

ASTRONOMY

Rittenhouse and the Transit of Venus

"A Classic of Science"

Washington's Contemporary Built His Own Telescope And Observatory for This Rare Astronomical Event

AN ACCOUNT OF THE TRANSIT OF VENUS OVER THE SUN'S DISC, 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 Committee appointed for that Observation, by the American Philosophical Society, held at Philadelphia, for promoting useful knowledge.

Communicated to the Society, July 20th, 1769, by Direction, and in Behalf of, the Committee; by Dr. Smith.

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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 *Phaenomenon*, the Transit of Venus over the Sun's Disc, 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 members of the *Norriton-Committee* live at some distance from each other, I am, therefore, at their request, now to digest and lay before you, in one view, the whole of our observations in that place; distinguishing, however, the part of each observer; and going back to the first preparations. For I am persuaded that the dependence, which the learned world may place on any particular Transit-Account will be in proportion to the previous and subsequent care, which is found to have been taken in a series of accurate and well conducted observations, for ascertaining the *going* of the time-pieces, and fixing the Latitude

and Longitude of the places of observation, &c.

And I am the more desirous to be particular in these points; in order to do justice to Mr. *Rittenhouse*, one of our Committee; to whose extraordinary skill and diligence is owing whatever advantage may be derived, in these respects, to our observation of the *Transit* itself. It is further presumed, that Astronomers, in distant countries, will be desirous to have not only the work and results belonging to each particular *Transit-Observation*, but the materials also, that they may examine and conclude for themselves. And this may be more particularly requisite, in a New Observatory, such as *Norriton*, the name of which hath perhaps never before been heard of by distant Astronomers, and therefore, its latitude and longitude are to be once fixed, from principles that may be satisfactory of the present, as well as on any future, occasion. . . .

As Mr. *Rittenhouse's* dwelling at *Norriton* is about 20 miles North-West of Philadelphia, our other engagements did not permit Mr. *Lukens* or myself, to pay much attention to the necessary preparations; but we knew that we had entrusted them to a gentleman on the spot, who had joined to a compleat skill in *Mechanics*, so extensive an *astronomical* and *mathematical* knowledge, that the use, management, and even the construction, of the necessary apparatus, were perfectly familiar to him. Mr. *Lukens* and myself could not set out for his house till *Thursday, June 1st*; but, on our arrival there, we found every preparation so forward, that we had little to do, but to examine, and adjust our respective telescopes to distinct vision. He had fitted up the different instruments, and made a great number of observations, to ascertain the going of his *Time-Piece*, and to determine the latitude and longitude of his *Observatory*. The laudable pains he hath taken in these material articles, will best appear from the work itself, which he hath committed into my hands, with the following modest introduction; giving me

NEXT TRANSIT JUNE 8, 2004

Venus passes across the sun's disk, as seen from the earth, four times every 243 years, in pairs of transits 8 years apart. The first transit observed by astronomers was on December 4, 1639. It had been calculated by Jeremiah Horrocks, a clergyman, who observed it; end, but missed the beginning because he had to hold services at the time.

The next pair of transits occurred in June, 1761 and 1769. The second of these was visible in the United States and was observed by Rittenhouse and his friends.

The transits of December 1874 and 1882 were studied by the great American astronomer Simon Newcomb. June 8, 2004 will be the date of the next transit of Venus, to be followed by one on June 6, 2012.

a liberty, which his own accuracy, care and abilities, leave no room to exercise.

Norriton, July 18, 1769

Dear Sir,

"The inclosed is the best account I can give of the Contacts, as I observed them; and of what I saw during the interval between them. I should be glad you would contract them, and also the other papers, into a smaller compass, as I would have done myself, if I had known how. I beg you would not copy any thing merely because I have written it, but leave out what you think superfluous.

I am, With great esteem and affection,
Yours, &c.

DAVID RITTENHOUSE."

