	5.	5,14	10.	11,51	20,36	19,08	7,08
34	5.	35.	45	5.	37.	59	5.	1,88	10.	14,77	20,40	19,10	7,10
35	5.	43.	17	5.	45.	31	5.	2,53	10.	14,12	20,50	19,18	7,28
36	6.	1.	13	6.	3.	27	4.	50,79	10.	26,86	20,84	19,34	7,78
37	6.	2.	39	6.	4.	53	4.	49,49	10.	27,16	20,90	19,38	7,88
38	6.	8.	7	6.	10.	21	4.	44,27	10.	32,38	20,96	19,42	7,97
39	6.	10.	4	6.	12.	18	4.	43,52	10.	33,13	21,0	19,44	8,00
40	6.	18.	37	6.	20.	51	4.	30,58	10.	46,07	21,04	19,46	8,20
41	6.	21.	49	6.	24.	3	4.	24,06	10.	52,59	21,10	19,48	8,32
42	6.	26.	13	6.	28.	27	4.	15,81	11.	0,84	21,14	19,50	8,40
43	6.	32.	18	6.	34.	32	4.	1,46	11.	14,19	21,18	19,50	8,60
44	6.	33.	55	6.	36.	9	4.	3,42	11.	13,23	21,20	19,46	8,68
45	6.	37.	29	6.	39.	43	3.	58,2	11.	18,45	21,22	19,43	8,76
46	6.	38.	55	6.	41.	9	3.	54,29	11.	22,36	21,24	19,40	8,82
47	6.	41.	39	6.	43.	53	3.	49,73	11.	26,92	21,26	19,36	8,92
48	6.	43.	57	6.	46.	11	3.	44,94	11.	31,71	21,28	19,34	8,98
49	6.	46.	25	6.	48.	39	3.	42,98	11.	33,67	21,29	19,31	9,02
50	6.	48.	49	6.	51.	3	3.	36,46	11.	39,19	21,30	19,29	9,17
51	6.	53.	17	6.	55.	31	3.	28,6	11.	48,01	21,34	19,26	9,21
52	7.	2.	1	7.	4.	15	3.	9,08	12.	7,57	21,38	19,24	9,48
53	7.	4.	33	7.	6.	47	3.	4,52	12.	12,13	21,39	19,20	9,56
54	7.	9.	26	7.	11.	40	3.	5,82	12.	11,83	21,40	19,10	9,70

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The foregoing neareſt diſtances of their centers are deduced from the meaſured diſtances of their limbs, taking their diameters as they are ſtated above: And the parallaxes are not computed, but meaſured from a projection of the diſk of the earth as ſeen from the Sun, the projection being 21 inches and an half in diameter.

The latitude of our obſervatory in Philadelphia is determined from the obſervations of Meſſrs. Maſon and Dixon with the above mentioned ſector. From a mean of thirty obſervations of the paſſage of ſome ſtars over the meridian, they found the latitude of the moſt ſouthern point of the city of Philadelphia to be 39°. 56′. 29″,2. Our obſervatory is north of this point, 26,2 ſeconds, and therefore its latitude is 39°. 56′ 55″,4.

In order to determine the parallax of the Sun, from the foregoing obſervations, it is neceſſary that our longitude from ſome fixed meridian ſhould be aſcertained with the moſt rigorous preciſion. For this purpoſe we have obſerved various eclipſes of Jupiter's ſatellites, that they might be compared with the correſpondent obſervations made at Greenwich and elſewhere, when we are furniſhed with them.

Eclipſes of JUPITER's SATELLITES, obſerved at *Philadelphia*, with a two feet reflector.

		D.	h.	m.	ſec.			
1767.	*April*	3,	7.	11,	23	Em.	*2d.*	Ap. T.
	May	30,	10.	15,	32	Em.	*1ſt.*	
	June	13,	9.	18.	6	Em.	*2d.*	
1768.	*Mar.*	1,	9.	46.	49	Im.	*1ſt.*	
	April	9,	10.	37.	2	Em.	*1ſt.*	
		25,	8.	56.	50	Em.	*1ſt.*	
	May	12,	10.	33.	9	Em.	*2d.*	
1769.	*Feb.*	16,	14.	21.	51	Im.	*1ſt.*	
		20,	15.	42.	1	Im.	*2d.*	
		23,	16.	16.	21	Im.	*1ſt.*	
	Mar.	17,	12.	45.	21	Im.	*2d.*	
1769.	*April*	3,	14.	50.	48	Im.	*1ſt.*	Ap. T.
		11,	9.	49.	14	Im.	*2d.*	
		12,	11.	15.	49	Im.	*1ſt.*	
	May	5,	11.	30.	28	Im.	*1ſt.*	
With a four feet reflector.								
	June	7,	8.	44.	37	Em.	*2d.*	
		22,	8.	27.	25	Em.	*1ſt.*	
		29,	10.	21.	55	Em.	*1ſt.*	
	Aug.	23,	12.	15.	48	Em.	*1ſt.*	
	Sept.	11,	7.	44.	41	Em.	*2d.*	

Since the foregoing account has been drawn up, we have been furniſhed with ſome obſervations of the eclipſes of Jupiter's ſatellites, made by the revd. Mr. Maſkelyne, aſtronomer royal, at Greenwich. By comparing theſe with the like obſervations made at Philadelphia and Norriton, we are enabled to ſettle the longitudes of our obſervatories.

But

But as there are but two or three of them correſpondent with ours, we muſt have recourſe to another method; which is firſt to compare them with the calculations in the nautical almanac, which were made for the meridian of Greenwich, that the error of the tables may be diſcovered by the mean of them; and then to compare ours with the ſame calculations, applying the errors of the tables to the longitude deduced from this compariſon. We may depend upon the reſult of this method with much more confidence, than upon any ſingle obſervation.

Here follow the Apparent Times of the Greenwich Obſervations compared with the calculations of the Nautical Almanac.

1769.	D.	h.	m.	ſec.	
Mar.	29,	12.	25.	7	Im. 1ſt obſ. at Green.
	29,	12.	24.	26	Do. p. calc. of N. Al.
				41	Error Weſt.
Apr.	11,	14.	50.	23	Im. 2d obſ. at Greenw.
	11,	14.	50.	4	Do. p. calc. of N. Al.
				19	Error Weſt.
	12,	16.	16.	13	Im. 1ſt obſ. at Greenw.
	12,	16,	16,	13	Do. p. calc. of N. Al.
				00	
June	8,	9.	41.	16	Em. 1ſt obſ. at Green.
	8,	9.	41.	26	Do. p. calc. of N. Al.
				10	Error Eaſt.
	15,	11.	35.	33	Em. 1ſt obſ. at Green.
	15,	11,	34.	55	Do. p. calc. of N. Al.
				38	Error Weſt.

1769.	D.	h.	m.	ſec.	
April	28,	14.	35.	17	Im. 1ſt obſ' at Green.
	28,	14.	36.	14	Do. p. calc. of N. Al.
				57	Error Eaſt.
May	6,	11.	51.	2	Im. 2d obſ. at Greenw.
	6,	11.	51.	45	Do. p. calc. of N. Al.
				43	Error Eaſt.
May	16,	9.	32.	15	Em. 1ſt obſ. at Greenw.
	16,	9.	31.	7	Do. p. calc. of N. Al.
			1.	8	Error Weſt.
July	1,	9.	50.	24	Em. 1ſt obſ. at Greenw.
	1,	9.	50.	37	Do. p. calc. of N. Al.
				13	Error Eaſt.

Now although the errors of the firſt ſatellite appear conſiderable, yet if we reject the obſervation of the 16th of May as being too near to the time of Jupiter's oppoſition with the Sun; the mean of thoſe, which give an eaſtern meridian correſponding with the calculations of the nautical almanac, exactly counterbalances the mean of thoſe which give a weſtern meridian correſponding with them. Therefore we have nothing to do but to reduce all our obſervations at Norriton and Philadelphia to the meridian of Philadelphia, and then compare them with the calculations in the nautical almanac.

The

The Norriton obſervations of the eclipſes of Jupiter's firſt Satellite are as follow.

		D.	h.	m.	ſec.	
1769.	*Feb.*	16,	14.	21.	10	Im. *1ſt.*
		23,	16,	15.	1	Im. *1ſt.*
	April	3,	14,	49.	25	Im. *1ſt.*
		10,	16.	46.	0	Im. *1ſt.*
		12,	11.	14.	37	Im. *1ſt.*
	May	5,	11.	29.	27	Im. *1ſt.*
1769.	*May*	14,	10.	2.	14	Em. *1ſt doubtful.*
		21,	11.	55.	13	Em. *1ſt.*
	June	6,	10.	11.	32	Em. *1ſt.*
		7,	8.	43.	44	Em. *2d.*
		13,	12.	5.	1	Em. *1ſt.*

Now if we compare the correſpondent obſervations at Philadelphia and Norriton on the 16th of February, the 12th of April, the 5th of May, and the 7th of June 1769, the difference of our meridians will be found from the mean of them to be 57 ſeconds of time. This is farther confirmed by the obſervations we have made on the tranſit of Mercury over the Sun, on the 9th of November, 1769, which being compleated before theſe ſheets were printed off, we have judged proper to inſert.

Apparent Time.	h.	m.	ſec.	
The external contact was at	2.	36.	9	by the mean of 4 obſervations at Philadelphia,
And at	2.	35.	17	by the mean of 3 obſervations at Norriton.
The difference is			52	
The internal contact was at	2.	37.	34	by the mean of 4 obſervations at Philadelphia,
And at - - -	2.	36.	34	by the mean of 3 obſervations at Norriton.
The difference is		1.	0	

Therefore the mean of both theſe makes the difference of our meridians 56 ſeconds of time, which muſt certainly be more accurate than what is deduced from a few correſponding obſervations of the eclipſes of Jupiter's ſatellites; both becauſe they afford 24 compariſons, all nearly agreeing among themſelves, and becauſe theſe tranſits, in the judgment of moſt aſtronomers, afford the beſt opportunities of ſettling the longitude of places. Hence if we add 56 ſeconds to the time of the Norriton obſervations of the eclipſes of Jupiter's ſatellites, they will be reduced to the meridian of our obſervatory in Philadelphia, and may be uſed in fixing our longitude from Greenwich, in the following manner.

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The calculated time per Nautical Almanac.	The obſerved Time at Philadelphia.	The Norriton obſ. red. to the merid. of Phil.	The difference of merid. of Gr. and Philadel.
D. h. m. ſec.	D. h. m. ſec.	D. h. m. ſec.	D. h. ſec.
1767. *May* 30, 15. 16. 10 Em. *1ſt.*	30, 10. 15. 32	- - - - -	5, 0. 38
June 13, 14. 17. 37 Em. *2d.*	13, 9. 18. 6	- - - - -	4, 59. 31
1768. *Mar.* 1, 14. 48. 24 Im. *1ſt.*	1, 9. 46. 49	- - - . -	5, 1. 35
April 9, 15. 36. 34 Em. *1ſt.*	9, 10. 37. 2	- - - - -	4, 59. 32
25, 13. 57. 46 Em. *1ſt.*	25, 8. 56. 50	- - - - -	5, 0. 56
May 12. 15. 34. 11 Em. *2d.*	12, 10. 33 9	- - - - -	5, 1, 2
1769. *Feb.* 16. 19. 22. 29 Im. *1ſt.*	16, 14. 21. 51	- - - - -	5, 0, 38
16, 19. 22. 29 Im. *1ſt*	- - - -	16, 14. 22. 6	5, 0. 23
20, 20. 42. 55 Im. *2d.*	20, 15. 42. 1	- - - - -	5, 0. 54
23, 21. 16. 35 Im. *1ſt.*	23, 16. 16. 21	- - - - -	5, 0. 14
23, 21. 16. 35 Im. *1ſt.*	- - - -	23, 16. 15. 57	5. 0. 38
Mar. 17. 17. 46. 4 Im. *2d.*	17, 12. 45. 21	- - - - -	5. 0. 43
April 3, 19. 51. 24 Im. *1ſt.*	3, 14. 50. 48	- - - - -	5. 0. 36
3, 19. 51. 24 Im. *1ſt.*	- - - -	3, 14, 50. 21	5. 1. 3
10, 21, 47. 14 Im. *1ſt.*	- - - -	10, 16. 46. 56	5. 0. 18
11, 14. 50. 4 Im. *2d.*	11, 9, 49. 14	- - - - -	5, 0. 50
12, 16. 16. 13 Im. *1ſt.*	12, 11. 15. 49	- - - - -	5. 0. 24
12, 16. 16. 13 Im. *1ſt.*	- - - -	12. 11. 15. 33	5, 0 40
May 5, 16. 31. 20 Im. *1ſt.*	5, 11, 30. 28	- - - - -	5, 0. 52
5, 16. 31. 20 Im. *1ſt.*	- - - -	5, 11. 30. 23	5, 0. 57
21, 16. 56. 49 Em. *1ſt.*	- - - -	21, 11. 56. 9	5, 0. 40
June 6, 15. 12. 59 Em. *1ſt.*	- - - -	6, 10. 12. 28	5. 0. 31
7, 13. 45. 13 Em. *2d.*	7, 8. 44. 37	- - - - -	5, 0. 36
7, 13. 45. 13 Em. *2d.*	- - - -	7, 8. 44. 39	5. 0. 34
13, 17. 6. 31 Em. *1ſt.*	- - - -	13. 12. 5. 57	5. 0. 34
22, 13. 28. 30 Em. *1ſt.*	22, 8. 27. 35	- - - - -	5, 0. 55
29, 15. 22. 11 Em. *1ſt.*	29, 10, 21. 55	- - - - -	5. 0. 16
Aug. 23, 12. 15. 49 Em. *1ſt.*	23, 7. 15. 48	- - - - -	5. 0. 1
Sept. 11, 12. 45. 10 Em. *2d.*	11, 7. 44. 41	- - - - -	5, 0. 29

