THE 1882 TRANSIT OF VENUS AND THE POPULARIZATION OF ASTRONOMY IN THE USA AS REFLECTED IN *THE NEW YORK TIMES*

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Abstract: After the disappointments of the 1761 and 1769 transits of Venus, the nineteenth century pair, in 1874 and 1882, offered astronomers the next opportunity to use these rare events in a bid to pin down a value for the solar parallax and hence that fundamental yardstick of Solar System astronomy, the astronomical unit. Only the 1882 transit was visible from the USA, and on the fateful day amateur and professional observers were scattered across the nation. While the value for the solar parallax derived from their combined observations was a significant improvement on the range of values obtained in the eighteenth century, there was considerable disquiet about the logic of using transits of Venus in this way when alternative approaches were available. In this paper we discuss some of the instruments that were used to observe the 1882 transit from American soil, review the scientific results from the overall American efforts and summarize the various reports that appeared in the pages of *The New York Times* and ultimately helped to generate a heightened public awareness of astronomy.

Keywords: 1882 transit of Venus, solar parallax, astronomical unit, *The New York Times*

1 INTRODUCTION

In the mid-1800s Sir George Biddell Airy (1801–1892, Britain's Astronomer Royal, described the determination of the astronomical unit, the mean distance of the Earth from the Sun, as "… the noblest problem in astronomy." (Airy, 1857: 208). Attempts at calculating this distance, up until the 1600s, led to figures much smaller than now known to be the case. The Greek Aristarchus of Samos (c. 310–230 B.C.) using clever geometry, with inaccurate data to implement it, concluded that the Earth-Sun distance was at least eighteen times, but not more than twenty times the Earth-Moon distance. Another Greek, Hipparchus of Nicaea (c. 162–126 B.C.), taking advantage of a solar eclipse in different degrees of totality at two different sites, applied trigonometry to the parallactic shift to calculate that the Earth-Moon distance was between sixty-two and seventy-four times the radius of the Earth. Using the radius of the Earth now known to be about 6,378 kilometers, Hipparchus' range for an Earth-Moon distance would be from 395,000 to 472,000 kilometers, a fair approximation for the time. The value of the radius of the Earth was well determined by the 1600s. Combining Hipparchus' determination with the premise of Aristarchus, the value of the astronomical unit could be calculated to be as low as (18 × 395,000) kilometers = 7,110,000 kilometers = 4,400,000 miles, lower by a factor of 20 than the actual value of 149,600,000 kilometers. Up until the first part of the seventeenth century, this value for the astronomical unit was commonly held.

It was in the seventeenth century that Johannes Kepler (1571–1630) stated his three truisms, later to be called 'laws', that provided a basis for a more accurate determination of the astronomical unit. According to his Third Law, for all the planets the squares of the periods of revolution are proportional to the cubes of the semi-major axes of their orbits. Therefore, if one could determine the absolute distance between any two members of the Solar System, one could further derive the distance between any two others, including that between the Earth and the Sun.

In 1627 Kepler published his *Rudolphine Tables* of planetary motion, named in honor of his patron, the Holy Roman Emperor Rudolph II of Prague. In these tables were predicted a transit of Mercury to occur on 7 November 1631 and a transit of Venus on 6 December 1631. Interestingly, and incorrectly, Kepler predicted that there would not be another Venus transit for 130 years. Transits of Venus are now known generally to occur in patterns of pairs about eight years apart, separated by about 105.5 and 121.5 years. Due to the 3.4 degree tilt of Venus' orbit with respect to that of the Earth, a transit can only occur when both planets are near the nodes of their orbits. Somehow Kepler missed the transit of 1639 in his calculations although ironically it would be the first

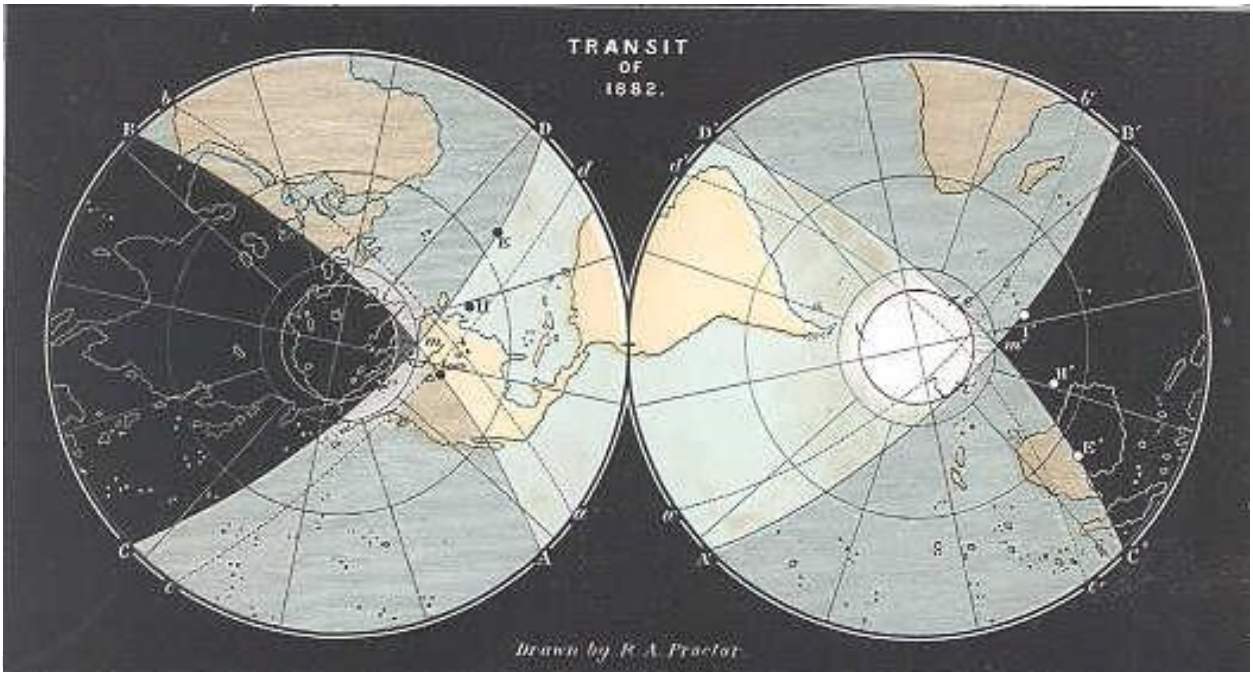


Figure 1: Visibility of the 1882 transit of Venus. The entire transit was visible from the pale blue areas, but only the ingress or egress phases from the darker blue areas. Those living in the black regions could not see the transit at all (after Proctor, 1882: Plate VII).

transit to be observed due to the efforts by the young Jeremiah Horrocks (1618–1641) who discovered Kepler's mistake (Proctor, 1882).[1]

It was Edmond Halley (1656–1742) who promoted the use of parallax observations during the next transits of Venus, to occur in 1761 and 1769, for the calculation of the Earth-Sun distance. In 1716 he wrote a proposal, which he contributed to the Royal Society:

> … scarce any problem will appear more hard or difficult than that of determining the distance of the sun from the earth, very near the truth; but even this, when we are made acquainted with some exact observations, taken at places fixed upon and chosen beforehand, will, without much labor be effected. And this is what I am now desirous to lay before this illustrious Society (which I foretell will continue for ages), that I may explain beforehand to young astronomers, who may perhaps live to observe these things, a method by which the immense distance of the sun may be truly obtained within a five-hundred part of what it really is. (cited in Proctor, 1882: 31-32).

Figure 2: German astronomers at Hartford in 1882 (after *Frank Leslie's Popular Monthly*, May 1883).

Halley described the method to be used though he knew he would not live to see the events himself. Halley's method and some variations thereof, notably that of Joseph-Nicolas Delisle (1688–1768), applied trigonometric interpretation to the apparent position of Venus on the disc of the Sun to determine a value for the solar parallax. Once this was known, a figure for the astronomical unit could be calculated. The many nations participating ultimately provided very discrepant values for the astronomical unit with documented parallax values ranging from 8.28″ to 10.60″ in 1761 and the somewhat tighter range of 8.43″ to 8.80″ in 1769 (Cottam et al., 2011: 226). Factors hindering the collection of accurate data were the difficulties in establishing longitude and latitude of the sites, and the unexpected presence of a 'black-drop effect' which blurred the image at the time of the internal contacts.

In 1874 the new tools of photography and spectroscopy were expected to be useful in providing a more accurate and precise value. This time the new nation of the United States would be participating in the efforts of the transit expeditions. The Americans launched eight expeditions, three in the Northern Hemisphere and five in the Southern Hemisphere. All the observing teams had some degree of success although there were some problems due to weather, and the 'black-drop effect' was not eliminated. It would be years before all the data were reduced. In fact, as late as 1880, Professor Charles A. Young (1834–1908) admitted, "The results of the transit of Venus observations have not yet been so fully published as might have been expected." (Young, 1880: 88) Indeed, the Americans did not publish any official result for the solar parallax from these efforts. However, David Todd (1855–1935), then of the National Almanac Office, published a 'provisional' value of 8.883 ± 0.034″, translating to a value for the

