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OBSERVATIONS OF THE TOTAL SOLAR ECLIPSE OF JUNE 8, 1918, AT MATHESON, COLORADO

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The Drake University Observatory eclipse expedition occupied a very favorable site at Matheson, Colorado. It was wholly through the courtesy of Dr. Edwin B. Frost, Director of the Yerkes Observatory, who with Prof. E. E. Barnard, had selected this station as one of two very desirable locations, that the expedition was so happily situated.

There were four eclipse parties at this station. Prof. Frank H. Loud was in charge of the company from Colorado Springs, Prof. C. A. Chant represented the University of Toronto, Toronto, Canada. Prof. Edison Pettit, of Washburn College, directed the Yerkes Observatory detachment assigned to this site. The writer and his assistant manned the instruments of the Drake Observatory.

The center of the moon's shadow crossed the meridian 103° 59′ W. in latitude 39° 9′ N. The position of our eclipse station, as determined by Pettit and his party, was:

Longitude 103° 59′ W.
Latitude 39° 10′ N.

We were, therefore, one minute of arc (less than a mile) north of the central line. Matheson Station (Rock Island Depot) bears 50° 35′ East of North, distance 8,430 feet. The altitude is about 6,000 feet.

CONTACTS

The first and fourth contacts were observed by Pettit and myself through my three-inch finder attached to the equatorial, by the projection method. Professor Pettit caught the first glimpse of the moon at $4^h\ 13^m\ 49^s.5$ and I caught it a half second later. The computed times of contact for our station, after applying the correction published by Arthur Newton in the Astronomical Journal No. 733, are:

1st contact 4^h 13^m 41^s.6 Mountain Summer Time.
2d contact 5 23 50 .7
3d contact 5 25 19 .6
4th contact 6 28 03 .7

We were a little surprised that we should have been nearly seven seconds slow in our observed time, for the contact was very sharp and easily detected. The second and third contacts were not observed directly, every observer being busy with his program. The fourth contact was observed in the same manner as the first, but the low sun together with the clouds, made the observations very uncertain, as the results show. Observed 4th contact 6^h 27^m 16^s, Mountain Summer Time.

BAILY'S BEADS

Baily's Beads were observed by Prof. C. C. Plitt, of Baltimore City College, Baltimore, Maryland, by projection on a white screen through my three-inch finder. He reports that they appeared at 5^h 23^m 51^s, Mountain Summer Time, which was just six seconds before time was called for the beginning of totality by the timekeeper. This agrees beautifully with the time for second contact, as computed by Professor Pettit. Professor Plitt said there were at least twenty-five beads and they were yellowish in color and very sharp. I have been unable to find much of a discussion of this phenomenon at previous eclipses. The earliest note I have found is by Lockyer, in 1836, who says, "Sometimes when the advancing moon has reduced the sun's disc to a thin crescent, or in the case of an annular eclipse, to a narrow ring, a peculiar notched appearance is presented in a part of the narrow strip, which makes it look like a string of beads. It is supposed to be the effect of irradiation." I know of no other station at which this phenomenon was observed at this eclipse.

THE FLASH SPECTRUM

This was observed visually with a small direct-vision, slitless ocular spectroscope (such as is placed over the eyepiece of the telescope for observing the spectrum of the stars) by my assistant, Mr. Donald Smith, who makes the following report: "The reversal of the Fraunhofer lines was observed at the instant preceding and at the instant following totality. The bright lines flashed out suddenly and lasted for approximately one second at each of the observations. Lines in the red and blue-green (probably due to hydrogen) and in the yellow (probably the helium line) were most conspicuous.

There was a very large number of small lines in the yellow and yellow-green especially. A faint continuous spectrum served as a background."

THE SHADOW BANDS

Mrs. Stella Meek Whisler, of Illinois College, Jacksonville, Illinois, observed this phenomenon by spreading upon the ground at the northwest corner of the shack a large piece of white oilcloth (about ten feet square). She reports as follows: "The shadow bands were very distinct and plainly visible just before and after the period of totality. They were black and white, each about one inch to one and one-fourth inches in width and three to four inches apart, and traveled in the direction of northwest and southeast, or parallel to the path of the shadow. Their direction of orientation was, northeast and southwest. They appeared by the hundreds and passed very rapidly, resembling ripples or waves on the water. They passed so rapidly I could not even guess at the number per second. The phenomenon of the shadow bands was one of the many beautiful and interesting sights observed during the eclipse. In both instances they passed in the same direction and at the same angle. They lasted for two or three seconds on each occurrence."

