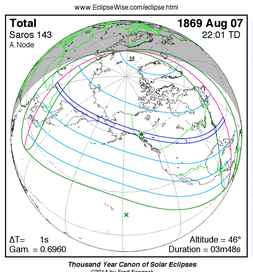
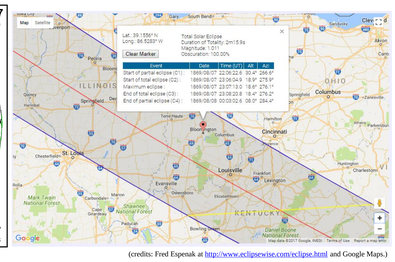
IU Eclipse History





(credits: Fred Espenak at http://www.eclipsewise.com/eclipse.html and Google Maps.)

Above: The path and timing of the solar eclipse of August 7, 1869, which was the last solar eclipse with totality visible in Bloomington. The eclipse of 2024 will again be visible as a total solar eclipse here.

1869: A Total Eclipse in Bloomington

The last total solar eclipse visible in Bloomington, with total coverage of the Sun by the Moon as seen from here on the IU campus, occurred on August 7, 1869. The eclipse started in the late afternoon and several IU professors met to view it at the house of Professor Theophilus Wylie (built by his cousin Andrew Wylie, who was the first president of IU), which had a rooftop observation deck (see picture below). Theophilus Wylie was one of the first to teach science at IU, having come to Bloomington in 1837 to teach mathematics and natural philosophy. He was one of the first in Bloomington to use a camera and to own a telescope, which he attempted to use together to photograph the total eclipse, though with what he considered little success.

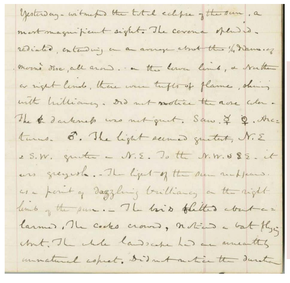
Professors Wylie, Ballantine, and Kirkwood observed the eclipse from the rooftop observation area of Theophilus Wylie's house, which can be seen in this undated early photograph. Now known as the Wylie House and open as a museum, this home was built by Theophilus' cousin Andrew Wylie, who was the first president of IU.

(credit: Indiana University Archives Photograph Collection, image number P0043540.)

Viewing the eclipse with Wylie were Elisha Ballantine, Daniel Kirkwood, and a few family members and out of town guests. In 1869, Ballantine was professor of languages, especially Latin and Greek, though he had originally taught mathematics at IU on his arrival in 1854. Kirkwood, who the campus observatory was later named after, was professor of mathematics, but influential as an American astronomer. He was well known for his theoretical and mathematical work in astronomy on orbits and trajectories, particularly of comets, asteroids, and meteors.

Professors Wylie (upper right), Kirkwood (above), and Ballantine (right)

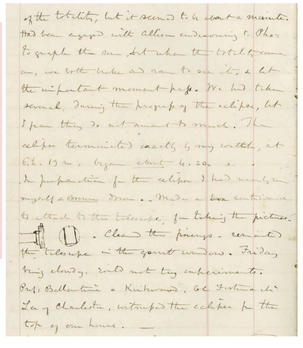
(credits: Indiana University Archives Photograph Collection and Wylie House Museum Image Collection, Bloomington, IN)



Transcript of Wylie's diary entry of August 8, 1869:

Yesterday – witnessed the total eclipse of the sun, a most magnificent sight. The corona splendid, radiated, extending on an average ¼ diam. of moon's disc, all around. On the lower limb & northern or night limb, there were tufts of flame, shining with brilliancy. Did not notice the rose color. The darkness was not great. Saw Mercury, Venus, Arcturus, Mars. The light seemed greatest N.E. & S.W., greater on N.E. To the N.W. & S.E., it was greyish. -- The light of the sun reappeared as a point of dazzling brilliancy on the right limb of the sun. -- The birds flitted about alarmed. The cocks crowed. Noticed a bat flying about. The whole landscape had an unearthly unnatural aspect. Did not notice the duration

(credit: Indiana University Archives Online – Theophilus Wylie diaries)



of the totality, but it seemed to be about a minute. Had been engaged with Allison endeavoring to Photograph the sun, but when the totality came on, we both broke and ran to see it, & let the important moment pass. We had taken several during the progress of the eclipse, but I fear they do not amount to much. The eclipse terminated exactly by my watch at 6h 19m [e.g., 6:19], began about 4.20. In preparation for the eclipse I had nearly run myself & Brown down. – Made a contrivance to attach to the telescope for taking the pictures. [See sketches in original, at right.] Cleaned the fixings -- remounted the telescope in the garret window. Friday being cloudy could not try experiments. Prof. Ballantine & Kirkwood, Col. Foster & Mr Lee of Charleston, witnessed the eclipse from the top of our house.

