Harvard University Art Gallery

John Winthrop, oil portrait by John Singleton Copley, ca. 1773 (detail)

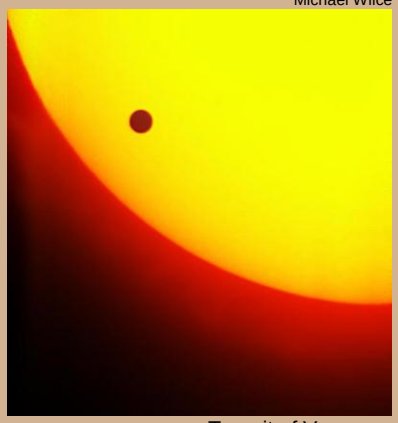
JOHN WINTHROP

"the most agreeable Sight, VENUS ON THE SUN."

Relation of a Voyage from Boston to Newfoundland for the Observation of the Transit of Venus, June 6, 1761

EXCERPTS

Michael Wilce



Transit of Venus as photographed in 2004

In June 2012 occurred a phenomenon we will not see again until 2117—the passage of a small black dot across the sun's surface. The dot is the planet Venus, and its transit takes three to seven hours. Thousands of people have made arduous journeys to observe the rare event, as did John Winthrop (great-great grandson of the first Massachusetts Bay governor) in 1761, when the transit was visible in North America (but only in Newfoundland and the Spanish west). Why bother? Because the mathematical calculations answered a host of questions and, besides, as Winthrop wrote, it gave the "high satisfaction of seeing the most agreeable Sight, VENUS ON THE SUN."

The Transit of the Planet Venus over the disc of the SUN, being a most important as well as curious phenomenon, has for a long time employed the consideration of Astronomers. The first notice that I find taken of it was by the sagacious *Kepler*, who flourished not long after the revival of the true astronomy by *Copernicus*; and in a work published in 1604 declared that no such thing could happen in that century, nor the next, till the year 1761. In this, however, that great man was mistaken. For an English Astronomer, *Jeremiah Horrocks*, then no more than 20 years of age but of an admirable genius, having corrected *Kepler's* Tables by some of his own observations, predicted and soon after observ'd this most rare phenomenon on the 24th of November O.S. in the year 1639, at *Hoole*, a small village about 12 miles N. from *Liverpool*. Having waited several hours with great impatience, he had at last the satisfaction to see the Planet as a black spot, just entering on the Sun, at a quarter past three in the afternoon. He made three observations of its positions in half an hour, when he was depriv'd of a longer sight of it by the setting of the Sun. He had given notice to an astronomical friend, Mr. *Crabtree*, who, at a few miles distance just got a sight of it between the clouds before Sun-set. These two were the only persons that ever saw Venus in the Sun before the present year.

THESE Transits became more generally known by a *Series* which the late Astronomer-Royal Dr. *Halley* publish'd, of all in a thousand years, from which it appears that none could happen between the years 1639 and 1761. But what made this of June 6, 1761, most of all famous, was a paper of the same learned author in the Philosophical Transactions for the year 1705, wherein he explains an important use to be made of it. Some uses of the transits of the inferior planets were obvious. They serve much better than any other phenomena to perfect the theory of these planets, which is more difficult to be settled than that of the superiors; and did they happen frequently, would be of admirable use in ascertaining the longitude of places on this globe. They likewise demonstrate the truth of the Copernican System, so far as it relates to these Planets, by making it evident that they respect the Sun and not the Earth as the center of their motions.

National Humanities Center, 2009: nationalhumanitiescenter.org/pds/. Some spelling and punctuation modernized by NHC for clarity. Complete image credits at nationalhumanitiescenter. org/pds/becomingamer/imagecredits.htm.

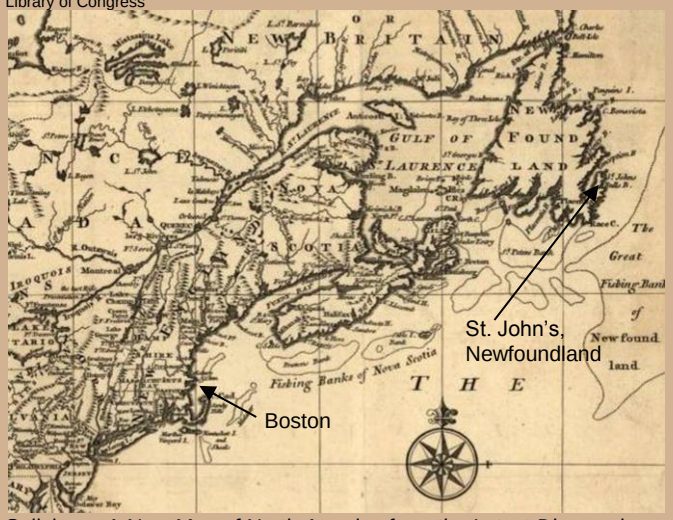
But Dr. Halley pointed out a new and singular use to be made of the Transit of Venus and to which no other phenomenon in the heavens is near so well adapted. This is in finding the Parallax of the Sun.