REPORT OF SHADOW BANDS IN THE TOTAL SOLAR ECLIPSE OF MAY 28, 1900

It is interesting to compare the above observations of the shadow bands with similar reports made by members of Prof. C. A. Young's party at Wadesboro, North Carolina, May 28, 1900. I quote Astrophysical Journal, Vol. 12, June-December, 1900: "These were satisfactorily observed by Mr. Reilly, Mr. Erdman and Mr. Meier upon two tent-flies, one inclined and nearly facing the eclipsed sun, the other lying upon the ground. The bands first appeared about a minute and a half before totality, lying in a plane nearly tangent to the uneclipsed arc of the sun's limb, about two inches wide, but wavy and irregular, separated by an interval of from five to seven inches and moving with a speed of about five or six miles an hour in the direction from southwest to northeast. As totality approached, the interval between the bands diminished, till they were only an inch or two apart, and the speed of their apparent motion increased enormously to the velocity of an express train. After totality, they were more irregular, close together, with no decided progressive motion but simply quivering or oscillating. They lasted about a minute and a half before fading out."

Prof. C. W. Crockett, of Rensselaer Polytechnic Institute, reports (see ibid) from observations at Juliette, Georgia: "A sheet was spread horizontally, the corners being tacked to stakes driven in the ground. The observers reported that the bands were about the width of a man's hand, wavy and indistinct, and that it was impossible to count them."

PHOTOGRAPHS OF THE CORONA

The three eclipse parties agreed upon a definite program. A break circuit chronometer owned by Professor Pettit operated three sounders, one in each shack. Prof. P. F. Whisler, of Illinois College, Jacksonville, Illinois, acted as official timekeeper. Beginning five minutes before the computed time of totality, he called each minute in the reverse order, as, five, four, three, two and one. Miss Vera Gushee, of Smith College, at the appearance of the corona, gave the signal to start by striking a large barrel with a hammer. This was the zero of our exposure time. At this signal, Professor Whisler called out the half beats of the chronometer, as zero, and, one. and, two, and . . . In our practice, I had been stopping on the eighty-sixth second, although our computed time gave us eighty-eight seconds.

With this program, I secured six photographs of the corona, one with the five-inch photographic doublet and five with the eight and one-fourth inch equatorial, which was provided with a photographic lens of 120 inches focal length by the John A. Brashear Co., and the regular driving clock. The photographic doublet was attached to the tube of the equatorial.

The photographs with the doublet and equatorial were taken simultaneously with forty seconds exposure, from the eighteenth to the fifty-eighth second of our program. The five-inch negative is badly overexposed. The corona merges into the sky effect and the prominences are reversed, that is, they are light in the negative. A slender halo, also reversed, standing out away from the moon's disc, connects the top of two prominences which are about sixty degrees apart. The corona is distinctly triangular in shape. The long eastern streamer forms the vertex of an isosceles triangle and the western streamers diverge to form the base. This is quite unusual. Most of the previous eclipses have shown a quadrangular or irregular four-rayed star shape. When we consider the position of the three great prominences and the fact that the longest streamers were directly above them, it seems not impossible that there is some connection between the prominences and the shape of the corona.

Only three star images (including Jupiter) are visible on this plate. Jupiter's image is very distinct, but too near the edge of the plate to be good. Beta and Zeta Tauri are at the very limits of the field, and their images appear as crescents.