The Preparations

It hath been mentioned before, that it was on Thursday afternoon, June 1st, that Mr. *Lukens* and myself arrived at *Norriton*, with a design to continue with Mr. *Rittenhouse* 'till the transit should be over. The prospect before us was

Muscle for muscle and bone for bone, the gorilla is more like man than he is like the lower monkeys.

Thomas Huxley

points out these resemblances in hands and feet in the next two

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very discouraging. That day, and several preceding, had been generally overcast with clouds, and frequent heavy rains; a thing not very common for so long a period at that season of the year in this part of America. But, by one of those sudden transitions, which we often experience here, on Thursday evening, the weather became perfectly clear, and continued the day following, as well as the day of the *Transit*, in such a state of serenity, splendor of sunshine, and purity of atmosphere, that not the least appearance of a cloud was to be seen.

June 2d, and the forenoon of June 3d, were spent in making the necessary preparations, such as examining and marking the foci of our several telescopes, particularly the reflector, with and without the micrometer. The reflector was also placed on a polar axis, and such supports contrived for resting the ends of the refractors, as might give them a motion as nearly parallel to the equator as such hasty preparations would admit. Several diameters of the Sun were taken, and the micrometer examined by such other methods as the shortness of time would allow.

The Sun was so intensely bright on the Day of the Transit that instead of using the coloured glasses sent from *England* with the Reflector, I put on a deeply-smoked glass prepared by Mr. *Lukens*, which gave a much more beautiful, natural and well-defined appearance of the Sun's Disk. The smoked glass was fastened on the Eye Tube with a little bees-wax, and there was no occasion to change it during the whole day, as there was not the least cloud, or intermission of the Sun's splendor.

Mr. *Rittenhouse*, in his previous projection had made the first external contact to be, *June 3d*, 2^h. 11' for lat. 40° N. and long. 5^h. W. of *Greenwich*; on a supposition of the Sun's horizontal parallax being 8". He happened to be very near the truth. For at 2^h. 10' 33" mean time, the 1st external contact was at *Norriton*, lat. 40°. 9'. 56" N. and long. 5^h. 1'. 31" west. Other calculations made it generally from 6' to 8' later for the same latitude and longitude.

Tho' this calculation was not given, to be entirely depended on, yet it was sufficient to make us keep what, in the sea-phrase, would be called a *good look-out*; and therefore, at *one o'clock*, we took off the Micrometer, which had been fitted to the Reflector with a power of 95, and adjusted it to distinct vision, with the same power to observe the

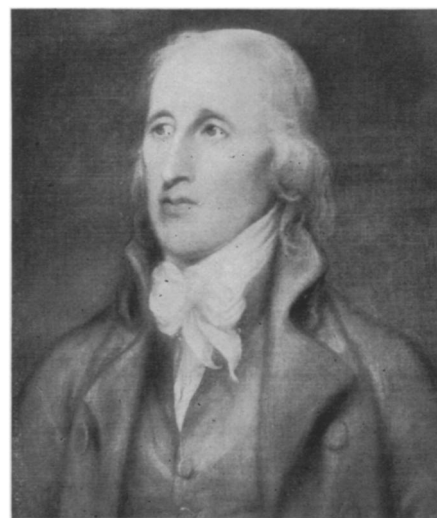
Contacts. And during the hour that was to intervene from *one* to *two*, we resolved to keep an alternate watch through the *Reflector*, on that half of the *Sun's* limb, where *Venus* was certainly expected to touch; while the others, not thus employed, were fixing what more remained to be done, as follows, viz.

First, That each of us might the better exercise our own judgment, without being influenced, or thrown into any agitation by the others, it was agreed to transact every thing by signals, and that one should not know what another was doing. The Situation of the Telescopes, the two Refractors being at some distance *without* the Observatory, and the Reflector *within*, favoured this design.