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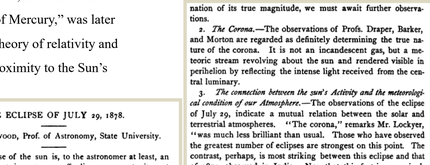
With thanks to University Historian Jim Capshew, Kirkwood Professor of Astronomy Caty Pilachowski, and the IU Libraries & Archives.

1878: Wylie's Trip To Colorado

The solar eclipse of July 29, 1878, was only visible as a partial solar eclipse from Bloomington. Theophilus Wylie, however, traveled to Boulder, Colorado, by train and carriage to see the eclipse in its totality. There he met up with a former student that worked and resided there: IU alumnus Charles Campbell, whose father Matthew Monroe Campbell was also a professor at Indiana University. The 67-year old Wylie reported that their climb together up a mountain outside Boulder, at noon on a warm July day, was exhausting, but that at the top they had "a fine view" both of the mountain peaks and of the valley below them. During the eclipse, Wylie observed that the corona was much brighter than what he'd seen in August of 1869. Wylie saw an impressive amount of detail and witnessed the phenomenon known as "Baily's Beads," which he drew in his notebook recording the trip. Despite this, Wylie noted that the 1878 eclipse "did not impress me as much as the eclipse of August 1869 – as the darkness was not near so great." Although Wylie's trip to view the eclipse was not an official research expedition, it meant that a representative of Indiana University was present alongside many of America's top astronomers of that era as well as thousands of others who had flocked to the still-developing American West, from Montana down through Texas, to observe the event. These included the American astronomer and pioneer in women's education in science Maria Mitchell, and the inventor Thomas Edison, who Wylie described meeting on his trip as the "greatest curiosity."

"Baily's beads" are the points of light that can appear along the edge of the Moon as it moves in and out of totality because of the uneven horizon formed by the lunar mountain ranges. Wylie described his view of them along with a couple of sketches:

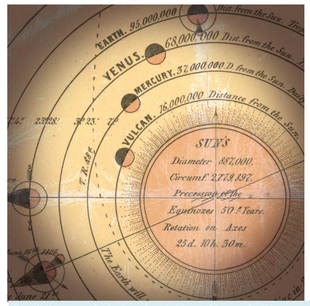


"When the sun began to show itself, I noticed the light first at A in the form of points of light, there were plainly visible 6 or 7 of these, and for each a radiation, such as is seen around a small hole when the sun is seen directly through it, the observer of course in the line of the ray and some distance between. I suppose these were Baily's beads. A phenomena of which I had not been thinking and for which I was not looking for."

(credit: Indiana University Archives Online – Theophilus Wylie diaries)

Following the 1878 eclipse, Daniel Kirkwood wrote a report for the Indiana School Journal on the scientific results obtained from the many observing stations along the eclipse's path of totality, highlighting the discoveries being made at the time. Kirkwood wrote, "A total eclipse of the sun is, to the astronomer at least, an event of great importance; affording an opportunity not otherwise presented for deciding various questions in solar physics."

One of the most newsworthy results of the 1878 eclipse observations was that two major astronomers claimed independently to have observed an intra-mercurial planet – a planet closer to the Sun than Mercury. Astronomers studying Mercury's orbit had previously noted that it had certain irregularities, which might be caused by the existence of another planet in a nearby orbit, and there had been occasional reports of possible sightings of such a planet as it passed in front of the Sun. However, Kirkwood noted, "The existence of an intra-Mercurial planet was still regarded as doubtful by many astronomers until the body was simultaneously observed by Professor James C. Watson and Mr. Swift during the total eclipse of July 29 [1878]." The question of the existence of this additional planet, which was named "Vulcan," continued for many decades before it was dismissed. The strangeness of Mercury's orbit, now known as "the advance of the perihelion of Mercury," was later explained by Albert Einstein's theory of relativity and is a result of Mercury's close proximity to the Sun's massive gravity.