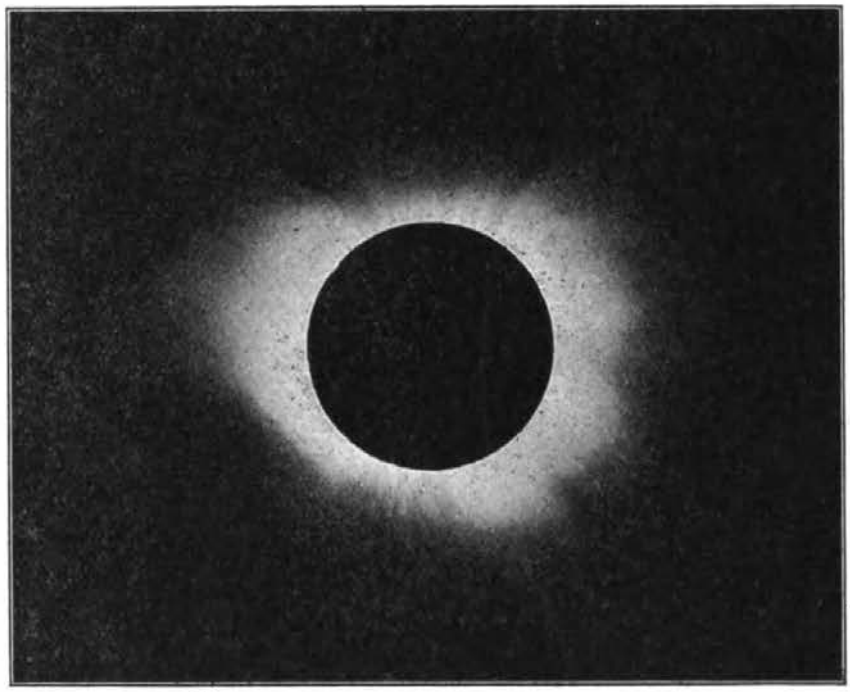

FIG. 133.—Plate No. 1. Exposure one second; $5^h\ 23^m\ 57^s$ to $5^h\ 23^m\ 58^s$.

Five photographs were taken with the eight and one-fourth inch equatorial with the following exposures:

No. of plate	Exposure time	Exposure interval	Make	Remarks
1	0 Sec. to 1 Sec.	1 second	Seed 23	Backed
2	6 Sec. to 11 Sec.	5 seconds	Seed 30	Backed
3	18 Sec. to 58 Sec.	40 seconds	Seed 30	Backed
4	63 Sec. to 74 Sec.	11 seconds	Seed 30	Backed
5	81 Sec. to 86 Sec.	5 seconds	Seed 23	Backed

The 1-second and the 5-second exposures are the best plates. They were developed with metol-hydrochinon developer. The structure of the corona is well shown on both plates. It is composed of interlacing rays radiating from the sun, giving a strong resemblance to the aurora. Some streamers are very much brighter than others

and can be traced a distance of two diameters of the sun, over a million and a half miles. Those about the poles, the so-called polar fans, are very distinct and strong. At the north pole, they seem to be longer and not so sharply curved, and apparently more numerous, while at the south pole they are sharply curved, especially toward the west. The western half of the corona is full of detail. Three distinct, petal-shaped extensions radiate from the center, covering an arc of about 120 degrees. One quickly thinks of the appearance of the petals of a white wild rose. This petal-like formation has been observed in many previous eclipses, but its structure has not been so apparent. It is made up of these bright rays which seem to bunch around the sun-spot zone. The dark rifts described in our textbooks are very probably the spaces between these petal-like formations.

Two slightly curved rays, extending from the southwest quadrant, cross at a very definite, measurable angle. The eastern streamer has many straight rays, a little brighter than the general corona, extending through it at small angles to its general direction. Three remarkably bright prominences stand out over the moon's disc at approximately 120 degrees apart. One of the most remarkable features, and, so far as I know, one which has not been observed in previous photographs, is the arching of the corona around the prominences. The upper eastern prominence, which is the highest, has three arches, one above the other, but not in the same plane. The lower western prominence has still larger arches, but slightly fainter. A small prominence is located near each pole of the sun.

The 40-second and 11-second exposures were sent to Professor Barnard at Yerkes Observatory, who very kindly consented to develop them for me. As was expected, the 40-second plate was badly overtimed, indeed to such an extent that the prominences were reversed. Professor Barnard stated in a letter to me that he did not know of a similar occurrence in eclipse negatives. The corona is nearly lost in the sky effect.

The 11-second plate is much better, but not as good as the shorter exposures.

Plate No. 5 is quite interesting. As noted above, I stopped the exposure promptly at the 86th second, although the signal to stop had not been given by the timer. The chromosphere is distinctly visible at the western edge of the moon's disc and is reversed, that is, light in the negative. At either end of the arc of the chromosphere is a prominence. The one at the southern end is extremely

delicate in structure, resembling the skeleton of some prehistoric bird.

The unexpected brilliancy of both the prominences and the corona was the universal comment of all observers. The apparent indenta-