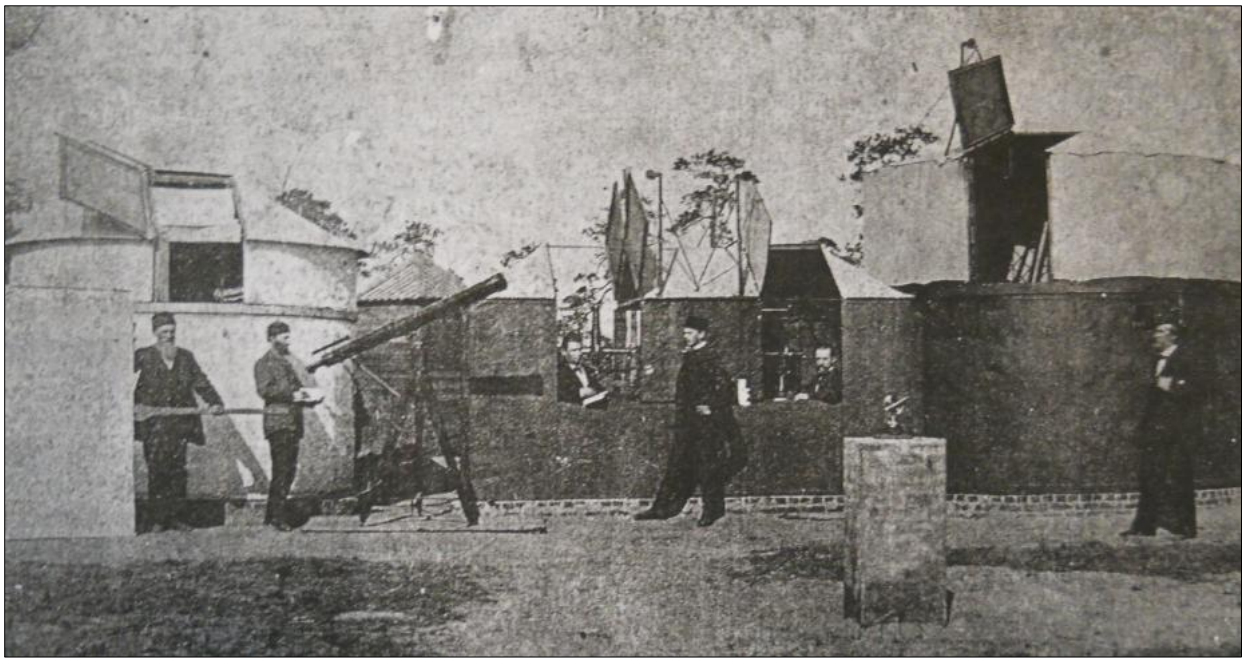


Figure 3: The 1882 German expedition site at Aiken (courtesy: Aiken County Historical Society). According to Duerbeck (2004: 14), Franz is second from the left.

astronomical unit of 92,028,000 miles, based upon data taken from *Observations*, *Part One*, *"General Discussion of Results"* of 1880 (see Todd, 1881).

2 THE 1882 TRANSIT OF VENUS

Disappointment in the results of the observations of the transit of Venus of 1874 might have dampened some of the enthusiasm for the upcoming transit of 1882 but there were reasons for renewed resolve. Weather permitting, this transit would be visible from much of Europe and the Americas (see Figure 1). It would last longer at about 6.3 hours, as opposed to the approximately 4.6 hours in 1874. This meant the area on the Earth where some part of the transit could be seen would be greater. But maybe most significant was the recognition that this would be the last transit for more than a century. If there was any doubt, this transit could not be ignored (Airy, 1880). The U.S. Congress therefore appropriated $177,000 for American efforts. Instruments would be improved and there would be expeditions this time both within and outside of American borders (see Dick, 1995).

2.1 Overseas Expeditions

In anticipation of the 1882 transit an international conference was held in Paris, in October 1881, to coordinate efforts. Fourteen nations participated (Orchiston and Buchanan, 1993). Discussion on methodology led to a general acknowledgement that photography had not led to satisfactory results in 1874, and as a result its use would be less significant in 1882.

Some countries, such as Portugal and Spain, that had not participated in previous transit parties, did attend the conference and would have their own parties in 1882. Some others, such as Norway and Chile, sent representatives to the conference but ultimately did not mount their own expeditions. Great Britain had a Transit Committee that decided to send numerous expeditions around the world, including to Canada in North America, and some sites that would not have access to all four contacts, such as South Africa (Koorts, 2004). Russia and the United States declined to participate in the Paris conference. America's Simon Newcomb did not have much faith in the established procedures, having been frustrated in his efforts in 1874 (see Tebbutt, 1883), while Russian astronomers had decided that observations of minor planets at opposition would be a less costly way of investigating the solar parallax than by using transits of Venus.

2.2 Foreign Expeditions to the United States

Although the United States did not attend the Paris conference, it would serve as host to transit parties from Belgium, France and Germany (see Duerbeck, 2004; Sheehan and Westfall, 2004).

Germany sent two expeditions to the United States, one going to Hartford in Connecticut (see Figure 2), and the other to Aiken in South Carolina (see Figure 3). Because of the disappointing results they obtained using the photographic method in 1874, the Germans decided to depend upon the planet's placement on the solar disk as measured with a heliometer. Here an object glass is divided diametrically into two halves, which can be manipulated by a screw in order to measure small angular distances between the focal images of two objects with a built-in micrometer used to bring the two objects into coincidence (Radau, 1874; Mauritius Expedition, 1874).

Expedition I, which went to the grounds of Trinity College in Hartford, Connecticut, was led by the astronomers Gustav Müller (1851–1925) and Friedrich Deichmüller (1855–1903) (Duerbeck, 2004). The morning of the transit the sky was overcast. Having missed the ingress contacts Müller reported

> … the ingress could not be observed, and only for one moment Venus was seen between first and second contact halfway in the Sun. Only after ingress the

Figure 4: The 1882 transit of Venus observatory structure at Aiken (photograph by the first author).

> clouds started to disperse with rapidity, and our mood started to rise. About one hour after external contact the clouds were so thin that we could start the heliometer measurements … Soon the sky improved, and remained quite good until the end …

They obtained eight full sets of heliometer readings (Knapp, 2004).

Julius Franz (1847–1913), Principal Astronomer at the Royal Observatory in Koenigsberg, headed Expedition II to Aiken, South Carolina. There the property of Henry Smith was selected, as it was far enough away from the railroad tracks to avoid the occasional jarring of the earth due to passing trains.

The public was very much interested in the goings-on at the Smith estate, but the Germans stationed guards to keep curious citizens away. It was said that even the Mayor of Charleston was kept away from the site of the scientific work taking place (Aiken and the transit of Venus, 1935). Aiken had been selected as a suitable site due to its usually fair climate, however unexpected rain prevented observation of the first two contacts. It did clear thereafter, allowing the Germans to make some satisfactory heliometric measurements for the duration of the transit. A total of forty-eight observations, three sets of sixteen each, were made. A marker, donated by the Germans, was placed at the site, the residence of Henry Smith, to commemorate the event. This marker was later donated by John Weems, then owner of the grounds, along with the observatory structures used, to the Aiken County Historical Museum (The transit of Venus, 1995), where it now stands with a descriptive plaque (see Figures 4-6).

This limestone slab of 27 × 31 inches, 4 inches thick, now cracked, contains the following inscription (with the English translation shown in brackets):

> Venus – Durchgang 1882 (The Transit of Venus 1882)
> Deutsches Station II (German Station No. II)
> 5h 26m 52s6 W 33° 31′51″ N

San Antonio, Texas, would host two expeditions. One of the four official American sites was on the grounds of what is now known as Fort Sam Houston. The Belgian nation would be participating in major scientific expeditions for the first time, here in San Antonio and in Santiago, Chile. Both Belgian parties were organized by Jean-Charles Houzeau (1820–

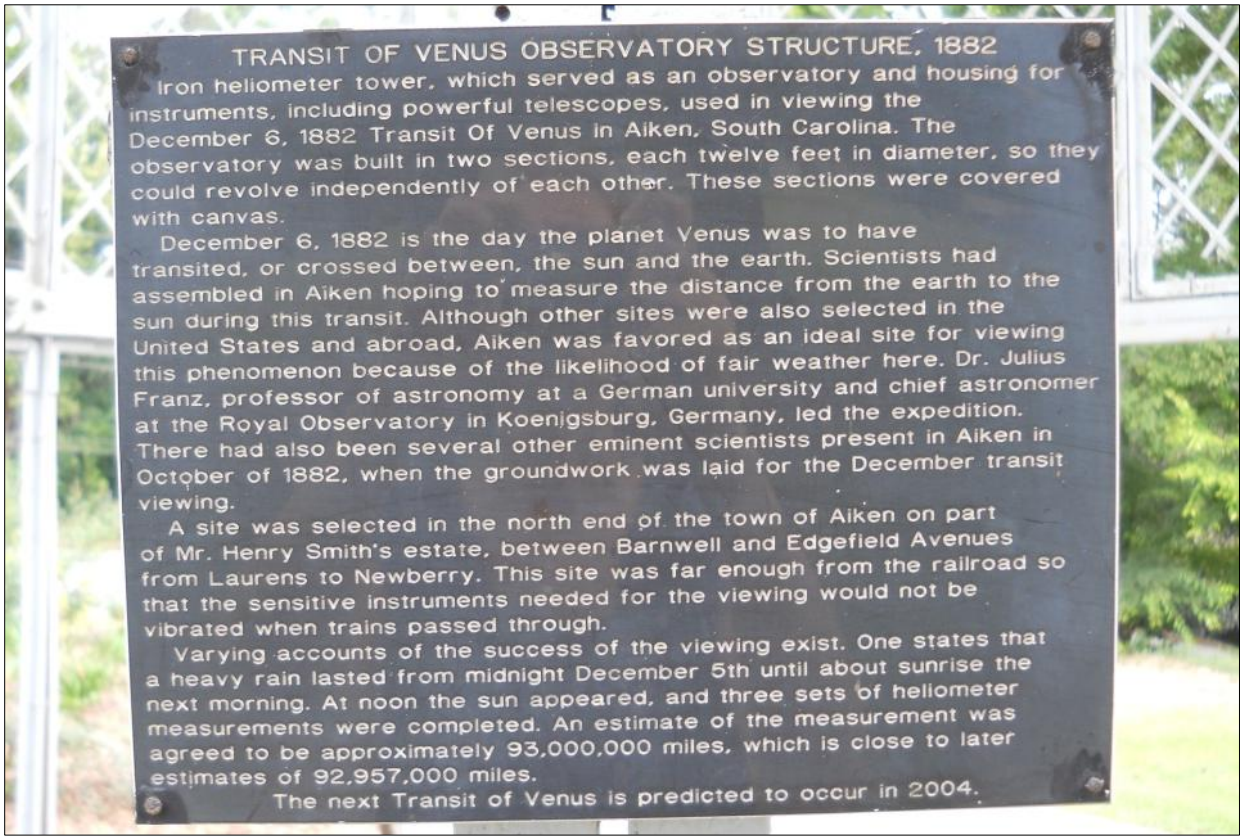


Figure 5: The plaque at the site of the 1882 German transit of Venus expedition at Aiken (photograph by the first author).

1888; Figure 7) who would himself head the party in San Antonio. The Belgians were about 500 meters to the west of the Americans, on private property. The methodologies of the two countries were different. Following the published instructions for all the official American expeditions, the Americans would be relying on the photographic method.