But Dr. *Halley* pointed out a new and singular use to be made of the Transit of Venus and to which no other phenomenon in the heavens is near so well adapted. This is in finding the Parallax of the Sun, which is so small that the Astronomers have never been able to discover it with exactness in any other method. If this were once known, the distance of the Sun, and of all the Planets, and of all the Comets, would be known too, and their magnitudes would also be known from their apparent diameters. This would give us a just idea of the vast dimensions of the solar system, and of the mighty globes which compose it. Nor can we, but by such observations, know whether the Earth continues to revolve at the same distance from the Sun, or whether it gradually approaches him, as there is some reason to suspect; nor whether the Sun remains of the same magnitude, or consumes away and is diminish'd by the light which he is incessantly sending forth.

The Parallax of the Sun is also an element that enters into the calculations of eclipses; and of what use these are in Astronomy, in Geography, in History and Chronology is too well known to need being insisted on at this day. It would likewise determine the quantity of matter in the Earth, or the proportion which this bears to that in the Sun, and show us precisely the amazing velocity with which light is darted from the Sun and other luminous Bodies; — and probably give us a deeper insight into many of the wonderful works of GOD. For such is the relation of the several branches of natural Philosophy to each other, and of all of them to moral Philosophy, that whatever tends to the perfection of one tends to perfect the other, in proportion to the connection there is between them. And a capital point once adjusted, may serve for the determination of others, which were not at first thought of. Thus, the exact measure of a degree on the meridian enabled Sir *Isaac Newton* to demonstrate his Theory of universal Gravity, a scheme which had never enter'd into the minds of any, when the degree was proposed to be measured, by which means that great man laid open the constitution of the astronomical world and pointed out the fundamental Law which the allwise CREATOR has established for regulating the several movements in this grand machine. . . .

Winthrop summarizes the plans of European monarchs and scientists to send observers to sites in Europe, Africa, and Asia to record the 1761 transit of Venus.

Library of Congress



Spilsbury, *A New Map of North America from the Latest Discoveries*, 1761, detail including the British Atlantic colonies of Massachusetts Bay and Newfoundland (Boston and St. John's marked)

Nor was *America* inactive on this singular occasion. His Excellency FRANCIS BERNARD, Esq. Governor of the Province of the *Massachusetts-Bay*, inspired with a just zeal for the advancement of [scientific] Literature, which he demonstrates on every opportunity, exerted himself to procure an observation in this quarter of the world. And as *Newfoundland* was the only British Plantation [colony] in which one could be made, and indeed the most western part of the Earth where the end of the Transit could be observ'd, for this was to happen before the Sun would be risen to any other part of *America* except the Savage coast of *Labrador*, he proposed by a message to the General Assembly of the Province then sitting at Boston to make provision for this purpose. . . .

. . . The Reverend the President and Fellows of Harvard College, in order to promote so laudable an undertaking, granted their Apparatus of astronomical instruments to be employ'd in this affair. Accordingly I carried an excellent Pendulum clock, one of Hadley's Octants with Nonius divisions and fitted in a new manner to observe on shore as well as sea, a refracting telescope with cross wires at half right angles for taking differences of Right Ascension and Declination, and a curious reflecting telescope, adjusted with spirit-levels at right angles to each other and having horizontal and vertical wires for taking correpondent altitudes, or differences of altitudes and azimuths. And taking with me for assistants two young Gentleman my Pupils, who had made good proficiency in mathematical studies. I embark'd at *Boston* on board the before-mentioned vessel [the Province-Sloop] commissioned by the Governor, May the 9th, and in 13 days arrived at *St. John's, Newfoundland.*

. . . The town of *St. John's* being bounded with high mountains toward the Sun-rising, so that no house in it would answer our end, we were obliged to seek farther, and after a fatiguing and a fruitless attempt or two fix'd on an eminence at some distance, from whence we could have a view of the Sun presently after his rising. As this place was open and had no building near it, we pitch'd some tents upon it for a shelter, which, together with our Apparatus and such materials as we had occasion to make use of, we convey'd up thither with the labor of several days.