Now if we take the mean of all the 21 foregoing determinations of our longitude from Greenwich, by the eclipſes of the firſt ſatellite, rejecting only thoſe of March 1ſt, and April 9th, 1768, which differ moſt from the others, the reſult will be 5^h. 0′. 35″ for the difference of our meridians. Theſe ought evidently to be rejected, as they differ near twice as much, from the mean of the reſt, as any other of the determinations do, yet the retaining of them will make no difference in the reſult. If the mean determination of the longitude be taken from the immerſions alone, rejecting that of the 1ſt of March, 1768, it will be 5^h. 0′. 36″, and if from the emerſions alone, it will be 5^h. 0′. 34″, when the obſervation of the 9th of April, 1768, is excluded. Therefore the mean of both, (which ſhould always be preferred,) is 5^h. 0′. 35″.

As a farther confirmation of this concluſion; if this difference of meridians be applied to the Greenwich obſervations

vations, of the firſt ſatellite, rejecting that of the 16th of May, to reduce them to the meridian of Philadelphia, and if they are then compared with the calculations in the nautical almanac; we ſhall have the ſame reſult from them alſo.

The calculated time per Nautical Almanac.				Greenwich obſervations reduced to the meridian of Philadelphia.		Difference of meridian of Greenwich and Philadelphia.
1769.	D.	h. m. ſec.		D.	h. m. ſec.	h. m. ſec.
Mar.	29,	12. 24. 26	Im. 1ſt.	29,	7. 24. 32	4. 59. 54
April	12,	16. 16. 13	Im. 1ſt.	12,	11. 15. 38	5. 0. 35
	28,	14. 36. 14	Im. 1ſt.	28,	9. 34. 42	5. 1. 32
June	8,	9. 41. 26	Em. 1ſt.	8,	4. 40. 41	5. 0. 45
	15,	11. 34. 55	Em. 1ſt.	15,	6, 34. 58	4. 59. 57
July	1,	9. 50. 37	Em. 1ſt.	1,	4. 49. 49	5. 0. 48
April	11,	14. 50. 4	Im. 2d.	11,	9. 49. 48	5. 0. 16
May	6,	11. 51. 45	Im. 2d.	6,	6. 50. 27	5. 1. 18

The mean of theſe determinations of the longitude, from the Greenwich obſervations of the firſt ſatellite, is $5^h. 0'. 35''$. But farther if we take the mean of all the determinations, derived from the eclipſes of the ſecond ſatellite, it will be found to be $5^h. 0'. 37''$. And laſtly, if the mean of all the determinations from the eclipſes of both firſt and ſecond ſatellite be choſen, the deduced longitude will be $5^h. 0'. 35''$. So that we may ſafely conclude, that the difference of meridians between Philadelphia and Greenwich, is $5^h. 0'. 35''$; and that Norriton is $56''$ of time weſt of Philadelphia, and its longitude is $5^h. 1'. 31''$. weſt. With this determination we muſt be contented until farther obſervations are made, by which it may be confirmed, or rendered liable to exception.

Theſe obſervations are ſufficient to determine every thing relative to the theory of Venus, and the parallaxes of the Sun and planets, as may be ſeen by the annexed projection of the tranſit, and the following calculations. Although the parallax of the Sun may be obtained from the obſerved neareſt diſtance of the centers of the Sun and Venus, yet this method cannot be ſo much depended on, as the compariſon of the contacts of the limbs obſerved in proper places, where the abſolute difference of time is conſiderable. Nevertheleſs, as the public ſeem very impatient

tient to know the reſult of what was done in this place, I have endeavoured to deduce it from our obſervations alone; and flatter myſelf, that in the concluſion it will be found pretty accurate; as it is nearly the ſame with what I had before found it to be, by an hundred and forty determinations of it, from the obſervations of aſtronomers on the tranſit of 1761; and alſo from another method, the invention of the celebrated Mr. Stuart, of Edinburgh; both which I have now annexed to the following calculations.

Having thus collected together all the elements neceſſary for the enſuing calculation, before I proceed to it, I muſt in juſtice to Dr. Williamſon and Mr. Prior, obſerve, that of the micrometer meaſures, the 2d, 3d, 19th, 20th, 21ſt, 22d, 23d, 24th, and 25th were made by Mr. Prior, and the 35th, 43d, 44th, and 54th by Dr. Williamſon, with the ſame adjuſtment of the focus, that I uſed in the others.

I have taken the trouble of making above fifty determinations of the middle of the tranſit, and find from a mean of them, that the neareſt approach of their centers was at $5^{h}.\ 21'.\ 27''$ mean time, or $5^{h}.\ 23'.\ 41'',7$ apparent time, which was haſtened by parallax $4'.\ 48''$ at Philadelphia; and therefore, that the central apparent time of the middle of the tranſit was $5^{h}.\ 28'.\ 29'',7$, according to our meridian.

By comparing together eighteen determinations of the neareſt diſtance of the center of the Sun and Venus, I find the mean of them to be $10'.\ 3'',58$, as ſeen in Philadelphia. But ſhe was then depreſſed $6'',91$ by parallax; and therefore, the geocent. neareſt diſtance of the centers was $10'.\ 10'',49 = 610'',49$. Therefore ſay,

As 72626,45 the diſtance of ♀ from the ☉ : 28879,55 her diſtance from ⊖ : : $610'',49$: heliocentric diſtance of their centers.

4. 861,0949
4. 460,5904
2. 785,6785

7. 246,2689
2. 385,1740 = $242'',7583 = 4'.\ 2'',7583$ the heliocentric diſtance of their centers.

As S, $3^{\circ}.\ 23'.\ 20''$ the incl. of ♀ orbit to the eclip. : R : : S, $4'.\ 2'',758$: Sine of ☉'s diſt. from the node of ♀.

8. 771,6803
10. - - -
7. 070,2506
8. 291,5703 = $1^{\circ}.\ 8'.\ 20'',23$ ☉ diſt. from the node of ♀.

Now ſuch is the peculiarity of the orbit of Venus and her horary motion at that time, that we may indifferently ſay,

As S, 1°. 8′. 20″.23 : Rad : : S, 10′. 10″,49 : S, of the angle of her viſible path with the ecliptic 8°. 33′. 11″,5.

Or as T, 4′. 2″.7583 : T, 10′. 10″,49 : : S, 3°. 23′. 20″ : S, of the angle of her viſible path=8°. 33′. 12″,3.

Or laſtly, if it ſhould be deemed more eligible to deduce her horary motion from the foregoing meaſures, and from a compariſon of it with the horary motion of the Sun, to deduce the angle of her viſible path, it may be done in the following manner, and will be found to be nearly the ſame.

For let A B repreſent the horary motion of ☉=2′.392375 (ſee fig. 2. pl. 4.)
B A C=the inclination of the orbit of ♀ with the ecliptic=3^{c}. 23′. 20″.
A C=the horary motion of ♀=3′.952942, as it may be deduced from the ſaid meaſures.
Then the angle DBC will repreſent the viſible path of ♀ with the ecliptic, and may be found as follows:

Let 2′.392375=horary motion ☉
3.922942=horary motion ♀=237″. 17652 whoſe Log. is 2. 375. 0716

As 6.345317=ſum of their horary motions - - - - - 0.802,4534
Is to 1.560567=difference of their horary motions - - - 0.193,2825
So is cot. of half of 3°. 23′. 20″, or cot. 1°. 41′. 40″ - - - 11.528,9451

To T, of half the diff. of the angles at B & C=83°. 8′. 27″.2=10.919,7742
To which add half the ſum of do. - - 88. 18. 20

171. 26 47,2 and the ſupl. of this is 8° 33′. 12″.8 =the angle of the viſible path of ♀

916,65=the difference of the ſemidiameters of ☉ and ♀
610,49=the geo. neareſt diſtance of their centers.

Sum, 1527,14=3. 183,8789
Diff. 306,16=2. 485,9484

2)5. 669,8273 the log. of the ſquare of half the tranſit line between the internal contacts.

2. 834,9136=the log. of half the tranſit line between int. cont.=683″,776
237″ 17652=2. 375,0716=the log. of ♀ hor. mot.

0. 459,8420=2h. 882982=2h. 52′. 58″,7=the ſemidu. between the in. cont.

974,65=the ſum of the ſemidiameters of ☉ and ♀
610,49=the geo. neareſt diſtance of their centers.

Sum, 1585,14 3. 200,0677
Diff. 364,16 2. 561,2922

2)5. 761,3599
2. 880,6799=the log. of half the tran. line between the ext. co.=759″,766
2. 375,0716=the log. of ♀ hor. mot.

0. 505,6083=3h. 20338=3h. 12′. 12″,168=the ſemiduration between the external contacts.

As R : Sec. 8°. 33′. 11″,5 :: 610″,49 : geo. latitude of ♀
10. - - -
10. 004,8572
2. 785,6785

2. 790,5357=617″,356=10′. 17″,336=the geo. lat. of ♀

As 72626,45 : 28879,55 :: geocentric latitude : heliocentric latitude of ♀
4. 861,0949
4. 460,5904
2. 790,5357

7. 251,1261

2. 390,0312=245″,4885=4′. 3″,4885=the heliocentric latitude of ♀

610,49
617,356

1227,846 3. 089,1440
96,866 0. 836,7038

3. 925,8478
1. 962,9239
2. 375,0716=the ſog. of hor. mot. of ♀

9. 587,8523=0h. 387126=23′. 13″,6536=the time between the middle and eclip. conjunction.

From the apparent time of the middle of the tranſit, viz. 5^h. 28′. 29″,7 deduct 23′. 13″,65 and the apparent time of the ecliptical conjunction will be 5^h. 5′. 16″,05, when the Sun's place given in the nautical almanac was 2^s. 13°. 27′. 18″,7, making the difference of our meridian from Greenwich 5^h. 0′ 35″, as found above. To his place in the ecliptic add his diſtance from the node of Venus, found above, viz. 1°. 8′. 20″,23, and the ſum gives the place of her aſcending node, 2^s. 14°. 35′. 38″,9.

From the middle of the tranſit, as ſeen at the center of the earth, viz. 5^h. 28′. 29″,7, apparent time, deduct the ſemi-duration between the internal contacts, viz. 2^h. 52′. 58″,7 and there remains 2^h. 35′. 31″, the apparent time of the firſt internal contact, without parallax. This I obſerved at 2^h. 31′ 26″ apparent time; the difference between theſe is the total effect of parallax in longitude and latitude, which is 4′. 5″. But upon the ſuppoſition that the Sun's horizontal parallax, on the day of the tranſit, was 8″,5204, the total effect of parallax ſhould have been 4′. 4″. Therefore ſay,

As 4′. 4″=244″ : 4″. 5″=245″ : : 8″,5204 : 8″,555= the hor. par. of the Sun on June 3d, 1769. Then

As 100000=his mean diſt. from the earth : 101506= his diſt. on the day of the Tranſit, : : 8″,555 : 8″,6838 his horizontal parallax at his mean diſtance from the earth.