The Belgians at both sites would be using the invention of Houzeau, a heliometer with unequal focal lengths (see Figure 8). The instrument has two objectives of different focal lengths whereby large and small images of both the Sun and Venus are produced. A large solar image is projected on a screen (seen below the heliometer tube in the image below). A smaller solar image produced by the short-focus objective is made to coincide with that of Venus by micrometer adjustment. The difference in micrometer readings between the "… small Sun centred on crosshairs, being the centre of the large Sun … [and the] … small Sun centred on large Venus …" enables determination of the distance between the centers of both objects (Sterken and Duerbeck, 2004: 26). Houzeau's assistant, Albert Lancaster (1849–1908), reported on the progress of the day. At 6:15am Houzeau went to the American site to compare chronometers. Upon returning to the Belgian site there was early frustration as the first two contacts were lost due to cloud cover. Then at about 9:30am, 12 minutes before the minimum distance of the centers, the sky cleared and 124 micrometer readings were taken (Lancaster, 1882). When combined with the results obtained from the partner group in Chile—which enjoyed perfect weather—Houzeau was able to calculate a final result for solar parallax of 8.911 ± 0.084″ (see Sterken et al., 2004).

In October of 2005 an historical marker was inaugurated and placed at the Belgian transit of Venus observation site (see Figure 9). The original structure, a wooden house that was occupied by the party, is no longer extant and has been replaced by the Bullis House Inn (see Figure 10), a bed-and-breakfast that was built between 1906 and 1909, which is now in itself a Texas state historic landmark. Note the unfortunate error on the marker, which states that 124 photographic plates were taken. The Belgians only obtained micrometric data, and took no photographs (see Sterken, 2009).

The French also sent an expedition to the United States (*Passage de Vénus* ..., 1883). The report of their efforts at Fort Marion in Saint Augustine, Florida, was made by the three members, Colonel François Perrier (1835–1888), Commandant Bassot and Captain Gilbert Defforges (1852–1915). These three took separate readings on three different telescopes, an 8-inch, a 6-inch and a 3-inch respectively. They achieved a fair degree of agreement, especially for the time of the 4th contact.

Captain Defforges reported that 200 photographs were taken of the planet on the Sun. He was also responsible for establishing the longitude at the site, working with Preston of the Coast Survey, who communicated with him telegraphically from Savannah before the transit. They also made another series of confirmatory tests after the event. Commandant Bassot had already established latitude by means of the observation of a number of familiar stars (ibid.).

Figure 6: The cracked historical marker from the 1882 German transit of Venus expedition at Aiken (photograph by the first author).

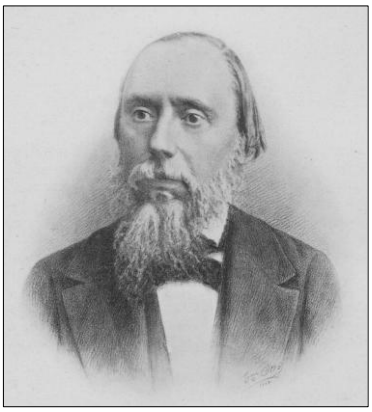


Figure 7: Jean-Charles Houzeau (after Sterken and Duerbeck, 2004: 25).

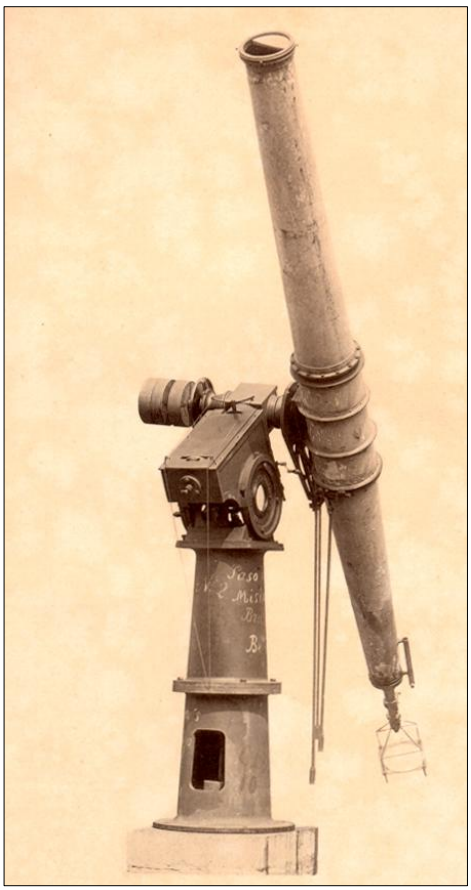


Figure 8: Heliometer with unequal focal lengths (adapted from Sterken et al., 2004: 26).

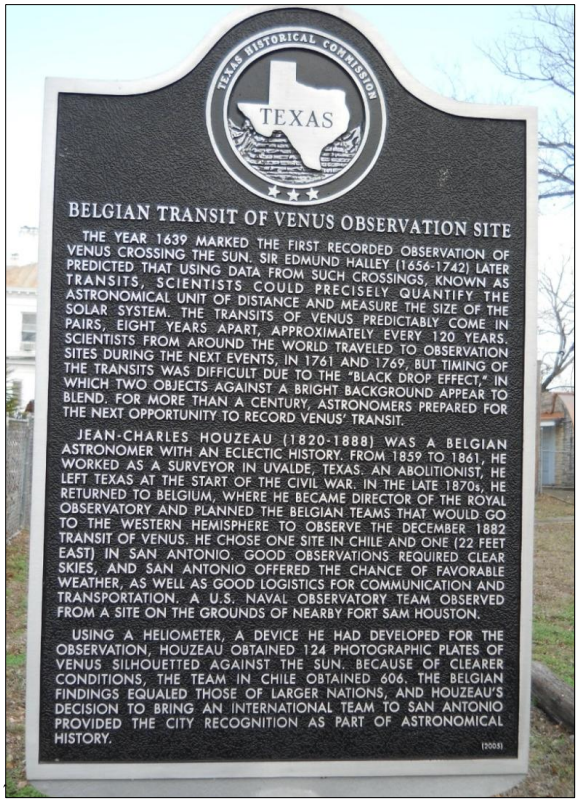


Figure 9: The historical marker for the 1882 Belgian transit of Venus expedition at San Antonio (photograph by the first author).

Figure 10: Bullis House Inn, site of the 1882 Belgian transit of Venus expedition at San Antonio (photograph by the first author).

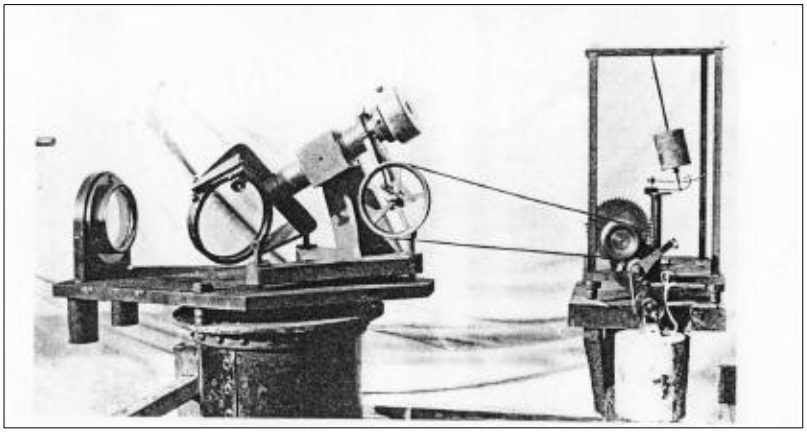


Figure 11: Close-up of the heliostat used at the Nagasaki site (after Janiczek, 1983: 58).

The French enjoyed good weather for the entire transit and Colonel Perrier noted with satisfaction the arrival of encroaching clouds soon afterwards: "Le temps est à la pluie et à la tempête!!!" (ibid.).

2.3 The US Transit Program

The Americans organised several northern parties for the 1882 transit, and all of these were in their home country, at San Antonio (Texas), Cedar Keys (Florida), Washington (D.C.) and Fort Selden at Cerro Roblero, in the New Mexico Territory in the west.

2.3.1 Instrumentation

The horizontal telescope with a heliostat (Figure 11) and photographic plate-holder was the instrument favored by the Americans during the transit of 1874. It used a clock-driven mirror to bring the solar image to a long-focus objective lens in a stationary horizontal telescope. It could produce relatively large and distortion-free images which were photographed and measured (e.g. see Janiczek, 1983; Lankford, 1987).

Unlike most of the Europeans, the Americans had decided to stay with the photographic method, and although the equipment for the 1882 transit would be the same as in 1874, on this occasion the more convenient dry collodion plates would be used (Dick et al., 1998).

2.3.2 Expeditions and Results

The Americans at the San Antonio site were on the grounds of the current military base of Fort Sam Houston (see Figure 12) and under the leadership of Asaph Hall (1829–1907; see Figure 13) from the U.S. Naval Observatory. First contact should have occurred at about 7:20am but was missed due to clouds, as it was to the Belgians 500 meters away. The Americans captured their first photograph of Venus as the sky began to clear at about 10:17am. By the time the transit terminated at about 1:30pm they had obtained 204 photographs (Viewing Venus, 1882). Having sent a telegram shortly after the event, Professor Hall reported in more detail on his successes and frustrations in a letter to Admiral Rowan that he penned on 8 December 1882 (Hall, 1882).

Besides the standard membership of all American expeditions, Hall was able to take advantage of some on-site military personnel, who were not astronomers, as cited in his letter to Rowan,

> Major Clous and Capt. Livermore made observations of the diameter of Venus with our double-image micrometer. Lt. Shunk assisted Mr. Woodward [assistant astronomer] in managing the heliostat and chronograph and was of very good service. (ibid.).

John Walter Clous was acting Judge Advocate in San Antonio at the time of the transit. Capt. William Roscoe Livermore was the base's Chief Engineer Officer, while William Alexander Shunk was a career military officer on a temporary assignment in San Antonio (Jacqueline Davis, personal communication, 2011). Hall and

Figure 12: Grounds of Fort Sam Houston, San Antonio (photograph by the first author).

his group would be remaining there for several more days to confer with the Belgians and to make other observations to assure the accuracy of their position and chronometers (Hall, 1882). An historical marker (see Figures 14 and 15) was dedicated on the grounds of Fort Sam Houston, near the American observing site on 3 December 2004 (Maley, 2005). The field where they made their observations is now an area of base officer housing. The marker is placed off a driveway a short distance from the precise location of their work, which is now in the grounds of a private residence (Jacqueline Davis, personal communication, 2011).