Secondly, Two persons, Mr. *Sellers*, one of our Committee, and Mr. *Archibald McClean*, both well accustomed to matters of this kind, were placed at one window of the Observatory, to count the clock and take the signal from Mr. *Lukens*. Two of Mr. *Rittenhouse's* family, whom he hath often employed to count the clock for him in his observations, were placed at another window to take his signal. My Telescope was placed close by the clock, and I was to count its beats, and set down my own time.

These preliminaries being settled, we prepared at two o'clock to sit down to our respective Telescopes; or (I should rather say) lie down to the *Refractors*, on account of the Sun's great height.

As there was a large concourse of the inhabitants of the county, and many from the city, we were apprehensive that our scheme for silence might be defeated, by some of them speaking, when they should see any of the signals for the Contacts; and therefore we found it necessary to tell them that the success of our observation would depend on their keeping a profound silence 'till the *Contacts* were over. And to do them justice, during the 12' that ensued, there could not have been a more solemn pause of silence and expectation, if each individual had been waiting for the sentence that was to give him life or death. So regular and quiet was the whole, that, far from hearing a whisper, or word spoken, I did not even hear the feet of the counters, who passed behind me from the windows to the clock; and was surprised when I turned from my Telescope to the clock, to find them all there before me, counting up their seconds to an even number; as I imagined, from



DAVID RITTENHOUSE

America's first important astronomer. He was two months younger than George Washington, and his bi-centenary is being celebrated in Philadelphia on the eighth of April.

the deep silence, that my associates had yet seen nothing of *Venus*.

As the Contacts are among the most essential articles relative to this phenomenon, it is material, before we set down the *times*, to give a particular account of the manner in which each observer judged of them, and the circumstances attending them.

Mr. Rittenhouse's Account

At 2^h. 11'. 39" per clock, the Revd. Mr. *Barton* of *Lancaster*, who assisted me at the Telescope, on receiving my signal, as had been agreed, instantaneously communicated it to the counters at the window, by waving a handkerchief; who walking softly to the clock, counting seconds as they went along, noted down their times separately, agreeing to the *same second*. And three seconds sooner than this, to the best of my judgment, was the time when the least impression made by *Venus* on the Sun's limb, could be seen by my Telescope.

When the Planet had advanced about one third of its diameter on the Sun, as I was steadily viewing its progress, my sight was suddenly attracted by a beam of light, which broke through on that side of *Venus* yet off the Sun. Its figure was that of a *broad-based pyramid*; situated at about 40 or 45 degrees on the limb of *Venus*, from a line passing through her center and the Sun's, and to the left hand of that line as seen through my Telescope, which inverted. About the same time, the Sun's light began to spread round *Venus* on each side, from the points where

their limbs intersected each other.

As *Venus* advanced, the point of the Pyramid still grew lower, and its circular Base wider, until it met the light which crept round from the points of intersection of the two limbs; so that when half the planet appeared on the Sun, the other half yet off the Sun was entirely surrounded by a semi-circular light, best defined on the side next to the body of *Venus*, which continually grew brighter, till the time of the internal contact.

Imagination cannot form any thing more beautifully serene and quiet, than was the air during the whole time; nor did I ever see the Sun's limb more perfectly defined, or more free from any tremulous motion; to which his great altitude undoubtedly contributed much.

When the *internal contact* (as it is called) drew nigh, I foresaw that it would be very difficult to fix the time with any certainty, on account of the great breadth and brightness of the light which surrounded that part of *Venus* yet off the Sun. After some consideration, I resolved to judge as well as I could of the co-incidence of the limbs; and accordingly gave the signal for the *internal contact*, at 2^h. 28' 45" by the clock . . . and immediately began to count seconds, which any one, who has been accustomed to it, may do for a minute or two, pretty near the truth. In this manner I counted no less than 1' 32" before the effect of the atmosphere of *Venus* on the Sun's limb wholly disappeared; leaving that part of the limb as well defined as the rest. From this I concluded that I had given the signal for the *internal contact* too soon; and the times given by the other observers at *Norriton* confirm me in this opinion.