This is nearly the ſame, with what is deduced from the beſt of the obſervations made on the tranſit of 1761: And according to this parallax of the Sun, the mean diſtances of the planets from the Sun will be, as they are exhibited in in the following table, taking a mean ſemidiameter of the earth 3985 Engliſh miles.

36693417	Mercury's	Mean diſtance from the Sun, in Engliſh miles.
68564850	Venus's	
94790550	the Earth's	
144431400	Mars's	
493005300	Jupiter's	
904307200	Saturn's	

On account of the difficulty of aſcertaining the preciſe moment of the middle of the tranſit, from the menſurations of the neareſt diſtances of the limbs of the Sun and Venus, and the ſmall difference of time between the contacts happening, at the center of the earth, and at any particular place on its ſurface; aſtronomers have generally preferred the compariſon of two obſervations at proper places, where the effects of parallax will be contrary to each other, retarding the contacts at one place and accelerating them at the other, for the purpoſe of deducing the parallax and diſtance of the Sun from them. We have an opportunity of confirming the former concluſions, by comparing our obſervations with thoſe that have been made at the royal obſervatory at Greenwich, as they have lately come to hand. They differ indeed conſiderably among themſelves, probably owing to the various methods, which the obſervers took to judge of the contacts, the account of which is not yet arrived here; yet they give a mean parallax of the Sun nearly the ſame that we have deduced from our own obſervations at Philadelphia. I have therefore inſerted them in this account of the tranſit, as they ſerve to ſhew that we have not loſt our labour and expence on this occaſion. The method I have uſed is firſt to reduce the Greenwich obſervations of the contacts to the meridian of our obſervatory in Philadelphia, by deducting from them the difference of longitude converted into time; and then to calculate the effect of parallax for both places at the apparent times of the contacts, upon the ſuppoſition of the Sun's horizontal parallax

parallax being 8″,5204 on the day of the tranſit. From this, the Sun's horizontal parallax is found either greater or leſs, as the calculated effect of parallax is greater or leſs, than what is obſerved.

The parallax of Venus in longitude at Greenwich, at the time of the firſt external contact was 16″,9, which haſtened the contact there 4′. 16″,5, and her parallax in latitude at the ſame time was 12″,97, which depreſſed her on the diſk of the Sun, lengthened her viſible path, and accelerated the contact 2′. 34″,5, ſo that the total effect of her parallax was to haſten the contact 6′. 51″ of time. In like manner her parallax in longitude at the internal contact was 16″,6, which haſtened it 4′. 12″ of time; and her parallax in latitude being 13″,42 at that time, for the ſame reaſon haſtened the ſaid contact 2′. 40″; and therefore the total effect of parallax to accelerate the internal contact at Greenwich is 6′. 52″.

At Philadelphia her parallax in longitude being 10″,74 at the external contact, haſtened it 2′. 43″; and her parallax in latitude being 4″,43, lengthened her viſible path on the Sun and haſtened the contact 53″ of time; whence its total effect was 3′. 36″ of time. In like manner her parallax in longitude at the internal contact being 11″,95 haſtened it 3′. 1″ of time, and her parallax in latitude being 4″,49 lengthened the tranſit line, and haſtened the contact 1′. 3″; and therefore the total effect of her parallax at that time to haſten the internal contact was 4′. 4″.

Now as the total effect of parallax both at Greenwich and at Philadelphia conſpired to haſten the contacts at both theſe places, with reſpect to the center of the earth, their difference is the whole effect they have on abſolute time, viz. 3′. 15″ at the external contact, and 2′. 48″ at the internal contact.

The contacts were obſerved at Greenwich at the apparent times mentioned in the following table, according to their meridian.

External Contact.			Internal Contact.			
h.	m.	ſec.	h.	m.	ſec.	
7.	10.	54	7.	28.	47	by Hitchins.
7.	11.	11	-	-	- -	Hirſt.
7.	10.	37	7.	29.	28	Dun.
7.	11.	19	7.	29.	20	Dollond.
7.	11.	30	7.	29.	20	Nairne.
7.	10.	58	7.	29.	23	Maſkelyne.

Theſe times are reduced to the meridian of Philadelphia, by ſubſtracting $5^{h}.0'.35''$ from them in the following manner.

	External Contact.			Internal Contact.			
	h.	m.	ſec.	h.	m.	ſec.	
	2.	10.	19	2.	28.	12	by Hitchins.
	2.	10.	36	-	-	- -	Hirſt.
	2.	10.	2	2.	28.	53	Dun.
	2.	10.	44	2.	28.	45	Dollond.
	2.	10.	55	2.	28.	45	Nairne.
	2.	10.	23	2.	28.	48	Maſkelyne.
M. of all is,	2.	10.	30	2.	28.	40,6	

The mean of all the times of the external contacts at Philadelphia is $2^{h}.\ 13'.\ 46'',6$, and of the internal contacts 2h. $31'.\ 28''$, as appears by page 49, and the difference between theſe means is the obſerved effect of parallax.

h.	m.	ſec.	h.	m.	ſec.	
2.	13.	46,6	2.	31.	28	at Philadelphia.
2.	10.	30	2.	28.	40,6	at Greenwich.
	3.	16,6		2.	47,4	the obſerved effects of

parallax, at the external and internal contacts. Therefore ſay,

As $3'.\ 15''=195''$ the calculated effect of parallax at the external contact is to $3'.\ 16'',6=196'',6$: : So is the aſſumed horizontal parallax of the Sun on the day of the tranſit $8'',5204$: to his true parallax on that day. And in like manner, as $2'.\ 48''=168''$: $2'.\ 47'',4=167'',4$: : $8'',5204$: the Sun's parallax on that day.

2. 290,0346	2. 225,3093
2. 293,5835	2. 223,7555
0. 930,4600	0. 930,4600
3. 224,0435	3. 154,2155
0. 934,0089=8″,59031 ⊙ hor. par.	0. 928,9062=8″,48997 ⊙ hor. par.

8″,48997

2) 17″,08028

8″,54014 the mean hor. par. of ⊙ on the day of the tranſit.

As 100000 : 101506 : : $8'',54014$: the Sun's horizontal parallax at his mean diſtance from the earth.

5. 000,0000
5. 006,4917
0. 931,4650

0. 937,9567=8″,66875 the Sun's hor. par. at his mean diſtance from the earth.

The

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The parallax of the Sun being fixed by the mean of ſuch compariſons as theſe, it is an eaſy matter to aſcertain not only the diſtances of the bodies, which compoſe the ſolar ſyſtem, but alſo their real diameters; that of the earth being previouſly known from the actual menſuration of ſome degrees on it's ſurface. For

As the rectangle of the parallax of the Sun, and his diſtance from the earth, is to the real diameter of the earth; ſo is the rectangle of the parallax and diſtance of any other planet from the Sun, to its real diameter.

As to my delineation of the tranſit, I have taken the elements of the projection from our own obſervations on the 3d of June, 1769. Plate 4, fig. 2.

THE neareſt approach of the centers having been determined, from the mean of a great number of computations, and found to agree very nearly with the meaſures that were actually made at the middle of the tranſit, it was accordingly ſet off on the diameter of the Sun, and through this point a chord was drawn at right angles to the ſaid diameter for the central tranſit line. This was then divided carefully into hours and minutes, according to the horary motion of Venus, determined by the preceding calculation, in ſuch a manner, as that the exact moment of the middle of the tranſit, at the earth's center, ſhould fall on the point of interſection between the ſaid diameter of the Sun and tranſit line; this moment of time having been previouſly determined, by the mean of a ſufficient number of computations.

The parallaxes of Venus, in longitude and latitude, as ſeen from Philadelphia, having been alſo adapted to the apparent times of the micrometer meaſures, on the ſuppoſition of the Sun's horizontal parallax being 8″,5204 on the day of the tranſit, they were accordingly applied to the projection, by which the places of her center were determined for the ſaid times. Round theſe, ſmall circles were drawn, with the radius of 29 ſeconds, to repreſent the diſk of Venus

Venus on the face of the Sun; andlines were drawn between the limbs, in the direction of their centers, of ſuch a determined length, as the micrometer has given them. Many of the meaſures were taken from the fartheſt limb of the Sun, as well as from the neareſt, to both limbs of Venus, and theſe meaſures were afterwards reduced to the neareſt diſtance of the neareſt limbs, as they are exhibited in the preceding table, uſing the diameters of the Sun and Venus, as they are ſtated above.

As a confirmation of the foregoing concluſions, I have ſubjoined the obſervations of aſtronomers, in different places, of the contacts and durations of the tranſit of 1761, as they have ſent them to the Royal Society, together with the longitudes and latitudes of the places of obſervation, on which the following calculations depend.

OBSERVATIONS on the TRANSIT of VENUS over the SUN, June 6th, 1761, N. S. Apparent Time.

Nam. of places.	1ſt Ex. Con.	1ſt In. Cont.	2d In. Con.	2d Ex. Cont.	Duration.
	h. m. ſec.	h. m. ſec.	h. m. ſec.	h. m. ſec.	h. m. ſec.
Greenwich,	- -	- -	8. 19. 0	8. 37. 9	- -
Shirburn Caſtle,	- -	- -	8. 15. 12	8. 33. 17	- -
Saville Houſe,	- -	- -	8. 18. 22	- - - .	- -
Spittal Square,	- -	- -	8. 18. 41	- - - -	- -
Chelſea,	- -	- -	8. 18. 4	- - - -	- -
Leſkard,	- -	- -	8. 0. 21	- - - -	- -
Paris,	- -	- -	8. 28. 27	8. 46. 44	- -
Bolongna,	- -	- -	9. 4. 57	9. 23. 0 to 7	- -
Rome,	- -	- -	9. 9. 36	- - - -	- -
Drontheim,	- -	- -	9. 1. 49	- - - -	- -
Upſal,	3. 20. 45	3. 37. 43 to 56 3. 38. 5	9. 28. 6	9. 46. 13 to 30	5. 50 5 to 26
Stockholm,	3. 21. 37	3. 39. 23 to 29	9. 30. 10	- - - -	5. 50. 41 to 47
Hernoſand,	3. 20. 40	3. 38. 26 to 35	9. 28. 52	9. 46. 43	5. 50. 17 to 26
Calmar,	- -	3. 23. 1	9. 23. 40	- - - -	5. 50. 39
Abo,	- -	3. 35. 50	9. 45. 59	10. 4. 42	5. 50, 9
Tornea,	3. 45. 44 to 51	4. 4. 0	9. 54. 8 to 22	10. 12. 18 to 22	5. 50. 9 to 21
Cajaneburg,	- -	4. 19. 5	10. 8. 59	- - - -	5. 49 54
Tobolſki,	- -	7. 0. 21	12. 49. 20.	13. 7. 39½	5. 48. 50
Cape G. Hope,	- -	- -	9. 39. 50	- - - -	- -
Rodrigues,	- -	- -	12. 35. 47	12. 53. 18	- -
Calcutta,	- -	8. 20. 58	14. 11. 34	14. 37. 38	5. 50. 36
Madraſs,	7. 31. 10	7. 47. 55	13. 39. 38	13. 55. 44	5. 51. 43
Tranquebar,	- -	- -	- -	- - - -	5. 51. 33
Great Mount.	- -	- -	- -	- - - -	5. 51. 20

N. of

N. of Places	Latitude.	Longitude fr. Greenwich	N. of Places.	Latitude.	Longitude fr. Greenwich.
	° ′ ″	h. m. ſec.		° ′ ″	h. m. ſec.
Greenwich,	51. 28. 37 N.	0. 0, 0	Hernoſand,	60. 38. 0 N.	1. 11. 28 E.
Shirb. Caſtle,	51. 39. 22 N	0. 4. 1 W.	Calmar,	56. 40. 30 N.	1. 5. 39 E.
Sav. Houſe,	- -	0. 0. 31 W.	Abo,	60. 27. 0 N.	1. 28. 33 E.
Spit. Square,	- -	0. 0. 16½ W.	Tornea,	65. 50, 50 N.	1. 36. 48 E.
Chelſea,	- -	0. 0. 40 W.	Cajaneburg,	64. 13. 30 N	1. 51. 50 E.
Leſkard,	50. 26. 55 N	0. 18. 32 W.	Tobolſki,	58. 12. 22 N.	4. 32. 52 E.
Paris,	48. 50. 14 N	0. 9. 16 E.	Cape G. Hope,	33. 55. 42 S.	1. 13. 35 E.
Bologna,	44. 29. 36 N	0. 45. 21. E.	Rodrigues,	19. 40. 40 S.	4. 12. 34 E.
Rome,	41. 53. 54 N	0. 49. 53 E.	Calcutta,	22. 30. 0 N.	5. 53. 44 E.
Drontheim,	63. 26. 10 N	0. 44. 3 E.	Madras,	13. 8. 0 N.	5. 20. 10 E.
Upſal,	59. 51. 50 N	1. 10. 26. E.	Tranquebar,	10. 56. 0 N.	5. 18. 8 E.
Stockholm,	59. 20. 30 N	1. 12. 26 E.	Great Mount,	- -	- -

The Parallax of the SUN, deduced from the 2d Internal Contact of the Limbs of the SUN and VENUS, in the Tranſit of 1761.