John Robie Eastman (1836–1913; Figure 16) from the United State Naval Observatory was the leader of the observing party at Cedar Keys, Florida (Prof. J.R. Eastman dies, 1913). As reported in his telegram (see Figure 17), the expedition at that site succeeded in catching the last three contacts. The circumstances were described in more detail in a letter of the same date to Vice Admiral S.C. Rowan, President of the Transit of Venus Commission. After the first contact the sky became so clear that many photographs were taken. The dry plates would soon be used up so it was decided to take some photographs using the wet process as well. "We then alternated groups of dry and wet plates until about five minutes before third contact we had exposed 150 dry plates

Figure 13: Asaph Hall (courtesy: usno.navy.mil).

Figure 14: Base Officer housing at Fort Sam Houston, with the historical marker just to the left of the tree (photograph by the first author).

Figure 15: Historical marker for the 1882 American transit of Venus expedition (photograph by the first author).

and 30 wet plates." Evidence of the degree of cooperation expected from all in this scientific endeavor was in the stated expectation that Eastman would communicate with both the Coast Survey party in Savannah and the French party at St. Augustine to help the French establish their longitude. However, as Eastman had yet to hear from either party he expressed his willingness to make this determination after the transit, and following the intense labors of the previous days he decided to take ten days vacation (Eastman, 1882).

Figure 16: John Robie Eastman (courtesy: photolib.noaa.gov).

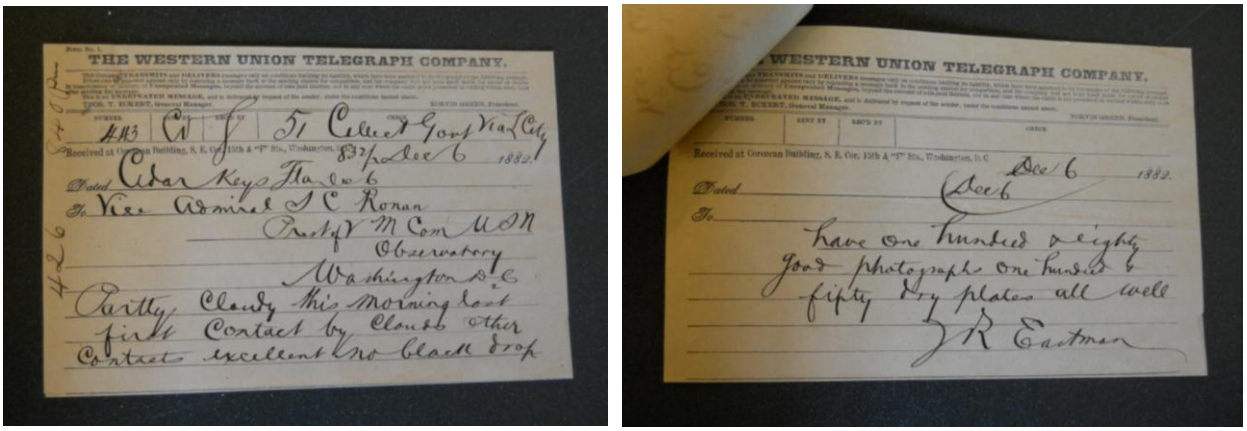


Figure 17: Eastman's telegram that was sent to Rowan (photograph by the first author; courtesy: National Archives, Washington D.C.).

George Davidson (1825–1911; see Figure 18) had charge of the American observing site at Fort Selden, New Mexico. On the day of the transit a telegram was sent to the Commission reporting complete success (see Figure 19): all four contacts were seen, measurements were taken of the diameter of Venus, and 216 "splendid" photographs were taken. On the same date Davidson also sent a short note to Julius Hilgard, Superintendant of the Coast Survey, conveying the same happy information (see Figure 20).

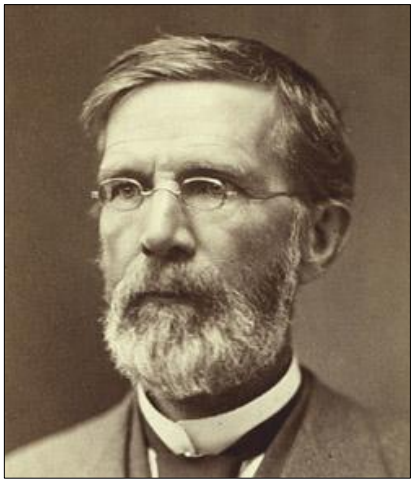


Figure 18: George Davidson (courtesy: history.noaa.gov).

William Harkness (1837–1903; see Figure 21) was in charge of the efforts in Washington, D.C. He was one of the only two remaining members of the American Transit of Venus Commission that had begun in 1871 and ended in 1891, anticipating the two transits of the century; the other person was Simon Newcomb (Dick, 2005). Harkness's party observed all four contacts at their site. The Americans never published a determination of the solar parallax based on their 1874 results but this time Harkness (1891) would do so:

> Professor Harkness, U.S.N., reports that the photographs of the last transit of Venus (more than 1400 photographs being available) lead to the following value of the solar parallax; $\pi = 8''.842 \pm 0.''0188$. With 3963.296 miles as the equatorial radius of the earth, the resulting mean distance of the sun is 92,455,000 miles, with a probable error of 123,400 miles. (*Report* ..., 1889).

In 1894 Harkness would publish an updated figure (Dick, 2005).

The four Southern Hemisphere sites selected were in South Africa, Patagonia, Chile and New Zealand. Simon Newcomb led the expedition to South Africa and established an observing station alongside the Huguenot Seminary for Girls at Wellington, where he encouraged local participation. Here only the first and second contacts would be visible. After the transit Newcomb left behind the instrument-mounting piers in the hope they would still be there at the time of the 2004 transit. They were not (Koorts, 2003). Lieutenant Samuel W. Very, U.S.N. was chief astronomer of the observing party that went Santa Cruz in Patagonia, where all four contacts were ob-

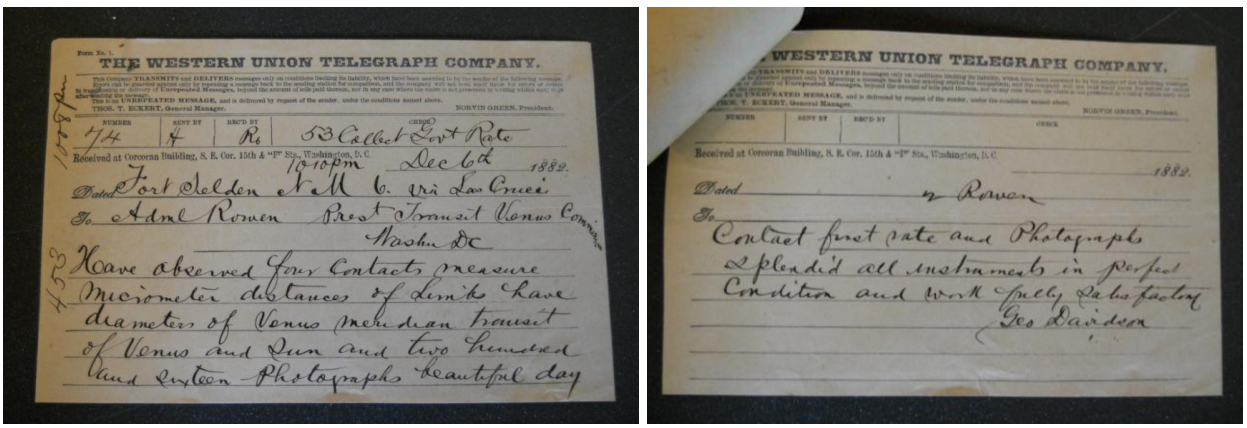


Figure 19: Davidson's telegram that was sent to Rowan (photograph by the first author; courtesy: National Archives, Washington D.C.).

served. Professor Lewis Boss (1846–1912) led the group to Santiago, Chile, where again all four contacts were observed. Edwin Smith (1851–1912), who led the 1874 US party to the Chatham Islands, was chief astronomer for the final group at Auckland, New Zealand, where only the two internal contacts were observed (Dick, 2003; Orchiston, 2004).

Not among the official eight expedition sites were those under Charles A. Young at Princeton and David Todd at the Lick Observatory at Mt. Hamilton, California. Todd, a Professor of Astronomy at Amherst College, was invited to observe the transit at Lick by Captain Richard S. Floyd. Todd accepted and the clear skies enabled him to obtain 147 photographs, 125 of which were deemed measurable. Princeton astronomer Charles A. Young stated that Todd's photographs may have been the best obtained (see Sheehan and Misch, 2004). In 2004 Misch and Sheehan found 142 of the original negatives in the Lick Observatory Plate Archive, and they constructed a movie of the event (ibid.). Young and Todd followed the instructions of the Commission and their data were included in the official report. Ultimately the southern US stations collected 587 measurable plates, and the northern stations (including Princeton and Lick) collected 793 (Dick, 2003). Most parties used the improved dry collodion emulsion plates. The Americans were generally fortunate with regard to weather conditions, and several parties, from both hemispheres, saw all four contacts. In all, seventeen hundred photographs were taken, the majority of which could be measured (Dick et al., 1998).

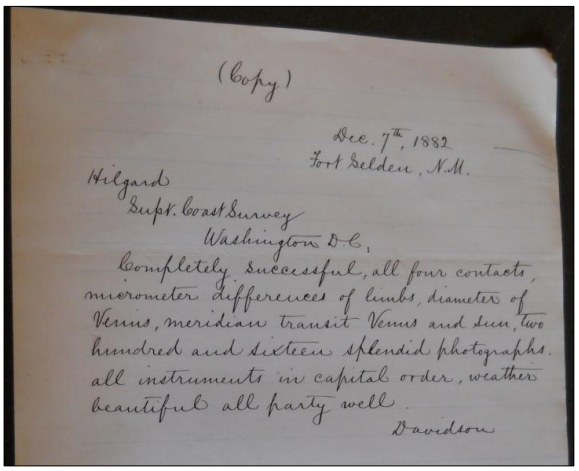
In America there was also cooperation from many established observatories across the country, as well as from private individuals. Instructions and time signals were available to anyone who was willing to contribute to the effort (ibid.).

Due to the high probability of inclement weather, the Harvard College Observatory had not been selected as a primary site by the Transit Commission. However, Edward C. Pickering (1846–1919) had some success there and reported his results to the American Academy of Arts and Sciences. Several of his observers recorded all four contacts (Pickering, 1882-1883). Maria Mitchell and her students observed from the grounds at Vassar College, as she had been denied participation in any Government expedition. Her group used a small version of the official photoheliostat, as well as an equatorial similar to those used by the U.S. expeditions, and succeeded in photographing the event (Sheehan and Westfall, 2004).