Detail from an 1846 educational school lithograph "Plan or Map of the Solar System," including the orbit of the planet Vulcan believed by some at the time to exist between the Sun and Mercury. Looking for such a planet close to the Sun became an important task for eclipse observers for the next several decades.

THE ECLIPSE OF JULY 29, 1878.

DANIEL KIRKWOOD, Prof. of Astronomy, State University.

A TOTAL eclipse of the sun is, to the astronomer at least, an event of great importance; affording an opportunity not otherwise presented, for deciding various questions in solar physics. The eclipse of July 29 was very successfully observed at numerous stations along the line of totality, and the preliminary reports of observers have been widely published. We will briefly specify some of the most interesting results.

1. *The Discovery of an Intra-Mercurial Planet.*—It is well known that the researches of Leverrier indicate a greater amount of perturbation in the motion of Mercury than can be accounted for by the influence of the known planets; that such unexplained disturbance has been referred to the action of either a planet or a zone of planetary matter within Mercury's orbit; and, finally, that round spots have been occasionally seen passing rapidly, like interior planets, across the sun's disk. The existence, however, of an intra-Mercurial planet was still regarded as doubtful by many astronomers until the body was simultaneously observed by Professor James C. Watson and Mr. Swift during the total eclipse of July 29. The brightness of this new member of the system was estimated by the former as about equal to that of a 9½ magnitude star; by the latter, as somewhat less. For the elements of its orbit and the determination of its true magnitude, we must await further observations.

2. *The Corona.*—The observations of Profs. Draper, Barker, and Morton are regarded as definitely determining the true nature of the corona. It is not an incandescent gas, but a meteoric stream revolving about the sun and rendered visible in perihelion by reflecting the intense light received from the central luminary.

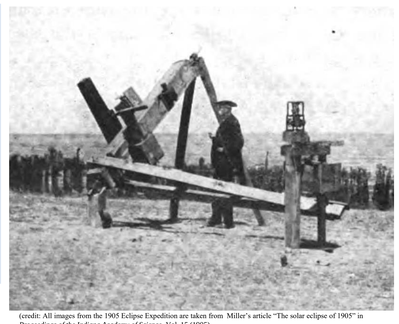
3. *The connection between the sun's Activity and the meteorological condition of our Atmosphere.*—The observations of the eclipse of July 29, indicate a mutual relation between the solar and terrestrial atmospheres. "The corona," remarks Mr. Lockyer, "was much less brilliant than usual. Those who have observed the greatest number of eclipses are strongest on this point. The contrast, perhaps, is most striking between this eclipse and that of 1871, observed in India. Now that this fact is recognized, the naturalness of it is apparent to everybody. We know that the sun's activity and the various meteorological and magnetical conditions on our own earth, which depend upon or are connected with it, wax and wane every eleven years or so. This is termed the sun-spot period. Thus the sun was very active in 1881, and it will be again very active in 1882. It is very sluggish now, and it will be sluggish again in 1889. In 1871 we had many spots, many prominences, many magnetic storms and auroras, heavy rainfall, and, let me add, no famines to speak of. Associated with these we had a large corona. This year there are no spots, the prominences are rare, the magnets were never so quiet, there are no auroras, and we are passing through a famine period. Associated with these we find a small corona. Hence it is that the astronomers agree that this year another connecting link has been added to the chain which binds together the solar changes."

4. The serrations known as Baily's beads remained visible, according to Mr. Colbert, for two and a half seconds, indicating that the mountains around the moon's disk are one and a half miles high.

1905: An Overseas Eclipse Expedition

In 1905, Indiana University sent an expedition overseas to Almazán, in the Soria region of northeastern Spain, to observe the total solar eclipse on August 30. Led by John A. Miller, a graduate of IU who had gone on to become IU Professor of Mechanics and Astronomy, and Wilbur A. Cogshall, the Assistant Professor of Astronomy, the expedition from IU hoped to capture detailed photographs of the solar corona, the outer layers of the Sun that become visible during a total eclipse when the brighter inner portion is blocked by the Moon. To do this, they would use a new telescope that had been motorized to move along with the Sun to reduce blurring and capture better detail. Multiple types of cameras, all much larger and far less automated than those of today, were used to capture images of the corona with different exposure times and resolutions. Additional cameras were being used to photograph the further area surrounding the Sun, looking for any possible additional planets visible close to the Sun, inside of the orbit of Mercury, such as the intra-mercurial planet Vulcan that was believed to have been observed in the 1878 eclipse. Along with the normal photographs, the expedition planned to photographically record spectra, which would show the differently-colored components of the light during different parts of the eclipse. Spectra like these were important for understanding what types of elements were present in the solar corona.