Cape of Good Hope & Leſkard.

h. m. ſec.		Parall ′ ″
9. 39. 50	*Cape,*	6 8
1. 32. 7	Diff. Longitude.	
8. 7. 43		
8. 0. 21	*Leſkard,*	1 4
7. 22		7 12

As 7.12 : 7.22 : : 8″,5

⊙'s Par. 8″,69

Cape & Sherburne Caſtle.

h. m. ſec.		Parall. ′ ″
9. 39. 50		6. 8
1. 17. 36	diff. longitude.	
8. 22. 14		
8. 15. 12	*Sherborne*	1. 12
7. 2		7. 20

Sun's Par. 8″,15

Cape & Chelſea.

h. m. ſec.		Parall. ′ ″
9. 39. 50		6. 8
1. 14. 15		
8. 25. 34		
8. 18. 4	*Chelſea,*	1. 11
7. 30		7. 19

Sun's Par. 8″,73

Cape & Saville Houſe.

9. 39. 50		6 8
1. 14. 5		
8. 25. 45		
8. 18. 22	*Saville,*	1. 11
7. 23		7. 19

Sun's Par. 8,57

Cape & Spittal Square.

9. 39. 50		6. 8
1. 13. 51		
8. 25. 59		
8. 18. 41	*Spit. Sq.*	1. 11
7. 18		7. 19

Sun's Par. 8,47

Cape & Greenwich.

9. 39. 50		6. 8
1. 13. 35		
8. 26. 15		
8. 19. 0	*Greenw.*	1. 11
7. 15		7. 19

Sun's Par. 8,42

Cape & Paris.

9. 39. 50	6 8
1. 4. 19	
8. 35. 31	
8. 28. 27	0 54
7. 4	7 2

Sun's Par. 8,54

Cape & Drontheim.

9. 39. 50	6. 8
0. 29. 32	
9. 10. 18	
9. 1. 49	2. 38
8. 29	8. 46

Sun's Par. 8,23

Cape & Bologna.

8. 39. 50	6 8
0. 28. 14	
9. 11. 36	
9. 4. 57	0. 29
6. 39	6. 37

Sun's Par. 8,54

Cape & Rome.

9. 39. 50	6. 8
0. 23. 42	
9. 16. 8	
9. 9. 36	0. 13
6. 32	6 21

Sun's Par. 8,74

Cape & Calmar.

9. 39. 50	6. 8
0. 7. 56	
9. 31. 54	
9. 23. 40	1. 59
8. 14	8. 7

Sun's Par. 8,62

Cape & Upſal.

9. 39. 50	6 8
0. 3. 9	
9. 36. 41	
9. 28. 6	2. 21
8. 35	8. 29

Sun's Par. 8,60

Cape & Hernoſand.

9. 39. 50	6. 8
0. 2. 7	
9. 37. 43	
9. 28. 52	2. 26
8. 51	8. 34

Sun's Par. 8,78

Cape & Stockholm.

9. 39. 50	6. 8
0. 1. 9	
9 38. 41	
9. 30. 10	2. 18
8. 31	8. 26

Sun's Par. 8,58

Cape & Abo.

9. 39. 50	6 8
+0. 14. 58	
9. 54. 48	
9. 45. 59	2. 38
8. 49	8. 38

Sun's Par. 8,68

Cape & Tornea.

9. 39. 50	6. 8
+0. 3. 13	
0. 3. 3	
9. 54. 8	3. 5
8. 55	9. 13

Sun's Par. 8,22

Cape & Cajaneburg.

9. 39. 50	6. 8
+0. 38. 15	
10. 18. 5	
10. 8. 59	2 59
9. 6	9. 7

Sun's Par. 8,49

Cape & Tobolſki.

9. 39. 50	6 8
3. 19. 17	
12. 59. 07	
12. 49. 20	3. 35
9. 47	9. 43

Sun's Par. 8,64

Cape & Madraſs.

h. m. ſec.	Parall. ′ ″
9. 39. 50	6. 8
4. 6. 35	
13. 46. 25	
13. 39. 38	0. 36
6. 47	6. 44

Sun's Par 8″,74

Cape & Calcutta.

h. m. ſec.	Parall. ′ ″
9. 39. 50	6. 8
4. 40. 9	
14. 19. 59	
14. 11. 34	2. 14
8. 25	8. 22

Sun's Par. 8″,55

Cape & Rodrigues.

h. m. ſec.	Parall. ′ ″
9. 39. 50	6. 8
2. 58. 59	
12. 38. 49	
12. 35. 47	3. 7
3. 2	3. 1

Sun's Par. 8″,54

Rodrigues & Leſkard.

12. 35. 47	3. 7
4. 31. 6	
8. 4. 41	
8. 0. 21	1. 4
4. 20	4. 11

Sun's Par. 8,80

Rodrigues & Sherburn caſtle.

12. 35. 47	3. 7
4. 16. 35	
8. 19. 12	
8. 15. 12	1. 12
4. 0	4. 19

Sun's Par. 8,00

Rodrigues & Chelſea.

12. 35. 47	3. 7
4. 13. 14	
8. 22. 33	
8. 18. 4	1. 11
4. 29	4. 18

Sun's Par. 8,86

Rodrigues & Saville houſe.

12. 35. 47	3. 7
4. 13. 4	
8. 22. 43	
8. 18. 22	1. 11
4. 21	4. 18

Sun's Par. 8,60

Rodrigues & Spittal ſquare.

12. 35. 47	3. 7
4. 12. 50	
8. 22. 57	
8. 18. 41	1. 11
4. 16	4. 18

Sun's Par. 8,44

Rodrigues & Greenwich.

12. 35. 47	3. 7
4. 12. 34	
8. 23. 13	
8. 19. 0	1. 11
4. 13	4. 18

Sun's Par. 8,33

Rodrigues & Paris.

12. 35. 47	3. 7
4. 3. 18	
8. 32. 29	
8. 28. 27	0. 54
4. 2	4. 1

Sun's Par. 8,53

Rodrigues & Drontheim.

12. 35. 47	3. 7
3. 28. 31	
9. 7. 16	
9. 1. 45	2. 38
5. 27	5. 45

Sun's Par. 8,05

Rodrigues & Bologna.

12. 35. 47	3. 7
3. 27. 13	
9. 8. 34	
9. 4. 57	0. 29
3. 37	3. 36

Sun's Par. 8,54

Rodrigues & Rome.

12. 35. 47	3. 7
3. 22. 41	
9. 13. 6	
9. 9. 36	0. 13
3. 30	3. 20

Sun's Par. 8,92

Rodrigues & Calmar.

12. 35. 47	3. 7
3. 6. 55	
9. 28. 52	
9. 23. 40	1. 59
5. 12	5. 6

Sun's Par. 8,67

Rodrigues & Upſal.

12. 35. 47	3. 7
3. 2. 8	
9. 33. 39	
9. 28. 6	2. 21
5. 33	5. 28

Sun's Par. 8,62

Rodrigues & Hernoſand.

12. 35. 47	3. 7
3. 1. 6	
9. 34. 41	
9. 28. 52	2. 26
5. 49	5. 33

Sun's Par. 8,90

Rodrigues & Stockholm.

12. 35. 47	3. 7
3. 0. 8	
9. 35. 39	
9. 30. 10	2. 18
5. 29	5. 25

Sun's Par. 8,51

Rodrigues & Abo.

12. 35. 47	3. 7
2. 44. 1	
9. 51. 46	
9. 45. 59	2. 30
5. 47	5. 37

Sun's Par. 8,75

Rodrigues & Tornea.

12. 35. 47	3. 7
2. 35. 46	
10. 0. 1	
9. 54. 8	3. 5
5. 53	6. 12

Sun's Par. 8,07

Rodrigues & Cajaneburg.

12. 35. 47	3. 7
2. 20. 44	
10. 15. 3	
10. 8. 59	2. 59
6. 4	6. 6

Sun's Par. 8,45

Rodrigues & Tobolſki.

12. 35. 47	3. 7
+0. 20. 18	
12. 56. 5	
12. 49. 20	3. 35
6. 45	6. 42

Sun's Par. 8,56

Rodrigues & Calcutta.

12. 35. 47	3. 7
1. 41. 10	
14. 16. 57	
14. 11. 34	2. 14
5. 23	5. 21

Sun's Par. 8,55

Rodrigues & Madraſs.

12. 35. 47	3. 7
1. 7. 36	
13. 43. 23	
13. 39. 38	0. 36
3. 45	3. 43

Sun's Par. 8,58

Tobolſki & Leſkard.

12. 49. 20	3. 35
4. 51. 24	
7. 57. 56	
8. 0. 21	1. 4
2. 25	2. 31

Sun's Par. 8,16

Tobolſki & Chelſea.

h. m. ſec.	Parall. ′ ″
12. 49. 20	3. 35
4. 33. 32	
8. 15. 48	
8. 18. 4	1. 11
2. 16	2. 24

Sun's Par. 8″,02

Tobolſki & Saville houſe.

h. m. ſec.	Parall. ′ ″
12. 49. 20	3. 35
4. 33. 22	
8. 15. 58	
8. 18. 22	1. 12
2. 34	2. 24

Sun's Par. 8″,99

Tobolſki & Spittal Square.

h. m. ſec.	Parall. ′ ″
12. 49. 20	5. 35
4. 33. 9	
8. 16. 11	
8. 18. 41	1. 11
2. 30	2. 24

Sun's Par. 8″,85

Tobolſki & Greenwich.

12. 49. 20	3. 35
4. 32. 52	
8. 16. 28	
8. 19. 0	1. 11
2. 32	2. 24

Sun's Par. 8,97

Tobolſki & Paris.

12. 49. 20	3. 35
4. 23. 36	
8. 25. 44	
8. 28. 27	0. 54
2. 43	2. 41

Sun's Par. 8,60

Tobolſki & Bologna.

12. 49. 20	3. 35
3. 47. 31	
9. 1. 49	
9. 4. 57	0. 29
3. 8	3. 6

Sun's Par. 8,59

Tobolſki & Rome.

12. 49. 20	3 35
3. 42. 59	
9. 6. 21	
9. 9. 36	0 13
3. 15	3. 22

Sun's Par. 8,20

Tobolſki & Calmar.

12 49. 20	3. 35
3. 27. 13	
9. 22. 7	
9. 23. 40	1. 59
1. 33	1. 36

Sun's Par. 8,23

Tobolſki & Upſal.

12. 49. 20	3. 35
3. 22. 26	
9. 26. 54	
9. 28. 6	2. 21
1. 12	1. 14

Sun's Par. 8,27

Tobolſki & Stockholm.

12. 49. 20	3. 35
3. 20. 26	
9. 28. 54	
9. 30. 10	2. 18
1. 16	1. 17

Sun's Par. 8,39

Tobolſki & Calcutta.

12. 49. 20	3. 35
1. 20. 52	
14. 10. 12	
14. 11. 34	2. 14
1. 22	1. 21

Sun's Par. 8,61

Tobolſki & Madraſs.

12. 49. 20	3. 35
0. 47. 18	
13. 36. 38	
13. 39. 38	0. 36
3. 0	2. 59

Sun's Par. 8'55

Cajaneburg & Saville houſe.

10. 8. 59	2. 59
1. 52. 20	
8. 16. 39	
8. 18. 22	1. 11
1. 43	1. 48

Sun's Par. 8″.11

Cajenburg & Spittal ſquare.

10. 8. 59	2. 59
1. 52. 7	
8. 16. 52	
8. 18. 41	1. 11
1. 49	1. 48

Sun's Par. 8,58

Cajaneburg & Greenwich.

10. 8. 59	2. 59
1. 51. 50	
8. 17. 9	
8. 19. 0	1. 11
1. 51	1. 48

Sun's Par. 8,74

Cajaneburg & Paris.