In 1882 the United States Transit of Venus Commission had published instructions for the observation of the upcoming transit. These were to be followed by all the official expeditions, to guarantee consistency in observing methods and the collection of data. It was also intended that they could be

> … adapted to the use of amateur observers who desire to be made acquainted with the methods by which they may make observations of value. (United States Transit of Venus Commission, 1882).

At the National Archives in Washington, D.C. there is a box containing 93 reports of observations


(Copy)

Dec. 7th, 1882
Fort Selden, N.M.

Hilgard
Supt. Coast Survey
Washington D.C.

Completely successful, all four contacts, micrometer differences of limbs, diameter of Venus, meridian transit Venus and sun, two hundred and sixteen splendid photographs. all instruments in capital order, weather beautiful all party well.

Davidson

Figure 20: Davidson's Letter to Hilgard (photograph by the first author: courtesy: National Archives, Washington, D.C.).

of the transit, submitted by those who were not on official Government expeditions. The majority of these people were amateur astronomers (Cottam, 2012: 208-209)

Once again reduction of data would be a time-consuming undertaking. The ligament that characterized the 'black drop' was often reported (Howlett, 1883), but not always (Horner, 1883; Todd, 1883). The presence of a Venusian atmosphere also was frequently reported (see Prince, 1883), but again not always (Howlett, 1883). These features would continue to complicate the accurate measurement of the photographs that was required for a valid interpretation of the event. By this time Simon Newcomb did not have much faith in the use of transits of Venus to solve the riddle of the astronomical unit, and in his 1895 monograph, *The Elements of the Four Inner Planets and the Fundamental Constants of Astronomy*, he ranked the value of results obtained by numerous methods above those obtained using transits of Venus (Newcomb, 1895: 166). In the previous year, William Harkness from the US Naval Observatory addressed the American Association for the Advancement of Science, and stated that his final best estimate for the solar parallax was 8.809 ± 0.0059″, which corresponds to a value of 92,797,000 ± 59,700 miles for the astronomical unit (Dick et al., 1998).[2] This result was closer to the parallax adopted by the International Astronomical Union in 1976 of 8.794148 ± 0.000007″ than the figure that Todd derived from observations of the 1874 transit (ibid.).

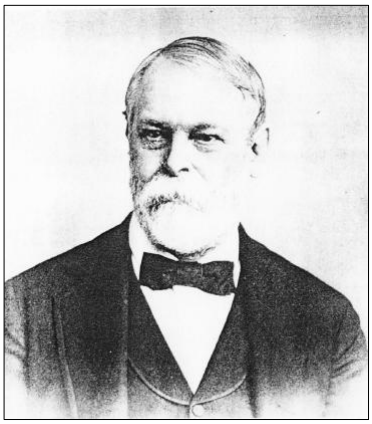


Figure 21: William Harkness, U.S. Naval Observatory (after Janiczek, 1983: 69).

3 The 1882 Transit of Venus and *The New York Times*

Since it was only eight years since the last transit, it was apparently deemed unnecessary by *The New York Times* to educate the public on the history and methodologies of such an event by means of lengthy articles, as had been done for the 1874 transit. However, there was some of this, on a smaller scale, as well as frequent updates on plans and expedition preparations in anticipation of the 1882 transit.

On 14 August 1881 *The New York Times* printed a short item describing the initial efforts in the selection of sites for the American parties. Help from the National Academy of Sciences was requested (The next transit of Venus, 1881). Later that month, on the 20th, the reader would learn that on the previous day Professor William Harkness read a paper titled "The Methods of Determining the Solar Parallax, with Special Reference to the Coming Transit of Venus" at the meeting of the American Association for the Advancement of Science in Cincinnati (General Telegraph News, 1881). On 3 February 1882, an article was reprinted from the *Providence Journal* which related that the upcoming transit would be visible throughout the Western Hemisphere and would last for six hours. Moreover, an "… intelligent observer … [with] … keen eyesight … with the use of smoked glass, might see the tiny dot on the planet with his naked eye." (The coming transit of Venus, 1882).

On 31 March 1882 *The New York Times* printed the speculation by Professor Daniel Kirkwood from the University of Indiana that the transit might provide an opportunity to watch for a satellite of Venus (General Notes, 1882a). On 3 August 1882 readers would learn that $75,000 was appropriated by the House of Representatives for the upcoming transit expeditions (Speech of President Curtis, 1882), and later that month, on the 22nd, there was an article listing all the American parties for transit observations that were subsidized by this appropriation. There were four northern hemisphere sites, all within the boundaries of the USA and its territories, and four in the southern hemisphere. The destinations of the expeditions and the members of all the parties were listed. The solar parallax and its significance were explained. There was also brief mention of some British, French and German parties (Gleanings from the mails, 1882).

On 27 November 1882 the *Times* reprinted another item from the *Providence Journal*, a general description of the transit and times it would be visible. Again all intelligent persons were reminded to observe this rare event "… with the aid of a piece of smoked glass ..." (The transit of Venus, 1882d). On 29 November 1882 there was a request from Professor Brooks of the Red House Observatory that prayers be made at all churches on Sunday, requesting clear skies for the observation of the transit (Prayers for astronomical science, 1882). On 5 December 1882, the day before the transit, there was an article with much information for the general public, the history of transits from the times of Kepler and Horrox (= Horrocks), the goals and methodologies of the observations, and some specifics about the parties. Readers were told how to prepare the smoked glass, and the times that the transit would be visible (Venus crossing the Sun's face, 1882).

This transit would find more cooperation among the various nations of the world, and *The New York Times* therefore would also report on foreign expeditions, as well as those sited on American soil.

On 30 January 1881, almost two years before the 1882 transit, readers of *The New York Times* could learn that the French Academy of Sciences had appointed an international Commission which, under the leadership of Monsieur Dumas, would prepare for the expeditions (Scientific gossip, 1881a). On 12 June 1881 one might further learn that the French Government was sending a scientific expedition to Cape Horn to study terrestrial magnetism, and this expedition would be accompanied by another party which would study the transit of Venus (Scientific gossip, 1881b). On 6 November 1881, French leadership in international cooperation in the observations of this transit became more apparent. Dumas, the President of the International Commission, would send instructions to all participating astronomers and observatories (Scientific gossip, 1881c).

On 28 November 1881 *The New York Times* reprinted an article from the Toronto (Canada) *Globe* of 25 November which expressed the opinion that their city could provide a favorable site for transit studies. The Canadians saw this as an opportunity to improve their standing in the astronomical scientific community (Preparing for the transit of Venus, 1881). On 14 November 1882 a reader could learn that Professor McCloud and Mr Payne were going to Winnipeg, Canada, to observe the transit (The transit of Venus, 1882c). On 6 December 1882 arrangements made at Kingston, Ontario, for observations at Queen's University Observatory were published (Little hope of seeing the transit, 1882). The next day a reader would learn that Canada was mostly cloudy during the time of the transit but occasional observations were made through gaps in the clouds (Across the Sun's face, 1882). On the other hand, on 29 December 1882 there was a 2-line article: "Toronto, Dec.28. -- Reports from various Canadian stations as to the transit of Venus have been received here. With one exception only they are considered very accurate." (The transit of Venus, 1882k).

On 12 April 1882 *The New York Times* reported that the French Government would send eight expeditions to study the transit, four to the northern hemisphere and four to the southern (Current foreign topics, 1882a). On 7 December 1882 it was reported that preparations for viewing the transit in Paris were fruitless due to the dark cloud cover (Across the Sun's face, 1882). On 23 December 1882 one could read that the results from the French party near the Straits of Magellan were awaited "… with great anxiety ..." (The late transit of Venus, 1882). Then on 4 January 1883 it was reported that "The French Commission telegraphed the Académie des Sciences that the results obtained in South America had exceeded all its hopes." (The South American states, 1883).

On 7 December 1882, in an article previously cited,

The New York Times published preliminary results already received from many countries. It was noted that in London clouds and snow made obser-vations at the Greenwich Observatory impossible. The British had more favorable conditions at Cork, Durban and Portsmouth. At Penzance they could see the transit for two hours. At other English venues clouds interfered with all of the observations. How-ever, there were good observing conditions in Cape Town, South Africa (Across the Sun's face, 1882).

On 17 September 1882 *The New York Times* noted that there would be four expeditions from foreign nations going to the western hemisphere: one to Costa Rica, one to the Straits of Magellan and two to the United States (Scientific gossip, 1882b). On 23 December 1882 a reader would learn that results from the Straits of Magellan were still awaited (The late transit of Venus, 1882).

The Belgians were quite successful in South Amer-ica. One could have read in *The New York Times* on both 14 December 1882 (The transit of Venus, 1882j) and 4 January 1883 (The South American States, 1883) that they had made 606 observations.

On 6 December 1882 *The New York Times* re-ported that "The Mexican government has supplied instruments to scientific societies throughout the re-public for making observations." (Little hope of see-ing the transit, 1882).

On 10 December 1882 on the front page there was a short item received from Havana on the previous day:

> At Manzanillo both the internal contacts of Venus were observed. The external contacts were not seen on account of the interposition of clouds. The ingress of the planet was observed in Porto Rico, but her egress was hidden by clouds. (The transit of Venus, 1882g).

The transit of Venus of 1882 was the first where the United States, as a sovereign nation, could host scientific expeditions from other countries.

On 19 June 1882 *The New York Times* revealed that the Germans had selected Aiken, South Carolina, as one of its sites for the upcoming transit. Members from their Royal Observatory would arrive in late October (General notes, 1882b). The next month, in an article of 9 July readers would learn that the Germans also planned to observe from a second, as yet unnamed, site in the USA (Scientific gossip, 1882a). On 30 August 1882, it was reported that there would actually be four German expeditions going to the western hemisphere, and the two in the United States would be based at the afore-mentioned site in South Carolina and in Connecticut. Each German party would consist of "… two astronomers, a student, and an assistant." (Current foreign topics, 1882b). On 3 November 1882 an article announced the arrival of a German party that would observe from Hartford, Connecticut. The members of the party were identified (Arrival of German astrono-mers, 1882). On 6 December 1882 there was an item about the preparations of the Germans at Hartford that were made on the previous day, the last before the transit. Hopes were expressed for good weather:

> If the day is clear three telescopic observations of the contacts at ingress and egress will be made at the station of the astronomers at Trinity College, two by the Germans and one with the college refractor. (Little hope of seeing the transit, 1882).