Above: The expedition camp, including the 60-foot long camera, enclosed in its tent. Each of the instruments shown was taller than a person, as visible in the photo to the right. The instruments were shipped in May, in 18 packages weighing approximately 3,000 pounds, taking about a month to reach their destination by steamer. The Indianapolis News, which helped fund the trip, reported on the extensive preparations and arrangements for the trip. The professors and students departed in late June in order to get to Spain and get everything set up in time for the eclipse on August 30th. Professor John Miller and his wife arrived back home in early October, with most of the equipment and photographic plates not arriving until the following month.

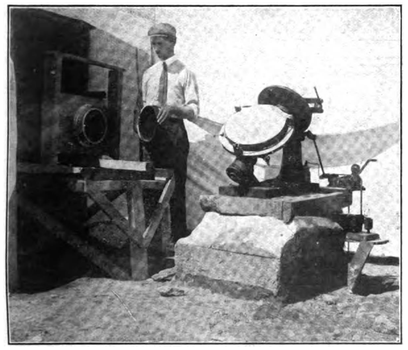


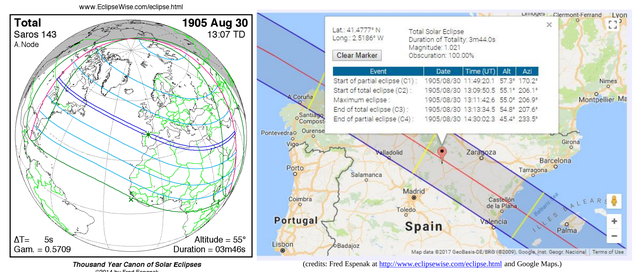
(credit: All images from the 1905 Eclipse Expedition are taken from Miller's article "The solar eclipse of 1905" in *Proceedings of the Indiana Academy of Science*, Vol. 15 (1905).

Transporting heavy equipment and setting up the observation station for such an expedition took a lot of work. IU's Professor of Romance Languages, A.F. Kuersteiner, made the advance arrangements for the expedition in Spain and served as an essential translator and coordinator for the team. The expedition team included three IU students, Earl C. Slipher, F.A. Crull, and C.J. Bulleit, who spent over three weeks working with Cogshall and Miller at the observation site in Spain. Earl Slipher went on to be an astronomer known for his photographic studies of Mars at Lowell Observatory in Arizona. C.J. Bulleit (who changed his last name later to Bulliet) became a journalist, author, and influential art critic in Chicago, known for helping popularize modern art. Additional people were recruited in Spain in order to help with handling all the instruments and photographic equipment, which included large glass photographic plates that had to be quickly moved in and out of place for their exposure, on the day of the eclipse.

Taking over 30 photographs using multiple instruments, all within the short time of the eclipse, required carefully coordinated and well-practiced efforts. Cogshall explained their system to the Indianapolis News after his return: "The arrangement was this. In the center of the camp we had mounted a large chronometer that beat off the seconds. Before it was placed one of the party – Crull, of Frankfort – counted the seconds in a loud voice. For three days we havd been practicing. … Every man had his post of duty and every one was to do a certain thing on a certain count of the seconds. For instance, the man manipulating the shutter or cap on the large camera was to remove it for the first exposure when the fifth second was counted and was to replace it when the seventh second was counted; he was to make another exposure, say, from the twentieth to the thirtieth second. … We drilled until we were perfect, and we worked like clockwork in the darkness."

Right: The opening for the 60-foot camera that was housed in a tent to maintain a darkroom for the exposure and processing of its photographic plates. A motorized mirror system was used to reflect the light reliably into the camera even as the Moon and Sun moved slightly during totality. Newspapers across the state bragged about the Hoosiers having the largest camera there for the eclipse in Spain. The instrument was reused by Miller and Cogshall in their 1918 eclipse expedition to Colorado, as well as later trips.

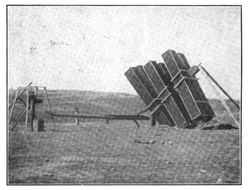


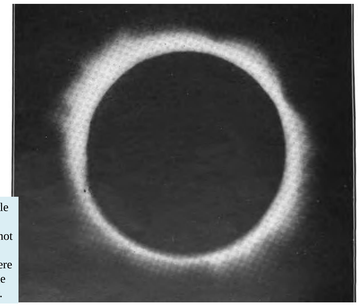


(credits: Fred Espenak at http://www.eclipsewise.com/eclipse.html and Google Maps.)