New York Public Library

J. Wells, *A View of the Entrance of St. John's, Newfoundland*, 1802, print after a drawing by Rev. J. Hall

We secured the Clock to a pillar set in the ground under a large tent. Near this tent and within call of the Clock we fix'd two others firmly in the ground: one, to mount the refracting telescope upon; the other, which was above 8 feet high, for a Style, having at top a plate of lead with a little hold for transmitting the Sun's rays; and we laid a large horizontal Platform on the ground to receive these rays. This Platform we kept cover'd to defend it from the Sun and the weather, and examin'd its position every time we made use of it by a very long level. On this we carefully traced a meridian line, by correspondent altitudes of the Sun, taken both with the Reflector and by the Sun's image on the Platform. And, in order fully to examine and verify the meridian and adjust our clock, we repeated these operations every fair day, and many times in a day, and continued them with an assiduity which the infinite swarms of insects, that were in possession of the hill, were not able to abate, tho' they persecuted us severely and without intermission, both by day and by night, with their venomous stings. It would be tedious, as well as needless, to give a detail of the observations we made with this intent: 'Tis sufficient that we regulated the clock with as much exactness as we could have done at home.

Thus prepared, we waited for the critical hour, which proved favorable to our wishes. The morning of the 6th of June was serene and clam. The Sun rose behind a cloud that lay along the horizon but soon got above it, and at $4^h\,18^m$ we had the high satisfaction of seeing that most agreeable Sight, VENUS ON THE SUN, and of showing it in our telescopes to the Gentlemen of the place who had assembled very early on the hill to behold so curious a spectacle. The Planet at first appear'd dim thro' the cloud, but in a short time became more distinct and better defined. Upon this, I applied myself to take the passage of the Sun's and Venus's preceding limbs by the vertical, and of their lower limbs by the horizontal wires in the

Reflector, and made the following observations, one of my assistants counting the Clock and the other writing down the observations as I made them.

Apparent Time

At	4^h	21^m 16^s	The Sun at the vertical
		27	Venus at the same
		23 2	Venus at the horizontal
		24 19	The Sun at the same
		27 25	Venus at the horizontal
		28 43	The Sun at the same
		35 11	The Sun at the vertical
		17	Venus at the same
		37 45	Venus at the horizontal
		39 5	The Sun at the same

Nicholas Dudish

2004 Transit of Venus

As Venus began now to draw near the Sun's limb, I prepared to observe her egress. The interior contact appeared at 4^h 47^m 17^s, and the exterior at 5^h 5^m 46^s.

The above observations gave me so many differences between the Sun's and Venus's altitudes and azimuths, from whence by spherical trigonometry I deduc'd the Planet's right Ascensions and Declinations and, from them, in the last place, her Longitudes and Latitudes. It would be neither of entertainment nor use to the Reader to insert the particulars of such tedious calculations. It will be enough to give the result of the whole, or the Planet's difference in Longitude from the Sun's center, and her Latitude at the time of each observation, which came out as follow:

Oxford Museum of the History of Science

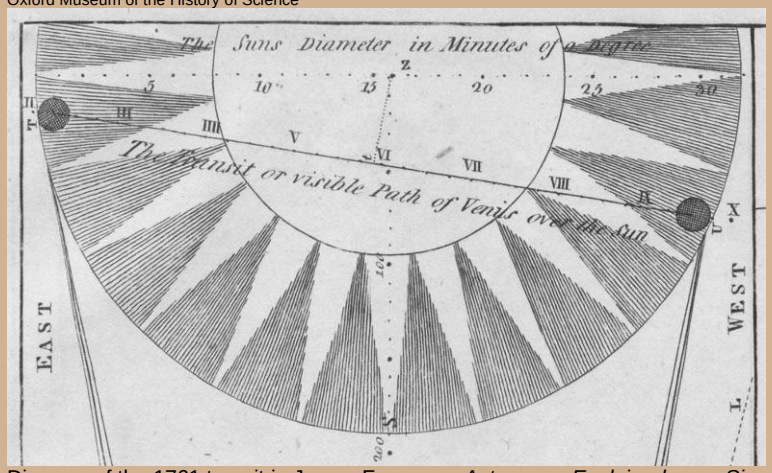


Diagram of the 1761 transit in James Ferguson, *Astronomy Explained upon Sir Isaac Newton's Principles*, first published in 1756; illustration from 1811 edition