Apparently there was some success at the Hartford site, as the Germans participated in the discussion of whether or not there was an atmosphere on Venus. On 8 December 1882 *The New York Times* reported that

> The German observers at Hartford are quoted as saying affirmatively that there were no indications of an atmosphere. (Article 2 – No title, 1882).

On 7 December 1882 *The New York Times* printed an article regarding the parties present in the San Antonio, Texas, area. Besides an American party, headed by Professor Asaph Hall, there was a Belgian party, headed by a Professor Houzeau (whose name was incorrectly reported as "Houzean"). The first two contacts were missed due to cloudy conditions but the sky cleared and observations were possible later. It was noted that Houzeau and his three assistants took no photographs, but they did obtain 120 (heliometers) measurements, which they wanted to compare with observations made by the Belgian party in Chile. Houzeau took his work very seriously during the transit, allowing no visitors, locking his gate, and using police to "… prevent an invasion …" However, he was quite cordial after the transit (see Fair success in Texas, 1882).

The United States also hosted an expedition party from France. On 6 August 1882 *The New York Times* related that

> The Secretary of War has granted permission to a party of French scientists to occupy Fort Marco, at St. Augustine, Florida, for the purpose of making obser-vations of the transit of Venus. (Notes from Washing-ton, 1882a).

On 8 December 1882 it was reported that the French party had clear weather and "… obtained good and complete observations …" (Watching the transit, 1882).

All four American government-subsidized observ-ation sites in the northern hemisphere were within the boundaries of the United States and its territories. Besides these, there were many other observatories and private individuals who took an interest in the event and made what contributions they could to the effort.

The official northern sites for the Americans listed in *The New York Times* on 7 December 1882, in-cluded the Naval Observatory at Washington, D.C., under William Harkness; San Antonio (Texas), headed by Professor Asaph Hall; Fort Selden (New Mexico), headed by Professor Davidson; and Cedar Keys (Florida), headed by Professor Eastman (The Government's work, 1882). On 6 December 1882 there was an article about the preparations going on at several observatories around the continent. The Naval Observatory had prepared a similar set-up to that used by the American expeditions for the 1874 transit. A long-frame structure to convey the light to the camera had been built onto the side of the building. The apparatus was listed and the article stated that, with the cooperation of the weather, a successful observation was expected (Little hope of

seeing the transit, 1882). However, on 7 December readers would learn that the weather did not cooperate, and although some measurements were taken and some photographs were obtained, overall the results were disappointing (The Government's work, 1882). Then on the next day Professor Davidson's report on the great success in New Mexico was published (Watching the transit, 1882). On 23 December 1882 readers learned that all of the government-subsidized parties employed the same apparatus and arrangements that had been used in 1874, and all of the parties, except for the one based in Washington, D.C., were quite successful (The late transit of Venus, 1882).

In addition, other observatories, colleges and individuals around the country participated in these efforts. Professor C.A. Young, who was active in keeping the public apprised of the various observations of this event, participated himself, using the facilities at Princeton University. When fears were reported by *The New York Times* on 12 November 1882 that a fire at a small building near the observatory at the University would not permit him to take any photographs (The transit of Venus, 1882b), Young quickly responded (on the 14th) stating that all had been restored and his party would be ready (Letters to the Editor – Messrs. Harper and Mr. Pym, 1882). Then on 7 December 1882 an article appeared which reported successful observations at Princeton. Equipment similar to that employed by the 1874 expeditions was used, as well as several other telescopes, and the Government provided photographic plates and emulsion. All four contacts were seen, and Young also conducted a spectroscopic examination of Venus' atmosphere (Fine results at Princeton, 1882).

On 22 November 1882 *The New York Times* reported that Harvard University did not expect to take any particular notice of the 1882 transit of Venus (A large spot on the Sun, 1882). However, on 7 December 1882 readers learned that many observations were made and data were collected there. All four contacts were observed (Good work at Harvard, 1882).

The New York Times reported on 16 July 1883 that the Litchfield Observatory in New York failed totally to observe the 1882 transit due to "… inexorable clouds ..." (Making celestial charts, 1883).

According to a short item in *The New York Times* on 4 December 1882, Lafayette College in Pennsylvania would make observations as directed by the Naval Department (The transit of Venus, 1882f). On 11 December 1882 Professor Coffin reported that all four contacts were seen. There was also mention of the 'black drop' effect that was apparent, and of a ring of light (atmosphere?) seen around the planet before the third contact (Observations of the transit, 1882).

On 8 December (Article 2 – No title, 1882) and 9 December of 1882 (The spot on Venus, 1882) *The New York Times* published Professor Langley's observations at Pittsburgh of a peculiar bright spot on the planet when it was halfway onto the disk of the Sun. No explanation was proposed. Langley was partially successful in his observation of the transit.

On 2 May 1880 *The New York Times* reported that the Winchester Observatory at Yale University ordered a heliometer that would be completed prior to the 1882 transit (Uniformity in time, 1880). On 3 December (The transit of Venus, 1882e) and 5 December of 1882 (The Yale astronomers, 1882) the members of their scientific party were identified and their preparations for the transit were described.

On 6 December 1882 *The New York Times* reported that Vassar College was making arrangements in Poughkeepsie, New York, to observe and photograph the upcoming transit (Little hope of seeing the transit, 1882). This party was led by Maria Mitchell, whose application to participate in an overseas expedition had been denied because of her gender (Sheehan and Westfall, 2004: 279).

On 7 December 1882 *The New York Times* described the efforts made at the Central High School in Philadelphia. Contacts were observed, but due to hazy conditions photographic, spectroscopic and micrometric observations were not attempted (Seen through a hazy sky, 1882).

The New York Times on 7 December 1882 reported that the four American transit of Venus parties in the southern hemisphere were based at Santa Cruz, (Patagonia), under Lieutenant Samuel W. Very; at the Cape of Good Hope (South Africa), under Professor Simon Newcomb; at Cordova (Chile), under Professor Boss; and at Auckland (New Zealand), under Professor Edwin Smith (The Government's work, 1882).

On 17 August 1882 *The New York Times* announced in its regular feature "Notes from Washington" that Lieutenant Samuel W. Very of the Navy would lead the transit party to Santa Cruz, Patagonia. They would leave from New York in a few days in the flagship *Brooklyn* (Notes from Washington, 1882b). A report was made on 4 January 1883 that observations there were marred due to rain (South American states, 1883). On 6 February 1883 readers learned of the progress of the returning party, which by then had reached Montevideo (Naval intelligence, 1883).

Reports on the expedition to Cape Town initially related to updates on the personnel. In the regular *New York Times* feature "Army and Navy News" readers learned on 15 August 1882 of the appointment of Lieutenant Thomas L. Casey, Jr., Engineer Corps to the Cape Town party (Army and Navy news, 1882a), and on 7 September 1882 of the appointment of Lieutenant E.W. Sturdy as Newcomb's temporary replacement as Superintendent of the Nautical Almanac Office during the latter's absence (Army and Navy news, 1882b). On 19 September 1882 *The New York Times* announced the departure of the expedition for the Cape of Good Hope on the steamship *Parthia* (Notes from the capitol, 1882). Two days later it was related that this, the first of the southern expeditions to leave for its site, would arrive at the Cape Town Observatory on about 1 November (The transit of Venus, 1882a). On 7 October 1882 it was announced that Professor Newcomb and his party left on the second leg of their journey, from Southampton to the Cape of Good Hope, on the steamer *Durban* (Current foreign topics, 1882c), while on 8 January 1883 *The New*

York Times related the success of the party, which reported good observations of the internal contacts. They obtained 236 photographs, more than 200 of which were measurable. They had landed at Plymouth on the previous day upon their return to the United States (Current foreign topics, 1883). In "Army and Navy Matters" on 12 September 1883, it was reported that Simon Newcomb had returned to the USA and resumed his duties at the Nautical Almanac Office (National capitol topics, 1883).

A second South American expedition was sent to Valparaiso in Chile. On 21 September 1882 it was noted in *The New York Times* that members at both of the South American venues selected would be able to observe the entire transit—weather permitting (The transit of Venus, 1882a). On 26 October 1882 readers learned that this expedition had departed from the USA on October 12 (South American affairs, 1882), and on 13 December 1882 there was the following short report:

> Panama, Dec. 12 -- Prof. Boss writes from Santiago, under date of the 9th inst., that the American observations of the transit of Venus were completely successful. The weather was splendid, and all the arrangements were carried out. The four contacts were observed, and the photographs and measurements taken were all satisfactory. (The transit of Venus, 1882h).

On 3 February 1883 there was an article subsequent to the return of Professor Lewis, who accompanied Boss, with his party. One learned of the courtesies extended them both by General Maturana of the Army as well as by the President of Chile. The circumstances surrounding the successful transit observations were described (The transit of Venus in Chili, 1883).

The remaining American expedition to foreign parts was sent to Auckland on the North Island of New Zealand. On 18 August 1882 *The New York Times* published the names of the members of this party, which was under the leadership of Edwin Smith from the Coast Survey. They would sail from San Francisco on 1 September (Notes from Washington, 1882c). On 3 September 1882, the reader learned that Smith would proceed to Japan after completing his transit work to make "… pendulum observations ..." (Notes from Washington, 1882d). In the article of 21 September 1882 which summarized the expeditions to the southern hemisphere, one would learn that only the egress contacts would be visible in New Zealand (The transit of Venus, 1882a). The summary article of 23 December 1882 told readers that the New Zealand party was successful in observing the last two contacts and that it took more than 200 photographs (The late transit of Venus, 1882).