10. 8. 59	2. 59
1. 42. 34	
8. 26. 25	
8. 28. 27	0. 54
2. 2	2. 5

Sun's Par. 8.30

Cajaneburg & Rome.

10. 8. 59	2. 59
1. 2. 7	
9. 6. 52	
9. 9. 36	0. 13
2. 44	2. 46

Sun's Par. 8,33

Cajaneburg & Bologna.

10. 8. 59	2. 59
1. 6. 29	
9. 2. 30	
9. 4. 57	0. 29
2. 27	2. 30

Sun's Par. 8,33.

Cajaneburg & Madraſs.

10. 8. 59	2. 59
3. 28. 20	
13. 37. 19	
13. 39. 38	0. 36
2. 19	2. 23

Sun's Par. 8.27

Stockholm & Spittal ſquare.

9. 30. 10	2 18
1. 12. 43	
8. 17. 37	
1. 18. 41	1. 11
1. 4	1. 7

Sun's Par. 8,12

Stockholm & Greenwich.

9. 30. 10	2. 18
1. 12. 20	
8. 17. 50	
8. 19. 0	1 11
1. 10	1. 7

Sun's Par. 8,88

Stockholm & Paris.

9. 30. 10	2 18
1. 3. 10	
8. 27. 0	
8. 28. 27	0. 54
1. 27	1. 24

Sun's Par. 8,80

Stockholm & Bologna.

9. 30. 10	2. 18
0. 27. 5	
9. 3. 5	
9. 4. 57	0. 29
1. 52	1. 49

Sun's Par. 8.73

Stockholm & Rome.

9. 30. 10	2. 18
0. 22. 33	
9. 7. 37	
9. 9. 36	0. 13
1. 59	2. 5

Sun's Par. 8,09

Stockholm

Stockholm & Madras.

h. m. ſec.	Parall. ′ ″
9. 30. 10	2 18
4. 7. 44	
13. 37. 54	
13. 39. 38	0. 36
1. 44	1. 42
Sun's Par. 8″,67	

Upſal & Paris.

9. 28. 6	2. 21
1. 1. 10	
8. 26. 56	
8. 28. 27	0. 54
1. 31	1. 27
Sun's Par. 8,89	

Upſal & Madras.

9. 28. 6	2. 21
4. 9. 44	
13. 37. 50	
13. 39. 38	0. 36
1. 48	1. 45
Sun's Par. 8,74.	

Calcutta & Bologna.

14. 11. 34	2. 14
5. 8. 23	
9. 3. 11	
9. 4. 57	0. 29
1. 46	1 45
Sun's Par. 8,58	

Abo & Rome.

9. 45. 59	2. 30
0. 38. 40	
9. 7. 19	
9. 9. 36	0. 13
2. 17	2. 17
Sun's Par. 8,50	

Sherburne & Tornea.

8. 15. 12	1. 12
1. 40. 49	
9. 56. 1	
9. 54. 8	3. 5
1. 53	1 53
Sun's Par. 8,50	

Upſal & Leſkard.

h. m. ſec.	Parall. ′ ″
9. 28. 6	2. 21
1. 28. 58	
7. 59. 8	
8. 0. 21	1. 4
1. 13	1. 17
Sun's Par. 8″,06	

Upſal & Bologna.

9. 28 6	2. 21
0. 25. 5	
9. 3. 1	
9. 4. 57	0. 29
1. 56	1. 52
Sun's Par. 8,0	

Calcutta and Saville Houſe.

14. 11. 34	2. 14
5. 54. 14	
8. 17. 20	
8. 18. 22	1. 11
1. 2	1. 3
Sun's Par. 8,37	

Calcutta & Madras.

14. 11. 34	2. 14
0. 33. 34	
13. 38. 0	
13. 39. 38	0. 36
1. 38	1. 38
Sun's Par. 8,50	

Hernoſand & Rome.

9. 28. 52	2. 26
0. 21. 35	
9. 7. 17	
9. 9. 36	0. 13
2. 19	2. 13
Sun's Par. 8,88.	

Greenwich & Paris.

8. 19. 0	1. 11
0. 9. 16	
8. 28.16	
8. 28. 27	c. 54
17	17
Sun's Par. 8,50	

Upſal & Saville Houſe.

h. m. ſec.	Parall. ′ ″
9. 28. 6	2. 21
1. 10. 56	
8. 17. 10	
8. 18. 22	1. 11
1. 12	1. 10
Sun's Par. 8″,74	

Upſal & Rome.

9. 28. 6	2. 21
0. 20. 33	
9. 7. 33	
9. 9. 26	0. 13
2. 3	2. 8
Sun's Par. 8,17	

Calcutta & Paris.

14. 11. 34	2. 14
5. 44. 28	
8. 27. 6	
8. 28. 27	0. 54
1. 21	1. 20
Sun's Par. 8,61	

Abo & Leſkard.

9. 45. 59	2. 30
1. 47. 5	
7. 58. 54	
8. 0. 21	1. 4
1. 27	1. 26
Sun's Par. 8,60	

Calmar & Madras.

9. 23. 40	1. 59
4. 14. 31	
13. 38. 11	
13. 39. 38	0. 36
1. 27	1. 23
Sun's Par. 8,91	

Greenwich & Leſkard.

8. 19. 0	1. 11
0. 18. 32	
8. 0. 28	
8. 0. 21	1. 4
7	7
Sun's Par. 8,50	

The parallax of the Sun may alſo be deduced from the total duration of the tranſit, as obſerved in different places, in the following manner.

Tranquebar & Calmar.

h. m. ſec.	Parall. ′ ″
5. 51. 33	6. 24
5. 50. 39	7. 21
54	57
Sun's Par. 8″,05	

Tranquebar & Upſal.

h. m. ſec.	Parrall. ′ ″
5. 51. 33	6. 24
5. 50. 26	7. 33
1. 7	1. 9
Sun's Par. 8″,25	

Tranquebar & Abo.

h. m. ſec.	Parall. ′ ″
5. 51. 33	6 24
5. 50. 9	7. 46
1. 24	1. 22
Sun's Par. 8″.71	

Tranquebar

Tranquebar & Cajaneburg.		*Tranquebar & Tobolſki.*		*Madras & Stockholm.*	
h. m. ſec.	Parall. ′ ″	h. m. ſec.	Parall. ′ ″		Parall. ′ ″
5. 51. 33	6. 24	5. 51. 33	6. 24	5. 51. 43	6. 33
5. 49. 54	8. 5	5. 48. 50	9. 3	5. 50. 42	7. 34
1. 39	1. 41	2. 43	2. 39	1. 1	1. 1
Sun's Par. 8″,33		Sun's Par. 8″,67		Sun's Par. 8″,50	
Madras & Tornea.		*Great Mount & Abo.*		*Great Mount & Tobolſki.*	
5. 51. 43	6. 33	5. 51. 20	6. 33	5. 51. 20	6. 33
5. 50. 9	8. 7	5. 50. 9	7. 46	5. 48. 50	9. 3
1. 34	1. 34	1. 11	1. 13	2. 30	2. 30
Sun's Par. 8,50		Sun's Par. 8,26		Sun's Par. 8,50	
Cajaneburg & Upſal.		*Cajaneburg & Calmar.*		*Tobolſki & Abo.*	
5. 49. 54	8. 5	5. 49. 54	8. 5	5. 48. 50	9. 3
5. 50. 26	7. 33	5. 50. 39	7. 21	5. 50. 9	7. 46
32	32	9. 45	44	1. 19	1. 17
Sun's Par. 8,50		Sun's Par. 8,70		Sun's Par. 8,72	

The parallax of the Sun may alſo be determined, by comparing the times of the internal contacts, as obſerved in various places, with the time of their happening as obſerved at the center of the earth. For this purpoſe the following elements are uſed, as they were calculated by Mr. *Short*, from the meaſures made at the tranſit in 1761, viz. the diameter of the Sun 31′. 31″, the diameter of Venus 59″, her horary motion 3′, 59″,8, the angle of her path 8′. 30″.10, the neareſt diſtance of their centers 9′. 32″, and the difference of their horizontal parallaxes 21″,35. Hence the apparent time of the 1ſt and 2d internal contacts was $2^{h}. 22'. 3''$, and $8^{h}. 20'. 4''$, reckoned by the meridian of Greenwich, without parallax, and the central duration was $5^{h}. 58'. 1''$.

Central Time & *Upſal.*		Central Time & *Upſal.*		Central Time & *Hernoſand.*	
h. m. ſec.	Parall. ′ ″		Parall. ′ ″		Parall ′ ″
2. 22. 3	0. 0	2. 22. 3	0. 0	2. 22. 3	0. 0
1. 10. 26		1. 10. 26		1. 11. 28	
3. 32. 29		3. 32. 29		3. 33. 31	
3. 37. 56	5. 12	3. 37. 43	5. 12	3. 38. 35	5. 10
5. 27		5. 14		5. 4	
Sun's Par. 8″,91		Sun's Par. 8″,55		Sun's Par. 8″,33	
Central Time & *Hernoſand.*		Central time & *Cajaneburg.*		Central Time & *Stockholm.*	
2. 22. 3	0. 0	2. 22. 3	0. 0.	2. 22. 3	0. 0
1. 11. 28		1. 51. 50		1. 12. 26	
3. 33. 31		4. 13. 53		3. 34. 29	
3. 38. 26	5. 10	4. 19. 5	5. 6	3. 39. 29	5. 16
4. 55		5. 12		5. 0	
Sun's Par. 8,09		Sun's Par. 8,66		Sun's Par. 8,07	

Central Time & *Abo.*	Parall. ′	″
2. 22. 3	0.	0
1. 28. 33		
3. 50. 30		
3. 55. 50	5.	16
5. 14		
Sun's Par. 8,44		

Central Time & *Tornea.*	Parall. ′	″
2. 22. 3	0.	0
1. 36. 48		
3. 58. 51		
4. 4. 0	5.	2
5. 9		
Sun's Par. 8,69		

Central Time & *Calmar.*	Parall. ′	″
2. 22. 3	0.	0
1. 5. 39		
3. 28. 42		
3. 33. 5	5.	22
5. 23		
Sun's Par. 8,52		

Central Time & *Tobolſki.*		
2. 22. 3	0.	0
4. 32. 52		
6. 54. 55		
7. 0. 28	5.	28
5. 33		
Sun's Par. 8,63		

Central Time & *Madras.*		
2. 22. 3	0.	0
5. 20. 10		
7. 42. 13		
7. 47. 55	5.	57
5. 42		
Sun's Par. 8,14		

Central Time & *Calcutta.*		
2. 22. 3	0.	0
5. 53. 44		
8. 15. 47		
8. 20. 58	5.	16
5. 11		
Sun's Par. 8,36		

The Sun's parallax deduced from the obſerved and calculated times of the 2d internal contact.

Central Time & *Spittal Square.*	Parall. ′	″
8. 20. 4	0.	0
0. 0. 17		
8. 19. 48		
8. 18. 41	1.	11
1. 7		
Sun's Par. 8,01		

Central Time & *SavilleHouſe.*	Parall. ′	″
h. m. ſec.		
8. 20. 4	0.	0
0. 0. 30		
8. 19. 34		
8. 18. 22	1.	11
1. 12		
Sun's Par. 8,62		

Central Time & *Paris.*	Parall. ′	″
h. m. ſec.		
8. 20. 4	0.	0
0. 9. 16		
8. 29. 20		
8. 28. 27	0.	54
53		
Sun's Par. 8,34		

Central Time & *Bologna.*		
8. 20. 4	0.	0
0. 45. 21		
9. 5. 25		
9. 4. 57	0.	29
28		
Sun's Par. 8,21		

Central Time & *Cape.*		
8. 20. 4	0.	0
1. 13. 35		
9. 33. 39		
9. 39. 50	6.	8
6. 11		
Sun's Par- 8,58		

Central Time & *Upſal.*		
8. 20. 4	0.	0
1. 10. 26		
9. 30. 30		
9. 28. 9	2.	21
2. 21		
Sun's Par. 8,50		

Central Time & *Upſal.*		
8. 20. 4	0.	0
1. 10. 26		
9. 30. 30		
9. 28. 7	2.	21
2. 23		
Sun's Par. 8,62		

Central Time & *Upſal.*		
8. 20. 4	0.	0
1. 10. 26		
9. 30. 30.		
9. 28. 3	2.	21
2. 27		
Sun's Par. 8,86		

Central Time & *Stockholm.*		
8. 20. 4	0.	0
1. 12. 26		
9. 32. 30		
9. 30. 11	2.	18
2. 19		
Sun's Par. 8,56		

Central Time & *Stockholm.*		
8. 20. 4	0.	0
1. 12. 26		
9. 32. 30		
9. 30. 8	2.	18
2. 22		
Sun's Par. 8,75		

Central Time & *Abo.*		
8. 20. 4	0.	0
1. 28. 33		
9. 48. 37		
9. 45. 59	2.	30
2. 38		
Sun's Par. 8,95		

Central Time & *Cajaneburg.*		
8. 20. 4	0.	0
1. 51. 50		
10. 11. 54		
10. 8. 50	2.	59
2. 55		
Sun's Par. 8,31		

Central Time & *Tobolſki.*		
8. 20. 4	0.	0
4. 32. 52		
12. 52. 56		
12. 49. 20	3.	35
3. 36		
Sun's Par. 8,54		

Central Time & *Calmar.*		
8. 20. 4	0.	0
1. 5. 39		
9. 25. 43		
9. 23. 40	1.	59
2. 3		
Sun's Par. 8,78		

Central Time & *Rodrigues.*		
8. 20. 4	0.	0
4. 12. 34		
12. 32. 38		
12. 35. 47	3.	7
3. 9		
Sun's Par. 8,59		

Central Time & *Calcutta.*		
8. 20. 4	0.	0
5. 53. 44		
4. 13. 48		
14. 11. 34	2.	14
2. 14		
Sun's Par. 8,50		

The

The Sun's parallax is alſo found, by comparing the total duration between the internal contacts, as it was obſerved in different places, with the duration at the center of the earth, viz. 5ʰ. 58′. 1″.