Above: The path of the solar eclipse of August 30, 1905, and its timing at the location of the IU Eclipse Expedition's location in Almazán, Spain.

Despite the expedition planners' hard work to find a location likely to have good weather during the eclipse, the skies that day proved cloudier than expected. Luckily, during totality the team was able to see the eclipse itself through a thin part of the clouds. Miller reported that they managed to get some reasonably good images showing the structure of the solar corona, although not nearly at the level of detail that they had hoped. Though pleased with some of the detail visible in their photographs, Miller acknowledged that "All the [photographic] plates lack the definiteness that would have resulted from good seeing." More disappointingly, the thin clouds obscuring and surrounding the Sun blocked even Mercury from being visible and completely prevented them from getting the good pictures of the surrounding sky that they needed in order to search for any intra-mercurial planets close to the Sun.





Despite the clouds, the 1905 expedition team was able to get some photographs showing the coronal structure, such at that displayed to the right, though not as sharply detailed as they would have liked. The intra-mercurial cameras (shown above), however, were unable to see through the clouds well enough to make out any stars or planets, much less search for Vulcan.

1918: Joint Expedition to Colorado

In 1918, Miller and Cogshall led another eclipse expedition together, this time to Brandon, Colorado for the total solar eclipse of June 8, 1918. In the 13 years since their expedition to Spain, Miller had taken a new position as professor at Swarthmore College, in charge of Swarthmore's Sproul Observatory, and Cogshall had taken over Miller's job in leading the Kirkwood Observatory at Indiana University. The Colorado eclipse offered a great opportunity for a joint expedition between the two observatories at their respective institutions. It also provided another chance to use some of the same equipment that they had attempted to use to photograph the eclipse in Spain, with hopes of better weather and eclipse visibility than before.

IU graduate Vesto M. Slipher (A.B. '01, A.M. '03, Ph.D. '09), whose younger brother Earl had been on the 1905 eclipse expedition, was also involved: as acting director of the Lowell Observatory located in Flagstaff, Arizona, Slipher worked with Cogshall and Miller to coordinate the Lowell group's observations with those of the IU and Swarthmore expedition, sharing instruments and information so that they could try to successfully duplicate and verify each other's results. Slipher was an expert in spectroscopy, producing and analyzing the spectrum that indicated the amount of each particular color or wavelength of light coming from an object, and Miller noted that the IU and Swarthmore eclipse expedition's spectroscopic program was largely due to Slipher's expertise and the loan of several spectrographs – devices used to produce a spectrum from the incoming light – from the Lowell Observatory.

This time, the weather cooperated and the expedition had clear skies and good seeing for the eclipse. Miller reported that the resulting photographic images "showed a wonderful mass of intricate detail":

"The shorter exposures show the coronal arches that surround the great number of prominences on the rim of the sun, not only the apparently large prominences, but the small ones also. The shape of these arches in general reminds one of Gothic arches, and one can not resist the temptation to believe the prominences markedly influence the shape of coronal structure. On the longer exposures a very great extension of the corona is shown, and, as one would expect, at some distance away from the sun the structure is very much simpler. The streamers are very much longer than one would expect, since it is so near the sunspot maximum. Some streamers on the plates made with the 11-foot lens are three diameters of the sun in length. The general shape of the corona is triangular, and the longer streamers interlace each other, apparently more than usual. However, on the sun's surface, a very great number of sunspots and great clouds of flocculi could be seen in the focal plane of the 62½ foot telescope, almost any day for two weeks preceding the eclipse. One would naturally guess that the corona would be rather complex."

Alas, Miller remarked, his task required that he stay at work in the darkroom deep within the tent, exposing and exchanging the photographic plates as totality occurred, just as he had for most of the 1905 eclipse. He thus saw the eclipse only as a reflection upon the photographic plates. However, "for those outside the dark room, the spectacle was a beautiful one."

One of the photographs taken by the IU-Swarthmore 1918 eclipse expedition in Brandon, Colorado, showing a detailed view of a skeleton or "Heliosaurus" prominence, a stream of material extending out from the surface of the Sun.

Credit: University of Chicago Photographic Archive, Image apf6-02363, Special Collections Research Center, University of Chicago Library.