The most complete article found in *The New York Times* dealing with the 1882 transit of Venus was printed after the event, on 23 December 1882. In this article of four-plus columns there was a summary of the goals and means of the various expeditions, and the following information summarizing the methods used, and the varying degrees of success in observing contacts. The following summary listing, including the "Key", is adapted from this article (ibid.):

KEY:

1,2,3,4 = numbers denoting contacts observed
P = photographs taken using standardized American methods (with the number of images in brackets)
P* = photographs taken by different method (ditto)
h = heliometer measures taken
h* = equivalent measures to the heliometers; but different means used
s = spectroscopic observations
p = photometric observations
m = micrometer measures of the planet's diameter

CANADIAN SITES:

1. Ottawa, Canada (1, 2, 3, 4)
2. Kingston, Canada (2, 3, 4)

US SITES:

3. Cambridge, Mass. (1, 2, 3, 4, s, p, m; several observers)
4. Providence, R.I. (2, P* (23))
5. Amherst, Mass. (3, 4)
6. South Hadley, Mass. (3, 4, s)
7. Hartford, Conn. (2, 3, 4, h, m; German Party)
8. New Haven, Conn. (1, 2, 3, 4, P* (150), h, m; several observers)
9. Helderburg Mountain, N.Y. (1, 2)
10. West Point, N.Y. (1, 2, 3, 4)
11. Poughkeepsie, N.Y. (3, 4, P* (9))
12. Brooklyn, N.Y. (1, 2, 3)
13. Columbia College, N.Y. (2, 3, 4)
14. Western Union Building, New York City (1, 2, 3, 4)
15. University City of New York, New York City (1, 2, 3, 4)
16. Elizabeth, N.J. (2, 3, 4)
17. Princeton, N.J. (1, 2, 3, 4, P (188), s, m; several observers)
18. Philadelphia, Penn. (1, 2, 3, 4)
19. Easton, Penn. (1, 2, 3, 4)
20. Allegheny, Penn. (1, 2, (?), s, m)
21. Pittsburg, Penn. (2, 3)
22. Wilmington, Del. (1, 2)
23. Baltimore, Md. (2, 3, 4; several observers)
24. Annapolis, Md. (2, 3, 4)
25. Naval Observatory, Washington, D.C. (1, 2, 3, 4, P (53), m; several observers)
26. Coast Survey, Washington, D.C. (2, 3, 4; several observers)
27. Signal Service, Washington, D.C. (1, 2, 3, 4)
28. Charlottesville, Va. (2, 3, 4)
29. Aiken, S.C. (3, 4, h, m; German Party)
30. St. Augustine, Fla. (1, 2, 3, 4, h*, P*(200), m; French Party)
31. Cedar Keys, Fla. (2, 3, 4, P (180), m; Government Party)
32. Chicago, Ill. (1, 2; several observers)
33. Madison, Wisc. (1, 2)
34. Northfield, Minn. (3, m)
35. Iowa City, Iowa (1, 2)
36. Ann Arbor, Mich. (4, m)
37. San Antonio, Texas (3, 4, P (200); Government Party)
38. San Antonio, Texas (3, 4, h*, m; Belgian Party)
39. Fort Selden, New Mexico (1, 2, 3, 4, P (216), m; Government Party)
40. Lick Observatory, California (2, 4, P (147), m)

FOREIGN SITES:

Potsdam, Prussia (1, 2, P*, s, m)
Jamaica (1, 2, 3, 4)
Pueblo, Mexico (1, 2, 3, 4, h*; French Party)
Chapultepec, Mexico (No contacts, P*(13))

Cape Town, South Africa (1, 2, P (?), American Government Party)
Durham, South Africa (1, 2)
Tasmania (3, 4, P (?); American Government Party)
Melbourne, Australia (3, 4, P (236[?]); American Government Party)
Santiago, Chile (completely successful, P (?); American Government Party)
Santiago, Chile (completely successful, h*, m; Belgian Party)

A comparison of this summary of Venus transit expeditions with information gleaned over the previous months would reveal that much of the information had been available to the public in previous articles, so interested readers could have followed and compared the relative successes of the different parties around the world and within the boundaries of their own countries. However, care was required as some of the information provided was wrong. For instance, neither Tasmania nor Melbourne, in Australia, hosted American transit of Venus parties in 1882—although in 1874 there were two different American parties in Tasmania, one in Hobart and the other in Campbell Town (see Orchiston, 2004; Orchiston and Buchanan, 1993; 2004).

Over the following months one would find other articles reflecting a degree of sustained interest in these scientific endeavors.

On the date of the transit itself, 6 December 1882, *The New York Times* printed an instance of a negative judgment on the various expeditions. The writer opined that Venus transits were just excuses for astronomers to request funds so that they could visit exotic places round the globe. The writer felt that during the 1874 transit the public had been misled when it was implied that transits only occurred about once in a century,[3] and he sarcastically remarked:

> No matter where an astronomer might live, the transit was never visible within a thousand miles of his home. The New-York astronomers had to go to Pekin; the Chinese astronomers had to go to Australia; and the Australian astronomers had to go to Europe. (The transit, 1882).[4]

On 17 December 1882 *The New York Times* published a compliment to American astronomers from the British popularizer of astronomer, Richard A. Proctor, reprinted from the *Gentlemen's Magazine*. Proctor was impressed with the Americans' use of photography and felt the results, once fully interpreted, would be very useful (A compliment to American astronomers, 1882).

On 31 December 1882, *The New York Times* reprinted an item from *Nature* which expressed the sentiment that the recent transits had awakened the intellectual world from "… the slumber of the ages ..." (The observations of 2004, 1882).

On 18 January 1883 *The New York Times* published a short item describing a social event at Delmonico's restaurant:

> There was a handsome display of flowers, the most notable of which was a design representing the transit of Venus. (The sheriff's jury, 1883).

On 10 February 1883 *The New York Times* printed another negative opinion on the profession of astronomy:

> An astronomer is a man who is sent at the cost of the nation on scientific picnics in connection with the transits of Venus, and who employs his time in between successive transits in discovering new asteroids. (Wiggins, 1883).

The New York Times on 13 June 1883 printed a short review of a new book by Richard A. Proctor, *Mysteries of Time and Space*, which included a chapter on the transits of Venus (see New publications, 1883).

Then on 27 June 1883 *The New York Times* printed the obituary of Stephen Alexander. Following the summary of his career as an educator and author was the following statement:

> For several years the aged astronomer had devoted his leisure hours to the study of the heavens from a small observatory in the rear of his residence, and there he observed the recent transit of Venus. (Obituary …, 1883).

4 DISCUSSION

During most of its existence in the second half of the nineteenth century *The New York Times* was typically only eight pages in length. The number of articles present in such a small publication that dealt with the 1882 transit of Venus was indicative of a significant interest in the subject, fostered by the popular appeal of the 1874 transit program (e.g. see Cottam et al., 2011). The reader was regularly updated on the failures and successes of the various 1882 parties—American and foreign—at the various venues. *The New York Times* printed a summary article later that year allowing its readers to compare achievements, and the means to these achievements. Later, after the transit, there were articles mentioning subsequent lectures and publications that might satisfy some lingering public interest in transits of Venus.

5 CONCLUSION

In the wake of the event of 1874 the general public in the USA was knowledgeable about the science and significance of transits of Venus. *The New York Times* delivered informative articles before, during and after the 1882 event. Readers were reminded of relevant lectures, and notified of publications written with a non-professional audience in mind. Letters to the Editor would reflect varying degrees of support in these costly endeavors. There was general interest in *The New York Times* articles regarding the various expeditions of different nationalities around the world, but in 1882 there was particular interest in the parties on their own soil, both American and foreign. The American public garnered pride in their country's abilities to contribute. As there would not be another transit of Venus for more than a century it was now to be seen if there was a lingering interest in other astronomical topics. Besides articles describing particular events such as eclipses and meteor showers *The New York Times* would begin to provide regular features on what celestial objects might be seen in the night sky. Such articles might contribute to the sustained interest and support of the public for future astronomical endeavors.

6 NOTES

1 Note that in addition to Horrocks, the transit was also observed by his friend, William Crabtree, (1610–1644; e.g. see Chapman, 2005).

2 Harkness' value was based on more than just the 1874 and 1882 transit results. As Dick et al. (1998: 247) relate, Harkness finally realized that the solar parallax was not an independent constant and treating it as such merely produced a mass of discordant values. In fact, the solar parallax

> … was inextricably entwined with lunar parallax, the constants of precession and nutation, the parallactic inequality of the Moon, the masses of the Earth and Moon, and the velocity of light, among others. He set about treating these constants as a system …

The result of his investigation was the value listed here.

3 But this is a totally unfair statement as numerous instances can be found in *The New York Times* where a full explanation was given of the frequency of transits.

4 These statements are equally ludicrous: no Chinese astronomers went to Australia to observe the 1874 or 1882 transit of Venus, and no Australian astronomers went to Europe to make their observations.

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8 REFERENCES

A compliment to American astronomers. *The New York Times*, 17 December 1882 (page 12).

A large spot on the Sun. *The New York Times*, 22 November 1882 (page 5).

Across the Sun's face. *The New York Times,* 7 December 1882 (page 1).

Aiken and the transit of Venus. *Story of Aiken – Centennial Edition*, 4-6 April 1935.

Airy, G.B., 1857. On the means which will be available for correcting the measure of the Sun's distance, in the next twenty-five years. *Monthly Notices of the Royal Astronomical Society*, 17, 208-221.

Airy, G.B., 1880. On the preparations to be made for observation of the transit of Venus, 1882, December 6. *Monthly Notices of the Royal Astronomical Society*, 40(7), 381-385.

Army and Navy news. *The New York Times*, 15 August 1882a (page 2).

Army and Navy news. *The New York Times,* 7 September 1882b (page 2).

Arrival of German astronomers. *The New York Times*, 3 November 1882 (page 8).

Article 2 – No title. *The New York Times,* 8 December 1882 (page 4).

Chapman, A., 2005. Jeremiah Horrocks, William Crabtree, and the Lancashire observations of the transit of Venus of 1639. In Kurtz, D.W. (ed.). *Transits of Venus: New Views of the Solar System and Galaxy*. Cambridge, Cambridge University Press. Pp. 3-26.

Cottam, S., 2012. The Popularization of Astronomy in America Subsequent to the Events of the Transits of Venus of 1874 and 1882 and the Total Solar Eclipses of 1868, 1869 and 1878. Ph.D. Thesis, James Cook University, Townsville, Australia.

Cottam, S., Orchiston, W., and Stephenson, F.R., 2011. The 1874 transit of Venus and the popularisation of astronomy in the U.S.A. as reflected in the *The New York Times*. In Orchiston, W., Nakamura, T., and Strom, R. (eds.). *Highlighting the History of Astronomy in the Asia-Pacific Region*. New York, Springer. Pp. 225-241.

Current foreign topics. *The New York Times*, 12 April 1882a (page 1).

Current foreign topics. *The New York Times*, 30 August 1882b (page 1).

Current foreign topics. *The New York Times*, 7 October 1882c (page 1).

Current foreign topics. *The New York Times*, 8 January 1883 (page 1).

Dick, S.J., 1995. The American transit of Venus expeditions of 1882. *Bulletin of the American Astronomical Society*, 27, 1331.

Dick, S.J., 2003. *Sky and Ocean Joined: the U.S. Naval Observatory, 1830-2000*. New York, Cambridge University Press.