Cent. Duration & at *Upſal.*	Parall.	Cent. Dur. & at *Upſal.*	Parall.	Cent. Duration & at *Tornea.*	Parall.
h. m. ſec.	′ ″	h. m. ſec.	′ ″	h. m. ſec.	′ ″
5. 58. 1	0. 0	5. 58. 1	0. 0	5. 58. 1	0. 0
5. 50. 7	7. 33	5. 50. 26	7. 33	5. 50. 15	8. 7
7. 54		7. 35		7. 46	
Sun's Par. 8,89		Sun's Par. 8,54		Sun's Par. 8,13	
Cent. Duration & at *Calmar.*		Cent. Dur. & at *Hernoſand.*		Cent. Duration & at *Tobolſki.*	
5. 58, 1	0. 0	5. 58. 1	0. 0	5. 58. 1	0. 0
5. 49. 54	8. 5.	5. 50. 17	7. 36	5. 48. 50	9. 3
8. 7		7. 44		9. 11	
Sun's Par. 8,53		Sun's Par. 8,65		Sun's Par. 8,63	
Cent. Dur. & at *Stockholm.*		Cent. Duration & at *Abo.*		Cent. Duration & at *Calcutta.*	
5. 58. 1	0 0	5. 58. 1	0. 0	5. 58. 1	0. 0
5. 50. 45	7. 34	5. 50. 9	7. 46	5. 50. 36	7. 30
7. 16		7. 52		7. 25	
Sun's Par. 8,16		Sun's Par. 8,61		Sun's Par. 8,40	
Cent. Duration & at *Upſal.*		Cent. Durat. & at *Cajaneburg.*		Cent. Dur. & at *Tranquebar.*	
5. 58. 1	0. 0	5. 58. 1	0. 0	5. 58. 1	0. 0.
5. 50. 2		5. 49, 54	8. 5	5. 51. 33	6. 24
7. 59	7. 33	8. 7		6. 28	
Sun's Par. 8,98		Sun's Par. 8,53		Sun's Par. 8,59	
Cent. Dur. & at *Hernoſand.*		Cent. Duration & at *Madras.*		Cent. Dur. & at *Great Mount.*	
5. 58. 1	0. 0	5. 58. 1	0. 0	5. 58. 1	0. 0
5. 50. 26	7. 36	5. 51. 43	6. 33	5. 51. 20	6. 33
7. 35		6. 18		6. 41	
Sun's Par. 8,48		Sun's Par. 8,17		Sun's Par. 8,67	
Cent. Dur. & at *Stockholm.*					
5. 58. 1.	0. 0				
5. 50. 42	7. 34				
7. 19					
Sun's Par. 8,22					

The mean of all the preceding determinations of the Sun's parallax is 8″52 on the day of the tranſit, in June, 1761, which gives 8″65 for his horizontal parallax at his mean diſtance from the earth.

Mr. Stuart of Edinburgh, whom I mentioned before, deduces the parallax and diſtances of the bodies that compoſe the ſolar ſyſtem, from the Newtonian theory of gravitation, and the periodical times of the Sun and Moon. As he proceeds upon the ſuppoſition that the diſtance of the Sun from the earth is very great, it would therefore ſeem, that the concluſion ſhould be accurate, in proportion to the greatneſs of that diſtance. His method depends

pends upon a ſeries of propoſitions, with long and difficult demonſtrations; ſo that the rules of calculation are not very obvious, without a conſiderable knowledge of geometry, in general, and a particular acquaintance with his very uſeful and ingenious treatiſe. I was deſirous of ſeeing what agreement there was between the reſult of his method of calculation, and the obſervations made on the tranſit of Venus; and therefore amuſed myſelf in a leiſure hour with the compariſon. As it may be agreeable to ſome, who have not time to read over the book, and to others, whoſe acquaintance with the mathematics will not admit of it, to have the practical rules of computation deduced from his propoſitions; I ſhall annex them to the foregoing calculations, together with the determination of the Sun's parallax and diſtance derived from them.

A Calculation of the horizontal Parallax and diſtance of the Sun, according to Mr. Stuart's method from the principles of gravitation.

D

Let P=the periodical time of the earth round the Sun=365. 256417824
p=the periodical time of the Moon round the earth= 27. 32162036
a=her revolution from apogee to apogee in time, 27. 554535
m=her mean diſt. from the earth, in ſemidi. of the earth= 60. 24
t=the tangent of the Sun's horizontal Parallax, at his mean diſtance.
S=the diſtance of the Sun from the earth.

Then according to Mr. Stuart's method,
$$\left\{\frac{P^2}{p^2}\times\frac{a^{\frac{2}{3}}-p^{\frac{2}{3}}}{5a^{\frac{2}{3}}-3p^{\frac{2}{3}}}=\frac{2-\sqrt{1-9m^2t^2}}{1-9m^2t^2+\sqrt{1-9m^2t^2}}\right.$$

Now if
$$\frac{p^2}{P^2}\times\frac{5a^{\frac{2}{3}}-3p^{\frac{2}{3}}}{a^{\frac{2}{3}}-p^{\frac{2}{3}}}=c;\text{ then } S=\frac{3m\times\overline{2+1.5c}}{2\sqrt{\overline{1-.5c}\times\overline{1+2c}}}\text{ nearly}$$

And
$$S=\frac{3m\times\overline{3+c}}{2\sqrt{\overline{1-.5c\times2+1.5c}}}$$
Nearly. S is greater than the firſt, and leſs than the leaſt in theſe theorems.

But the parallax and diſtance of the Sun, may be found nearly, in a ſhorter method, by the following rules, derived from the foregoing; by ſaying,

1. As the cube root of the ſquare of the Moon's periodic revolution round the Earth, viz. $\overline{27{,}32162036}|^{\frac{2}{3}}$
Is to the cube root of the ſquare of her revolution from apogee to apogee, viz. $\overline{27{,}554535}|^{\frac{2}{3}}$
So is 1 to a fourth number, which call A=1.0056748164.

2. As 5 A—3 : A 1 : : 1 : a fourth number, which call B.=.002797833=the mean diſturbing force of the Sun; the ☽'s force=1.

3. As the rectangle of B and the ſquare of the periodic time of the Earth round the Sun, viz. $B\times\overline{365{,}2564}|^{2}$
Is to the ſquare of the periodic time of the moon round the Earth, viz. $\overline{27{,}32162036}|^{2}$
So is 1, to a fourth number, which call C=1,999840899.

4. As $\overline{C-1}|^{2}$: 12 : : C : to a fourth number; to which add 1, and from the ſquare root of that ſum ſubtract 1, and multiply the remainder by the half of C—1, or 0,4999204495, and call that product D=1,9999715505.

5. Subtract

5. Subtract D from 2, multiply the remainder by D, and call the ſquare root of the product E. =.007543089.

6. As three times the Moon's mean diſtance from the Earth, in ſemidiameters of the Earth is to E, ſo is R, to the tang. of the Sun's horary parallax, at his mean diſtance, $=8'',65$.

7. As 1 : 3 : : the Moon's mean diſtance in miles: the Sun's mean diſtance in miles = 94,982,600.

In determining the parallax of the Sun, from the obſervation made in our obſervatory on the 3d of June, 1769, I have only made uſe of the time of the internal contact, as I noted it on that day, together with ſome of my own micrometer obſervations, without attending to thoſe of the other gentlemen who obſerved with me. But as the Society has a right to expect a full account of the reſult of the other obſervations, which were made on that occaſion; and as ſuch account may tend to corroborate the foregoing calculations, I have, with Dr. Williamſon's permiſſion, ſubjoined a calculation of his, founded entirely on his own obſervation, which being very ſhort, I have inſerted entire in his own words, except what refers to the manner in which he judged of the contacts, &c. which I have tranſcribed in another place, (ſee page 46.) From this, which is very ſimilar to the obſervations made by the other gentlemen on that committee, the Society will perceive, that our obſervations muſt have been made with conſiderable accuracy, as the reſult of the calculation is nearly the ſame.

DR. WILLIAMSON's *Determination of the* PARALLAX *of the* SUN, *from his Obſervation of the* TRANSIT *of* VENUS, *at Philadelphia, June 3d,* 1769.

"WITH a refracting teleſcope, 24 feet long, which magnified near 100 times, I obſerved,

The external contact at $2^h. 11'. 31''$ } Mean Time.
Internal do. at 2. 29. 10 }

"With a micrometer of Dollond's conſtruction, fitted to a Gregorian reflector, which magnified 100 times, I meaſured the diſtance of Venus from the limb of the Sun; alſo the diameters of the Sun and Venus, as follows:

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	Mean Time.			Neareſt Diſtance of the Center of ⊙ and ♀.		Neareſt Diſtance of the Limbs of ⊙ and ♀.	
	h.	m.	ſec.	m.	ſec.	m.	ſec.
At	5.	43.	17	10.	14,12	5.	2,53
	6.	32.	18	11.	14,19	4.	1,46
	6.	33.	55	11.	13,23	4.	3,42
	7.	9.	26	12.	11,83	3.	5,82

" I meaſured the diam. of Venus on the Sun, and found it to be 55″,42. I alſo frequently meaſured the diam. of the Sun, on the day of obſervation, and the next day, and found it to be 31′. 31″,30.

" From theſe data, I ſhall attempt to deduce the Sun's par. except that I ſhall make no uſe of the meaſure at 6^{h}. 32′. 18″, which I ſuſpected was not accurate at the inſtant it was made, wherefore I immediately made another meaſure, viz. at 6^{h}. 33′. 55″.

" The neareſt diſt. of the limb of the Sun from that of
Venus at 5^{h}. 43′. 17″ } mean time compared together,
And at 6 33. 53 }
give the apparent neareſt diſt. of their centers 10′. 3″,7, or 603″,7, and the parallax of Venus was at that time ſouth 6″,91 nearly. Therefore, the geocent. neareſt diſt. of their centers was 610″,61. Then,

" As 72626,3 the relative neareſt diſt. of Venus from the Sun,

" Is to 28894,9 her diſt. from the earth.

" So is 610″,61 the geocent. neareſt diſt. of the cent. of the Sun and Venus,

" To 242″,936=4′. 2″,936, the heliocent. diſt. of their centers at the neareſt approach.

" As Sine 3°. 23′. 20″ the given inclin. of Venus's orbit to the ecliptic: Is to Radius,

" So is S, 242″,936, the heliocent. diſt. of the cent. of the Sun from Venus, at the middle of the tranſit,

" To the Sine of 410″,5=1°. 8′. 25″, the Sun's diſk, from the node of Venus at the ecliptical conjunction.

" As S, of 1°. 8′. 25″, the Sun's diſt. from the node of Venus,

" Is to 10′. 10″,61, the geocent. neareſt diſt. of their centers

" So

“ So is Rad: to the S, of 8°. 32′. 57″,6, the angle of Venus's viſible path with the ecliptic.