Science News Letter, April 2, 1932

ZOOLOGY

"Riotous Living" Doubles Weight of Town Skunk

THE PRODIGAL skunk that deserts this country home and goes to live in town increases his substance by riotous living.

Prof. J. W. Hamilton, Jr., of Cornell University, has examined nearly five hundred specimens of skunks, and finds that those caught in towns weigh ten or twelve pounds, as against five or six pounds for their countrybred brethren. The town skunks' stomachs showed that they were devotees of the easy living offered by garbage piles; they contained breadcrusts, meat, eggshells and fruits.

Science News Letter, April 2, 1932

COSMOLOGY

Entire Universe Still Young, Little Older than Earth Itself

THE FAR-FLUNG universe of stars, nebulae and star-dust is not much older than the solar system and the earth itself.

This startling conclusion was presented by Dr. Ernst J. Opik of Tartu University Observatory, Esthonia, now serving as lecturer in astrophysics at Harvard, who closed a symposium on the time scale held during the dedication of the new Harvard Observatory astrophotographic building.

Facts gathered by Dr. Opik indicate that the age of our universe is not very much more than 3,000 million years. The probable length of known geologic time is something like 1800 million years.

This reduction in the time that the universe could have existed may have far-reaching effects on astronomical theory and conceptions. It deals a severe blow to the idea that the universe of stars and nebulae is an outgrowth of a process of relatively slow evolution.

"We infer that not much more than 3,000 million years have elapsed since the spiral nebulae, the stars, and the star-dust or meteors were born out of the original parent system, which we call chaos because we do not know much about it," Dr. Opik said.

Most impressive was evidence of the universe's youth brought to earth by meteorites or "falling stars." Dr. Opik reported that Prof. Fritz Paneth, chemist at the University of Königsberg, Germany, has determined the age of a number of meteorites by analyzing their relative contents of helium and radium. He found values ranging from 100 to 2,900 million years. Pultusk stone meteorites which were seen to fall in 1868 gave a preliminary age of 500 million years, which due to loss of helium in space and in museums during sixty years is probably a minimum age. Astronomers are confident that these meteorites came from interstellar space. These chemical determinations of age suggested to Dr. Opik a low age for the stellar universe.

Double stars also shine evidence that the universe is young. Dr. Opik found that statistics of the distribution of distances and relative magnitudes in double stars indicate that since their origin

the masses of the stars could not have decreased appreciably. The drop in luminosity of an average dwarf star since its origin can not have been more than half a magnitude, Dr. Opik found as another indication of the universe's youth.

"Stars of different spectral classes cannot have evolved from one another," he said. "They must have been created simultaneously and their age is too short for any appreciable evolution."

The terrific rushing away of the nebulae as signalled in the reddening of their light, which is considered evidence of an expanding universe, indicates, in Dr. Opik's opinion, a possible age of the extragalactic universe of only a few thousand million years.

Ten years ago the universe was thought to be ten million million years old; now Prof. Opik divides these old estimates by a million or so and makes the universe about the same age as the earth, about three thousand million years.

Science News Letter, April 2, 1932

ARCHAEOLOGY

Doubt Raised That Troy Is Located Correctly

THE TROY that millions of high school students have laboriously located on the map of Asia Minor may not be the Troy of Homer, after all.

Critics are raising new doubts that Hissarlik, commonly accepted to be Troy, fits the specifications of the historic city. The mound of Hissarlik was excavated by Heinrich Schliemann in 1870, and ruins of nine successive cities were found on the site. The sixth of these cities, built about 1500 B. C. and destroyed some three centuries later, is the one known as the Trojan War city.

Homeric scholars are disturbed by the revival of doubts, long dormant, that Hissarlik is the scene of Troy, reports *Antiquity*.

The latest declaration that the site of Troy must still be sought is by a French scholar, M. Vellay. The Greek ships that sailed to Asia Minor for the siege of Troy must have been drawn up on the Hellespont, M. Vellay emphatically