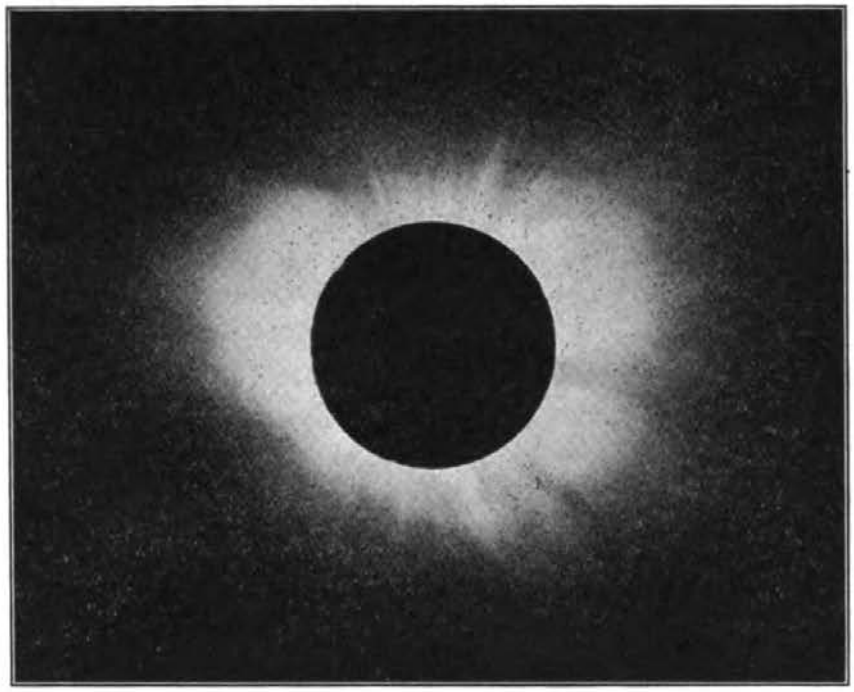

FIG. 134.—Plate No. 2. Exposure five seconds, $5^h\ 24^m\ 03^s$ to $5^h\ 24^m\ 08^s$.

tion of the moon's disc at the base of the prominences was so conspicuous that the bystanders were eagerly inquiring the cause.

THE WEATHER

The weather conditions on the day of the eclipse caused much anxiety. The day dawned with a cloudless sky, as most days do at this time of year in Colorado. The forenoon passed without the appearance of a cloud to mar the peace of mind of the observer or that beautiful blue firmament of which those western mountains alone can boast. A very gentle wind blew from the north, shifting slightly to the northeast. About noon, the usual white cloud banks began to appear on the horizon. By two o'clock, the sky was well dotted with large, cumulus clouds. It was dramatic, at least for the observers, as one by one these beautiful forms floated lazily over the sun. About four-thirty, thin cirrus clouds began to gather low on the western horizon. Several times between first and second contacts, the sun was completely hidden behind these slowly-moving

clouds. However, not more than five minutes before totality, the sun came out between two great cumulus clouds and a large rift in the cirrus cloud bank floated leisurely over the sun. It was the most precious bit of blue sky, I think I have ever seen. My first photograph shows a trace of the haze on the eastern limb of the moon. The other plates, however, do not indicate the slightest trace of a cloud. The fourth contact was observed through rather thick haze.

The darkness did not seem as intense as I had anticipated. The observers seemed to have no difficulty in reading the faces of their watches. This is easily accounted for, not only by the comparatively short duration of the eclipse, for we must remember that the sun is still shining some forty miles away, but by the cloudy condition of the sky as well. The clouds seem to reflect the light into the shadow path. Just before totality, the temperature fell 5°F. The air felt very much like the air in a low swale or hollow at night. The prairie owls came out and gave their cries, and the night hawks circled overhead. I heard distinctly the roosters at a nearby farm house crow several times after the shadow passed.

The phenomenon of the approaching shadow was a disappointment to all. No distinct outline was seen, either in the distance or just at the moment of totality. Like a flash, the sun's light went out and we found ourselves in darkness. The receding shadow was more conspicuous. The sunlight seemed to be chasing the shadow over the distant hills. The weird, unnatural appearance of the landscape, which was so notable before totality, did not follow the re-appearance of the sun.

HISTORICAL

Solar eclipses, like many other astronomical phenomena, occur with a regular periodicity. All eclipses occurring at the same node at intervals of eighteen years ten and a half days form what is known as a series. Using the eclipse of June 8, 1918, as illustration, we find that it is the forty-first of a series which started as a very small partial eclipse near the south pole on March 10, 1179 (See F. E. Seagrave's article on "Recurrence of Solar Eclipses" in "Popular Astronomy," May, 1918), and that it has re-occurred every eighteen years, constantly increasing in magnitude until it became annular on June 4, 1323. The first total eclipse in this series was on April 25, 1846, and they will continue to be total until August 22, 2024, after which they become partial and disappear about the year 2278. We have therefore just celebrated the forty-first birthday of a

phenomenon which gives substantial promise of living to a ripe old age.

It must not be inferred, however, that the entire earth is visited by eclipses only at such long intervals. Indeed, we have on the average forty-one solar eclipses in a single eighteen-year period, and of those about ten are total. But since the shadow track is not wide—from fifty to one hundred miles, in general—a total solar eclipse at any given locality is a rare sight, occurring on an average about once in three hundred and sixty years.

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