“ From 8°. 32′. 57″6, the angle of Venus's viſible path,

“ Subt. 3. 23. 20, the inclination of Venus's orbit with the eclipt. and the remainder is 5°. 9′. 37″,6. Then

“ As S, 5°. 9′. 37″,6 the diff. of the angle of Venus's viſible path and the inclin. of her orbit, &c.

“ Is to S, 8°. 32′. 57″,6 the angle of Venus's viſible path with the eclipt.

“ So is 2′,392375 the given hor. motion of the Sun.

“ To 3′,95412 the hor. motion of Venus.

“ As Rad. Is to T, 8°. 32′. 57″,6 the angle of Venus's viſible path.

“ So is S, 1°. 8′. 25″ the Sun's diſt. from the node of Venus.

“ To T, 10′. 17″,2 Venus's geocent. latitude.

“ As 72626,3 the relative diſt. of Venus from the Sun,

“ Is to 28894,9 her diſtance from the earth.

“ So is 617″,2 her geocent. latitude.

“ To 245″,56 her heliocent. latitude.

“ From 15′. 45″,65 the ſemid. of the Sun,

“ Take 27″,71 the ſemid. of Venus, and the difference is 15′. 17″,94., the diſt. of the center of the Sun from the center of Venus at the inter. contact. But the geocent. neareſt diſt. of their centers was found 610″,61. From theſe (b. Euc. 1. 47) the length of half the tranſit line between the int. contacts is found to be 685′,397 which divided by the hor. motion of Venus gives the ſemiduration of the tranſit between the two internal contacts 2^{h}. 53′. 20″,2.

“ In the ſame manner, from the geocent. lat. of Venus, and the neareſt diſt. of her center from the center of the Sun, we find the time of Venus paſſing from the eclipt. conjunction to the middle of the tranſit 22′. 44″,9. Then from 5^{h}. 28′ 47″, which I find to be the central time of the middle of the tranſit, deduct 22′. 44″,9, and the remainder, viz. 5^{h}. 6′. 2″,1, will be the apparent time of the ecliptical

ecliptical conjunction when the Sun's place was 2^s. 13°. 27′. 20″,5, as calculated by the aſtronomer royal, on the ſuppoſition that our obſervatory is weſt of Greenwich 5^h. 0′. 35″.——To the Sun's place in the eclipt. add his diſt. from the node of Venus 1°. 8′. 25″. The ſum is 2^s. 14°. 35′. 45″,5, the place of Venus's aſcending node.

" From the micrometer meaſures above given, it appears that the center of Venus was at her neareſt approach to the center of the Sun at 5^h. 21′. 44″ mean time, or 5^h. 23′, 59″ appar. time. But on account of the parallax of Venus, the appar. time at the center of the Earth was 4′. 48″ later, which brings it to 5^h. 28′. 47″ as I have mentioned. From this deduct the ſemidurat. 2^h. 53′. 20, and the remainder 2^h. 35′. 27″ is the time of the internal contact at the center of the earth. This contact I obſerved as above, at 2^h. 29′. 10″ mean time, or 2^h. 31′. 25″ apparent time. This difference, therefore, viz. 4′. 2″, is the obſerved effects of Venus's parallax both in latitude and longitude.

" But on the ſuppoſition that the Sun's horizontal parallax, at her mean diſt. from the earth was 8″,65, as Mr. Short has ſtated it at the former tranſit, then his horizontal parallax, on the 3d of June, the day of the tranſit, would have been 8″,5204, in which caſe the total effect of her parallax, to haſten the internal contact at Philadelphia, ſhould be 4′. 1″. Therefore,

" As 4′. 1″ is to 4′. ″2, ſo is 8″,5204 to 8″,556, the Sun's horizontal parallax on the day of the tranſit, according to the foregoing obſervations.

" Hence we have 8″,685, the Sun's horizontal parallax at his mean diſtance from the earth. Then ſay,

" As the Tang. of the Sun's horizontal parallax: is to the ſemidiameter of the earth,

" So is Rad. to the diſtance of the earth from the Sun, viz. 94791100 Engliſh miles, taking the earth's mean ſemidiameter at 3985.4 miles.

An

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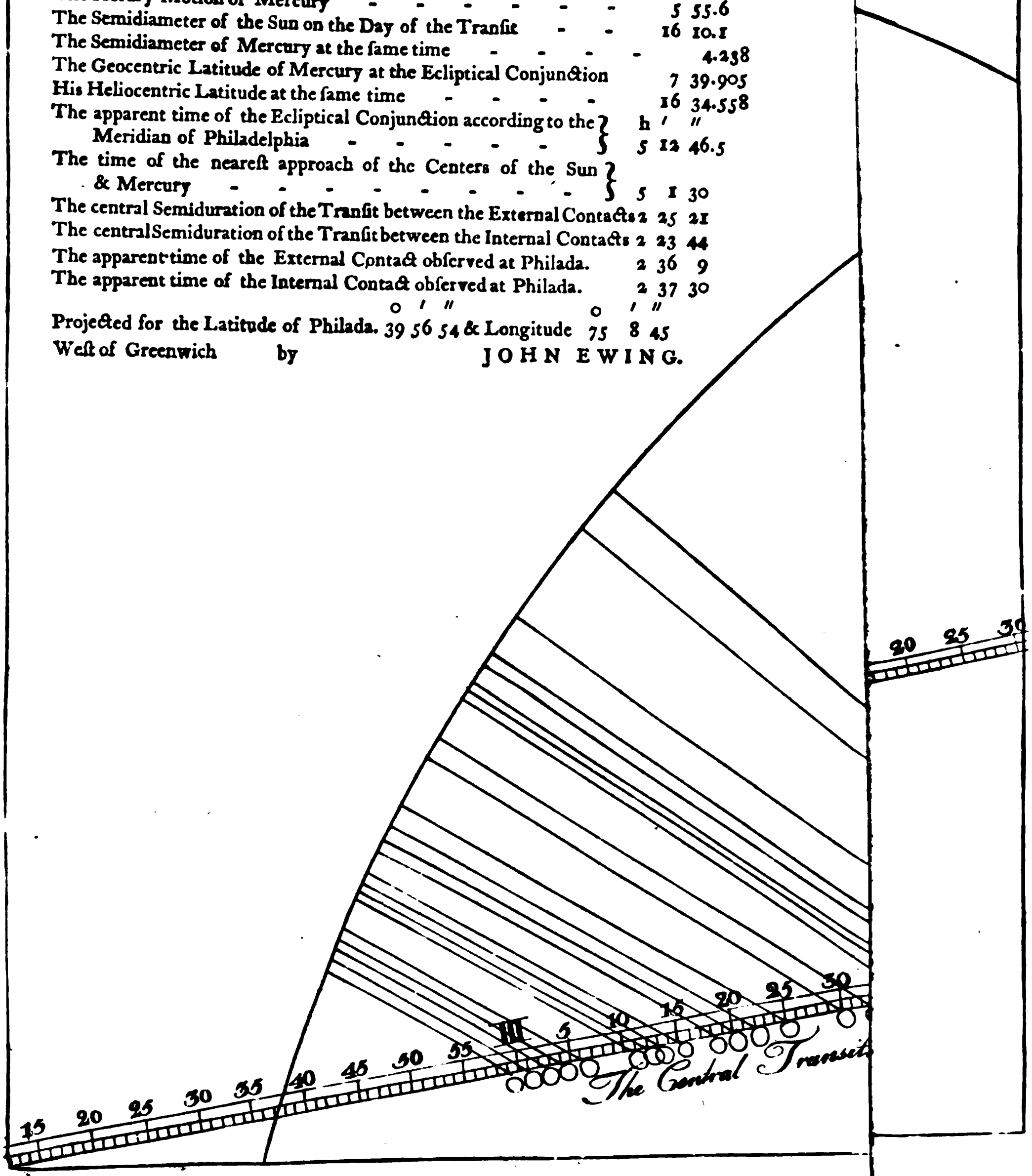
A Projection of the

	s	°	′	″
The place of the Sun & Mercury at the Ecliptical Conjunction	7	17	50	41
The place of the aſcending Node of Mercury - - - -	1	15	35	29
The Sun's Diſtance from the Node of Mercury - . -		2	15	12
The Angle of his viſible path with the Ecliptic - - -		3	21	18
The Horary Motion of Mercury - - - - - - -			5	55.6
The Semidiameter of the Sun on the Day of the Tranſit - -			16	10.1
The Semidiameter of Mercury at the ſame time - - - -				4.238
The Geocentric Latitude of Mercury at the Ecliptical Conjunction			7	39.905
His Heliocentric Latitude at the ſame time - - - -			16	34.558
		h	′	″
The apparent time of the Ecliptical Conjunction according to the Meridian of Philadelphia - - - - - -		5	12	46.5
The time of the neareſt approach of the Centers of the Sun & Mercury - - - - - - - - -		5	1	30
The central Semiduration of the Tranſit between the External Contacts		2	25	21
The central Semiduration of the Tranſit between the Internal Contacts		2	23	44
The apparent time of the External Contact obſerved at Philada.		2	36	9
The apparent time of the Internal Contact obſerved at Philada.		2	37	30

Projected for the Latitude of Philada. 39° 56′ 54″ & Longitude 75° 8′ 45″
Weſt of Greenwich by JOHN EWING.



An Account of the Tranſit of MERCURY *over the* SUN, *on November 9th, 1769. N. S.*

IN the judgment of moſt aſtronomers, the tranſits of Mercury and Venus over the Sun afford the beſt opportunities, for ſettling the longitudes of places on the earth, even preferable to that derived from the eclipſes of Jupiter's ſatellites, when the parallax of the Sun is previouſly known. Thoſe of Mercury happen frequently, and although they are of but little importance in determining the parallax of the Sun and the dimenſions of the ſolar ſyſtem, by reaſon of his great diſtance from the earth, and the difference of their parallaxes being leſs than that of the Sun; yet they have been carefully obſerved, for the purpoſe of ſettling his theory, and the longitudes of the places of obſervation. The ſociety therefore ſenſible of the importance of this phœnomenon, both to the perfection of aſtronomy in general, and particularly for completing the purpoſes deſigned to be anſwered by the obſervation of the tranſit of Venus, have appointed the ſame committee, with the addition of two other gentlemen, to obſerve the tranſit of Mercury on the 9th of November, 1769, in Philadelphia, that had been before appointed to obſerve that of Venus.

Having ſtill the ſame inſtruments in our obſervatory, which we uſed on the former occaſion, together with a new time-piece made by Mr. Duffield of this city, with an ingenious contrivance of his, in the conſtruction of the pendulum, to remedy the irregularities ariſing from heat and cold; we paid the utmoſt attention to the going of the clock both before and after the tranſit. From comparing a ſufficient number of correſponding altitudes of the Sun's limbs, we found that our clock was too ſlow for mean time 1′. 20″ and the equation of time being 15′. 49″,6 or to avoid fractions 15′. 50″; 17′. 10″ were added to the times of all our obſervations, as they were written down in the obſervatory, to reduce them to apparent time. In this manner we obtained the time of the ſubſequent obſervations. Dr. Williamſon, Mr. Shippen and myſelf uſed the ſame teleſcopes, we had uſed before in obſerving the tranſit of Venus; excepting that on this occaſion I choſe that power of the teleſcope which magnifies the diameters of objects an hundred times. Mr. Evans uſed the reflecting teleſcope formerly uſed by Mr. Biddle at the Capes.