Dick, S.J., 2005. The American transit of Venus expeditions of 1874 and 1882. In Kurtz, D.W. (ed.). *Transits of Venus: New Views of the Solar System and Galaxy*. Cambridge, Cambridge University Press. Pp. 100-110.

Dick, S.J., Orchiston, W., and Love, T., 1998. Simon Newcomb, William Harkness and the nineteenth-century American transit of Venus expeditions. *Journal for the History of Astronomy*, 29, 221-255.

Duerbeck, H.W. 2004. The German transit of Venus expeditions of 1874 and 1882: organization, methods, stations, results. *Journal of Astronomical History and Heritage*, 7, 8-17.

Eastman, J.R., 1882. Letter to S.C. Rowan, dated 6 December. Original in National Archives (Washington).

Fair success in Texas. *The New York Times*, 7 December 1882 (page 2).

Fine results at Princeton. *The New York Times*, 7 December 1882 (page 2).

General notes. *The New York Times*, 31 March 1882a (page 4).

General notes. *The New York Times*, 19 June 1882b (page 4).

General Telegraph News. *The New York Times*, 20 August 1881 (page 5).

Gleanings from the mails. *The New York Times*, 22 August 1882 (page3).

Good work at Harvard. *The New York Times*, 7 December 1882 (page 2).

Hall, A.S., 1882. Letter to S.C. Rowan, dated 8 December, Original in National Archives (Washington).

Harkness, W., 1891. Solar parallax from the transit of Venus photography. *Publications of the Astronomical Society of the Pacific*, 3(14), 46.

Horner, Maures, 1883. Observations of the transit of Venus, 1882, Dec. 6, made at Mells, ten miles south of Bath. *Monthly Notices of the Royal Astronomical Society*, 43, 276-277.

Howlett, F., 1883. Notes on the transit of Venus. *Monthly Notices of the Royal Astronomical Society*, 43, 278-279.

Janiczek, P.M., 1983. Remarks on the transit of Venus expedition of 1874. In Dick, S.J., and L.E. Doggett (eds.). *Sky and Ocean Joined: Proceedings of the Sesquicentennial Symposium of the U.S. Naval Observatory December 5 and 8, 1980*. Washington, U.S. Naval Observatory. Pp. 52-73.

Knapp, P., 2004. From the Archives – Trinity and the transit of Venus, 1882. *Trinity Reporter*, Spring, 13-15.

Koorts, W.P., 2003. The 1882 transit of Venus and the Huguenot Seminary for Girls. *Monthly Notices of the Astronomical Society of South Africa*, 62(3&4), 76-87.

Koorts, W.P., 2004. The 1882 transit of Venus: the British expeditions to South Africa. *Monthly Notices of the Astronomical Society of South Africa*, 63(3&4), 34-57.

Lankford, J., 1987. Photography and the 19th-century transits of Venus. *Technology and Culture*, 28, 648-657.

Letters to the editor – Messrs. Harper and Mr. Pym. *The New York Times*, 14 November 1882 (page 4).

Little hope of seeing the transit. *The New York Times*, 6 December 1882 (page 5).

Making celestial charts. *The New York Times*, 16 July 1883 (page 9).

Maley, P.D., 2005. 1882 U.S. Naval Observatory expedition commemorated. *StarScan*, 21 (1), 4.

Mauritius Expedition, 1874 Division 1, Chapter 1, The Heliometer. *Dun Echt Observatory Publications*, 2, 1-10 (1874).

National capitol topics; Army and Navy matters. *The New York Times*, 12 September 1883 (page 2).

Naval intelligence. *The New York Times*, 6 February 1883 (page 2).

New publications. *The New York Times*, 13 June 1883 (page 3).

Newcomb, S., 1895. *The Elements of the Four Inner Planets and the Fundamental Constants of Astronomy*, Washington: Government Printing Office.

Notes from the capitol. *The New York Times*, 19 September 1882 (page 5).

Notes from Washington. *The New York Times*, 6 August 1882a (page 7).

Notes from Washington. *The New York Times*, 17 August 1882b (page 1).

Notes from Washington. *The New York Times*, 18 August 1882c (page 1).

Notes from Washington. *The New York Times*, 3 September 1882d (page 1).

Obituary: Stephen Alexander LL.D., *The New York Times*, 27 June 1883 (page 4).

Observations of the transit. *The New York Times*, 11 December 1882 (page 1).

Orchiston, W., 2004. The nineteenth century transits of Venus: an Australian and New Zealand overview. *Journal of Astronomical Data* 10, 219-308.

Orchiston, W. and Buchanan, A., 1993. Illuminating incidents in Antipodean astronomy: Campbell Town, and the 1874 transit of Venus. *Australian Journal of Astronomy*, 5(1), 11-31.

Orchiston, W. and Buchanan, A., 2004. 'The Grange', Tasmania: survival of a unique suite of 1874 transit of Venus relics. *Journal of Astronomical History and Heritage*, 7, 34-43.

Passage de Vénus du 6 Décembre 1882: Rapports Préliminaires, *1883*. Paris, Académie des Sciences, 7, 47, 50-56.

Pickering, E.C., May 1882-May 1883. Observations of the transit of Venus, December 5 and 6, 1882, made at the Harvard College Observatory. In *American Academy of Arts and Sciences, Boston, Proceedings*. Pp. 15-40.

Prayers for astronomical science. *The New York Times*, 29 November 1882 (page 2).

Preparing for the transit of Venus (from the Toronto Canada *Globe*), *The New York Times*, 28 November 1881 (page 2).

Prince, C.L., 1883. Note on the transit of Venus, 1882, Dec. 6. *Monthly Notices of the Royal Astronomical Society*, 43, 278.

Proctor, R.A., 1882. *Transits of Venus: A Popular Account of Past and Coming Transit. Fourth Edition.* London, Longmans, Green.

Prof. J.R. Eastman dies. *The New York Times*, 27 September 1913.

Radau, M., 1874. (translation) The transit of Venus. *Appleton's Journal of Literature, Science and Art*, 12(281), 170-174.

Report of the Superintendent of the U.S. Naval Observatory, for the Year Ending June 30, 1889. Washington, Government Printing Office (1889).

Scientific gossip. *The New York Times*, 30 January 1881a (page 4).

Scientific gossip. *The New York Times*, 12 June 1881b (page 4).

Scientific gossip. *The New York Times*, 6 November 1881c (page 6).

Scientific gossip. *The New York Times*, 9 July 1882a (page 4).

Scientific gossip. *The New York Times*, 17 September 1882b (page 5).

Seen through a hazy sky. *The New York Times*, 7 December 1882 (page 2).

Sheehan, W. and Misch, A., 2004. Ménage à trois: David Peck Todd, Mabel Loomis, Todd, Austin Dickinson, and the 1882 transit of Venus. *Journal for the History of Astronomy*, 35, 123-134.

Sheehan, W., and Westfall, J., 2004. *The Transits of Venus*. Amherst, Prometheus Books.

South American affairs. *The New York Times*, 26 October 1882 (page 2).

Speech of President Curtis. *The New York Times*, 3 August 1882 (page 3).

Sterken, C., 2009. Venus 1882 and Jean-Charles Houzeau. *Astronomische Nachrichten*, 330, 582-585.

Sterken, C., Duerbeck H., Cuypers, J., and H. Langenaken, 2004. Jean-Charles Houzeau and the 1882 Belgian transit of Venus expeditions. *Journal of Astronomical Data*, 10(7), 309-330.

Tebbutt, J., 1883. Note on Professor Newcomb's remarks on the Windsor Observations of the transit of Venus in 1874. *Monthly Notices of the Royal Astronomical Society*, 43, 279-280.

The coming transit of Venus (from the *Providence Journal). The New York Times*, 3 February 1882 (page 2).

The government's work. *The New York Times*, 7 December 1882 (page 2).

The late transit of Venus. *The New York Times*, 23 December 1882 (page 3).

The next transit of Venus. *The New York Times*, 14 August 1881 (page 2).

The observations of 2004. *The New York Times*, 31 December 1882 (page 4).

The sheriff's jury. *The New York Times*, 18 January 1883 (page 5).

The South American states, *The New York Times*, 4 January 1883 (page 2).

The spot on Venus. *The New York Times*, 9 December 1882 (page 1).

The transit. *The New York Times*, 6 December 1882 (page 4).

The transit of Venus. *Journal of the Aiken County Historical Society*, 11(2), 1, 3-4 (September 1995).

The transit of Venus. *The New York Times*, 21 September 1882a (page 8).

The transit of Venus. *The New York Times*, 12 November 1882b (page 9).

The transit of Venus. *The New York Times*, 14 November 1882c (page 1).

The transit of Venus. *The New York Times*, 27 November 1882d (page 2).

The transit of Venus. *The New York Times*, 3 December 1882e (page 1).

The transit of Venus. *The New York Times*, 4 December 1882f (page 5).

The transit of Venus. *The New York Times*, 10 December

1882g (page 1).
The transit of Venus. *The New York Times*, 13 December 1882h (page 2).
The transit of Venus. *The New York Times*, 14 December 1882j (page 2).
The transit of Venus. *The New York Times*, 29 December 1882k (page 2).
The transit of Venus in Chili. *The New York Times*, 3 February 1883 (page 8).
The Yale astronomers busy. *The New York Times*, 5 December 1882 (page 7).
Todd, D.P., 1881. The solar parallax as derived from the American photographs of the transit of Venus. *The Observatory*, 51, 202-205.
Todd, D.P., 1883. On the observations of the transit of Venus, 1882, December 5-6, made at the Lick Observatory, Mount Hamilton, California. *Monthly Notices of the Royal Astronomical Society*, 43, 273-276.
Uniformity in time. *The New York Times*, 2 May 1880 (page 2).
United States Transit of Venus Commission, 1882. *Instructions for Observing the Transit of Venus, December 6, 1882. Prepared by the Commission, Authorized by Congress, and Printed for the Use of the Observing Parties by Authority of the Hon. Secretary of the Navy*. Washington, Government Printing Office.
Venus crossing the Sun's face. *The New York Times*, 5 December 1882 (page 12).
Viewing Venus. *San Antonio Express*, 7 December 1882.
Watching the transit. *The New York Times*, 8 December 1882 (page 5).
Wiggins. *The New York Times*, 10 February 1883 (page 4).
Young, C.A., 1880. Recent progress in solar astronomy. *Princeton Review,* January-June 1880, 88-104.

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