Winthrop presents his calculations with tables and drawings and then concludes:

BY the foregoing observations we are now enabled to predict with certainty what Dr. *Halley*, in his paper beforementioned, only suspected, that Venus will again pass over the Sun on the 3^d of June in the year 1769, the former part of which Transit will be visible in our horizon for about 5^h in the afternoon, but the Sun will set before it is ended. That Transit will be more convenient for finding the Parallax than the present has been; but not because "Venus will then describe a line nearer the diameter of the Sun," which is the reason assigjdn'd in the London Magazine for June 1761. The Planet will hardly come so near. The true reason is because Venus will then describe a more northerly path on the Sun. After that, there will not be another Transit for above 100 years, viz. [namely] not 'till the 8^{th} of December in the year 1874. But the whole of that will be invisible here, the middle happening about midnight. The next after that will not be in the year 1996, as it is in Dr. Halley's *Series*. This *Series* was founded on the old hypothesis of the immobility of Venus's

Harvard University Collection of Historical Scientific Instruments

Reflecting telescope by Benjamin Martin, used by Winthrop in Newfoundland to view the 1761 Transit of Venus

Nodes, which appears to be erroneous. The observation of the late Transit has made it certain that these Nodes have a retrograde motion, tho' a very slow one, which is agreeable also to the Theory of Gravity. And from hence it follows that the next Transit after that of 1874 will not be till the year 2004, on the 8th of June, the latter part of which will be visible here after sun-rise. How Astronomy transports us into distant Futurity! . . .

As there was some reason to suspect that Venus had a Satellite, partly from two observations of M. *Caffini* at Paris in the years 1672 and 1686, but principally from one that was made by Mr. *Short* at London on the 23d of October 1740, I entertained hopes of seeing it pass over the Sun; and with this thought view'd the Sun with great attention in the Reflector, both on the 5th and 6th of June, but in vain. There were several spots then on the Sun, but none that I saw could be a Satellite.

To conclude. The path of Venus, above determin'd, is her visible path, as affected by parallax at *St. John's*, which will be different from her visible path in distant parts of the Earth, where parallax has a different effect. This visible path, and the apparent motion of Venus in respect of the Sun, are here rightly determin'd, even if the elements employ'd in the calculation, such as the latitude and longitude of the place, and those supplied by the astronomical tables, should not be exactly such as we supposed them. Any small difference in these particulars must equally affect the motion both of the Sun and Venus, and therefore, 'tho it would alter their places in respect of the equinoctial points, it would produce no sensible [discernible] difference in the relative motion of one to the other, nor any error in the situation of Venus in respect of the Sun.

The comparison of the observations made in the N.W. parts of the world with those in the S.E., when all of them come to be laid together, will give the true path of Venus, abstracted from parallax, by which means the quantity of the parallax will at length be discovered. The right determination of which point will render this year 1761 an ever-memorable era in the annals of astronomy.

*_END_*

NASA

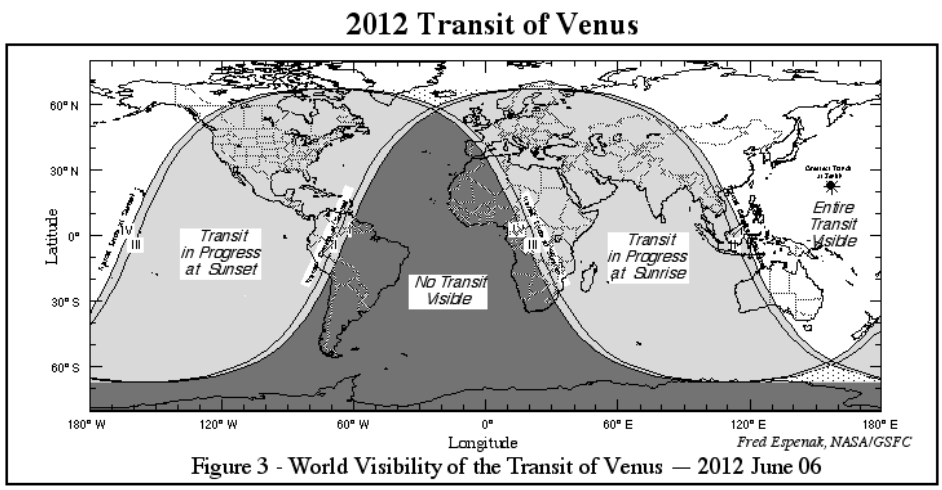


Figure 3 - World Visibility of the Transit of Venus — 2012 June 06