On the day of the tranſit, we aſſembled together at the obſervatory, adjuſted our teleſcopes to diſtinct viſion, appointed an aſſiſtant to count the clock with an audible voice, and agreed that no other perſon ſhould ſpeak, nor move from his teleſcope, until both contacts were over; but write down his own obſervation ſeparately by himſelf, that it might be compared with the others. The ſky being very ſerene, and the limb of the Sun well defined in our teleſcopes, we obſerved the contacts, as they are exhibited in the following table,

Obſervers.	External Cont.	Int. Cont.	Par. in Vert.	Par. p. to his P.	Par. in his Path.
	h. m. ſec	h. m. ſec.	"	"	"
Dr. Williamſon,	2. 36. 5Ap.T.	2. 37. 30	3,74	3,44	1,48 at the External Contact.
Mr. Shippen,	2. 36. 12	2. 37. 40			
Mr. Evans,	2. 36. 9	2. 37. 38	3,745	3,44	1,49 at the Internal Contact.
Myſelf.	2. 36. 9	2. 37. 30			

I happened to have that part of the limb of the Sun, on which Mercury entered, in the middle of the field of my teleſcope, with my eye intent upon it; ſo that I am certain, that there was not the leaſt impreſſion on the Sun's limb, perceptible by my teleſcope, a ſingle ſecond of time before I diſcovered it. So that I am not ſurprized that Dr. Halley, who had obſerved a tranſit of Mercury in the Iſland of St. Helena, concluding that, that of Venus would be equally inſtantaneous, expected, that the contact of her limb with the Sun might be determined to a ſingle ſecond of time. The atmoſphere of Venus renders it quite otherwiſe, and produces an uncertainty of 5 or 6 ſeconds of time, in judging of the contacts; whereas no ſuch thing was perceptible in Mercury. The firſt appearance of Mercury, on the Sun's limb, was a ſteady ſmall ſpeck, black, well-defined, and not larger in my teleſcope than the dot of a pen. But that of Venus was tremulous, obſcure, and ill-defined, growing gradually darker as ſhe advanced on the Sun. If Mercury has an atmoſphere, it muſt be ſo rare and low, that his diſtance from us renders it abſolutely imperceptible with the teleſcopes that we uſed. At the internal contact, the creſcent of light round the body of Mercury cloſed inſtantaneouſly, ſo that it might be judged of with more preciſion than that of Venus; his atmoſphere giving us no diſturbance in this caſe. We could not have a fairer opportunity, for aſcertaining the truth of theſe concluſions; as our teleſcopes were in good order, and well adjuſted, and the ſky was remarkably clear and ſerene, on both of theſe days. On the firſt of them, not a cloud appeared from morning till evening, and on the latter, none till about four o'clock, when the Sun was very low; and both the tranſits began between two and three o'clock, in the afternoon.

About three o'clock, I applied myſelf to the micrometer, to meaſure the diameters of the Sun and Mercury, and the neareſt diſtance of their limbs; while Dr. *Williamſon* read off the diviſions of the micrometer, and a third perſon wrote them down, with the times of making them. Theſe meaſures make the diameter of the Sun on the 9th of November 1769, 32′. 20″,2 or his ſemidiameter 970″,1 ſeconds, and the ſemidiameter of Mercury 4″,238. The meaſures of the leaſt diſtances of their limbs reduced to minutes and ſeconds of a degree, with the parallaxes of Mercury adapted to the apparent times of the obſervations, as they are determined from a very large projection of two inches to a ſecond of his hor. parallax, are ſet down in the following table.

Apparent

Apparent Time. h. m. ſec.	Neareſt diſtance of limbs of ☉ & ☿	Parrallax of ☿ in the vert.	Par. per. to his path.	Parallax in hi path.
2. 59. 40	1'.54",1	3,"81	3",4	1",725
3. 1. 0	2. 0,62	3,81	3,396	1,73
3. 2. 35	2. 8,284	3,82	3,393	1,745
3. 4. 30	2. 20,832	3,825	3,39	1,765
3. 6. 10	2. 26,048	3,826	3,386	1,78
3. 10. 33	2. 48,216	3,835	3,38	1,83
3. 12. 6	2. 57,244	3,841	3,379	1,84
3. 12. 56	3. 2,56	3,844	3,376	1,85
3. 15. 4	3. 13,744	3,850	3,375	1,865
3. 18. 4	3. 26,032	3,856	3,369	1,87
3. 19. 18	3. 30,596	3,86	3,366	1,888
3. 21. 30	3. 41,68	3,864	3,363	1,915
3. 24. 0	3. 51,684	3,875	3,36	1,95
3. 30. 0	4. 20,8	3,895	3,34	2,0
3. 33. 30	4. 35,144	3,90	3,338	2,02
3. 36. 40	4. 51,444	3,905	3,334	2,04
3. 37. 40 }	5. 2,202	3,915	3,33	2,065
3. 39. 25 }				
3. 41. 10 }	5. 21,406	3,930	3,325	2,09
3. 42. 50 }				
3. 46. 58	5. 37,184	3,935	3,32	2,145
3. 55. 32	6. 8,48	3,96	3,30	2,2
3. 59. 10	6. 26,084	3,97	3,29	2,24
4. 28. 50	7. 54,756	4,0	3,22	2,42
4. 47. 50	8. 35,18	4,02	3,15	2,51

N. B. In the above table, the meaſure at $2^{h.}\,37'.\,40''$ was taken between the neareſt limb of the Sun and the interior limb of Mercury neareſt to the Sun's center, and is $5'.\,2''202$, the ſame with the diſtance of their neareſt limbs at $3^{h.}\,39'.\,25''$: So alſo the diſtance between the neareſt limb of the Sun, and the interior limb of Mercury, at $3^{h.}\,41'.\,10''$, was the ſame with the diſtance of their neareſt limbs at $3^{h.}\,42'.\,50''$, viz. $5'.\,21'',406$. The ſame is to be ſaid of the laſt meaſure, which was taken from the neareſt limb of the Sun to the limb of Mercury neareſt to the Sun's center.

If a computation be made from the above meaſures, the apparent neareſt diſtance of their centers will be found to be $451'',914$. But Mercury was then depreſſed by parallax $3'',11$; ſo that the geocentric neareſt approach of their centers was $455'',024$, which happened at $5^{h.}\,1'.\,15''$ apparent time, when his par. in the vert. was $4'',042$, and in his path $2'',53$, and perpend. to his path $3'',11$.

The horary motion of Mercury as ſeen from the Earth is alſo determined from the above meaſures to be

5'

5′. 56″,941=5″,94856, which is nearly the ſame with what is given by Dr. Halley's tables of Mercury. On the day of the tranſit, he moves, by them, at the rate of 15″,334 per hour. The Sun's horary motion on that day is ſtated in the nautical almanac at 2″,516, and their difference, viz. 12′,818 is his horary motion from the Sun, as ſeen at that diſtance. Then ſay,

As the diſtance of ☿ from ⊖, is to his diſtance from ⊙, So is this horary motion to his horary motion from ⊙, as ſeen from ⊖.

4. 830,2920=log. of 67653.8
4. 495,3305=log. of 31284.6
1. 107,8203=log. 12.818

5. 603,1508

0. 772,8588=5′. 92733=5′. 55″,6398 ☿ hor. mot. from ⊙, as ſeen from ⊖.
15. 334=horary motion ☿.
2. 516=horary motion ⊙.

As 17. 850=1. 251,6382=the ſum of horary motions ⊙ and ☿.

Is to 12. 818=1. 107,8203=their difference.
So is cot. 3°. 29′. 40″=11. 214,2067= } the log. cot. of half the incl. of ☿'s orbit with the ecliptic=½ 6°. 59′. 20″.

12. 322,0270

To Log. Tang. 11. 070,3888=85°. 8′. 22″.
86. 30. 20=½ ſup. of 6°. 59′. 20″.

Sum=171. 38. 42
The ſupplement whereof is 8. 21. 18=the angle of ☿'s viſible path with the ecliptic.

As Rad : Sec. 8°. 21′. 18″ : : geo. neareſt diſt. : the geo. lat. of ☿.
10. 000,0000
10. 004,6342
2. 658,0343=455″,024=geo. neareſt diſtance.

2. 662,6685=459″,905=geo. lat. of ☿=7′. 39″,905

As diſt. of ☿ from ⊙ : his diſt. from ⊖ : : geo. lat. : his heliocent. latitude.
4. 495,3305
4. 830,2920
2. 662,6685

7. 492,9605

2. 997,6300=994″,558 the hel. lat. of ☿=16′. 34″,558

As T, 6°. 59′. 20″ : R : : T, 16′. 34″,558 : Sine of ⊙'s diſt. from the node of ☿.
9. 088,4133
10. - - -
7. 683,0140

8. 594,6007=2°. 15′. 12″,2=⊙'s diſt. from the node of ☿.

459,905=geocent. lat. ☿.
455,024=geocent. neareſt diſt. of ⊙ and ☿.
Sum=914,929=2. 961,3873
Diff.= 4,881=0. 688,5088

2)3. 649,8961 1. 824,94805

1. 824,94805=66″,8264= } the length of part of the tranſit line between
2. 551,0104 ☿ hor. motion } the middle of the tranſit and the eclipt. con-
in ſeconds. } junction.
—1. 273,9376=0h. 187205=0h. 11′. 16″,458=the time between the middle and ecliptical conjunction.

974,338=the ſum of the ſemidiameters of ⊙ and ☿.
455,024=the geo. neareſt diſt. of their centers.

Sum=1429,362=3. 155,1422
Diff.= 519,314=2. 715,4300

2)5. 870,5722

2. 935,2861=861″,561 } half the length of the tranſit line from the external contact.
2. 551,0104=the horary motion of ☿ on ⊙, as ſeen from ⊖.

0. 384,2757=2h. 422567=2h. 422567=2h. 25′. 21″,24 the ſemiduration from the external contact.
965,862 the diff. of the ſemidiameters of ⊙ and ☿.
455,024 the geo. neareſt diſtance of their centers.

Sum=1420,886=3. 152,5691
Diff.=510,738=2. 708,2833

2) 5. 860,8524

2. 930,4262= } 851,974=the length of half the tranſit line from the internal contact.
2. 551,0104=hor. mot. of ☿.

0. 379,4158=2h. 39561=2h. 23′. 44″,196
Now to 2h. 36′. 19″ the time of the external contact,
Add 2. 25. 21 the ſemidur. between the external contacts.

The Sum, 5. 1. 30 is the time of the neareſt approach of their centers.
To this add, 11. 16,5 the time from the middle to the ecl. conjunction.
The ſum, 5. 12. 46,5 is the apparent time of the ecl. conjunction at Philadelphia.
To this add, 5. 0. 35 the diff. of meridians between Greenwich and Philadelphia.
The ſum, 10. 13. 21,6 is the time of the ecl. conjunction at Greenwich, when the Sun's place, according to the Nautical Almanac, is 7s. 17° 50′. 41″, and that of Mercury is 1s. 17°. 50′. 41″, by Dr. Halley's tables. From this ſubtract 2°. 15′. 12″, the Sun's diſtance from the node of Mercury, and the remainder 1s. 15°. 35′. 29″, is the place of his node at that time.

The PROJECTION *of the* TRANSIT *of* MERCURY, *Pl.* V.

THE following projection of the tranſit of Mercury over the Sun, on the 9th of November, 1769, was made from the foregoing meaſures and calculations, on the ſuppoſition that the Sun's horizontal parallax, at his mean diſtance is 8″,65, and therefore, 8″,7437 on the day of the tranſit. In this caſe, the horizontal parallax of Mercury, at his mean diſtance, will be 14″,1132, and on the day of the tranſit 12″7856, and therefore his horizontal parallax from the Sun on that day is 4″,0419, being the difference of their parallaxes.

The delineation was made in the ſame manner as that of the tranſit of Venus. The elements for it were collected from

from the preceding calculation, and the parallaxes of Mercury were meaſured upon a very large projection, for that purpoſe, adapted to the apparent times of the micrometer meaſures, and applied to the projection. By theſe, the apparent places of Mercury were determined, as ſeen at Philadelphia; and ſmall circles were drawn round them, with the radius 4″,238, to repreſent his diſk on the face of the Sun. From the limbs of the Sun and Mercury, lines were drawn in the direction of their centers, of the preciſe length exhibited in the foregoing table of meaſures.

Upon the whole, I have given a full and faithful account of our obſervations of the tranſits of Venus and Mercury, in the foregoing ſheets; and if they ſhould be found, in the concluſion, to contribute any thing to the advancement of aſtronomical knowledge, it muſt reflect an honor on our new obſervatory, and give pleaſure to all the lovers of ſcience, as well as to,

Gentlemen,
Your moſt obedient
And very humble ſervant,

Philadelphia, July 19th, 1769. JOHN EWING.

An Account of the Tranſit of Venus, *over the* Sun's *Diſk, as obſerved near* Cape Henlopen, *on Delaware Bay, June* 3d, 1769. *By* Owen Biddle, Joel Bailey, *and Drawn up By* Owen Biddle.

AGREEABLE to the appointment of the *American Philoſophical Society*, to obſerve the *tranſit of Venus* at the light-houſe, near Cape-Henlopen, I ſet out by water from Philadelphia, accompanied by Joel Bailey, and Richard Thomas, the latter of whom had offered to accompany us at his own expence, and proved very ſerviceable in the aſſiſtance he gave us.

On the 26th of the 5th month (May) we arrived at *Lewes-Town*, and immediately endeavoured to gain ſuch information