Observations of the Total Solar Eclipse of August 30th, 1905.

By John A. Miller, Indiana University.

Early in the year 1905 the Observatory of Madrid published detailed information regarding the eclipse that was to occur on August 30th of that year. Among other things this "Memoria" contained the results of a long series of observations of the prevailing meteorological conditions of many stations well distributed along the path of totality in Spain. The state of the sky in the immediate vicinity of the sun had been observed daily from 12:30 to 1:30 p. m. (the time at which the eclipse occurred) from the 15th of August till the 15th of September. The results of these observations, as well as the data gathered by the regularly established meteorological stations, touching the mean relative humidity, mean temperature, the velocity and direction of the prevailing winds, etc., had been tabulated. From these data it appeared that the probability of clear weather in the eastern half of the belt was exceptionally large, and indications for good eclipse weather were perhaps best in the regions near Ateca, Almazán and Daroca. The eastern half of the belt of totality in Spain held about 50 eclipse stations, established by astronomers from every nation of Europe, from the United States, and Mexico. The Lick Observatory expedition was located near Ateca; the United States Naval Observatory at Daroca. The observers from Kirkwood Observatory, Indiana University, Bloomington, Indiana, chose Almazán, Spain a small town northeast of Madrid in the Province of Soria. The approximate position of this station is longitude=13 m. 56 sec. W. of Greenwich, latitude=41° 10′.

The party consisted of Professor W. A. Cogshall, of Indiana University; Messrs E. C. Slipher, F. A. Cruli, and C. J. Bulleit, students of the university; Professor A. F. Kuersteiner, Mrs. Miller, and myself. We were assisted in the manipulation of our instruments on the day of the eclipse by Mr. and Mrs. Charles W. Thompson of California, and Señores Louis Nebot, Francisco Jodra, Victor Jiemenez, and Esteban Milla, of Almazán.

The observations planned were: (1) Photographs of the corona; (2) a photographic search for intra-mercurial planets; (3) a photograph of the spectrum of each of the flashes, and a photograph of the spectrum of the corona during totality.

For photographing the corona we used four different cameras. The first was a "tintype" lens kindly loaned us by Mr. Spratt of Bloomington. It has an aperture of two and one-half inches and a focal length of eight inches. Three plates were exposed in this camera and on them we hoped

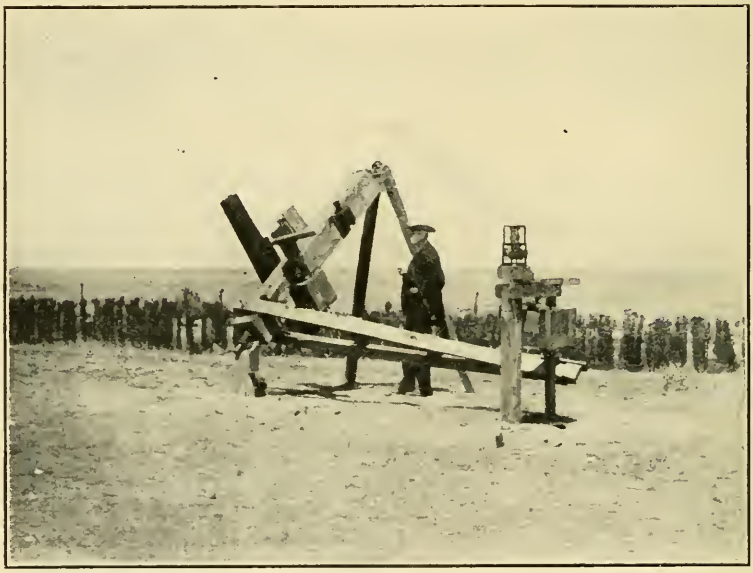

Fig. I. The Polar Axis Carrying the Short Focus Cameras.

to get long, faint coronal streamers. The second was a portrait lens of the Petzval pattern, of five inches aperture and focal length twenty-eight inches. This is an exceedingly good lens and gives superb definition over a small area and is very rapid. In this camera we exposed five plates, varying the exposure from two to 84 seconds, hoping to get detail of the outer corona and in the longer exposures to detect the presence of faint streamers. The lens of the third camera is the visual objective of the old telescope used by the late Professor Kirkwood and others for many college generations. Its diameter is three and one-half inches and its focal

length fifty inches. In this camera we exposed four plates. These three cameras, together with a spectroscope, were mounted on a wooden polar axis that was built at the camp.

The objective of the fourth camera has a diameter of nine inches and a focal length of 60 feet. This lens was constructed by Mr. O. L. Petitdidier. The front lens is of the ordinary crown glass, and the back lens of a boro-silicate flint. Quoting Petitdidier from a letter to the writer: "From the point of view of constants they (the pieces of glass) leave nothing to be desired, as the proportional dispersion is practically the same in all parts of the spectrum, so that we should have a perfect achromatic." When the samples of the boro-silicate came, however, it was found that it had a decidedly yellow tinge. It was found also that its composition was unstable, and that it oxidized very rapidly in the presence of moisture. After a conference with Mr. Petitdidier, however, we decided to have our lens made of the boro-silicate flint, and to seal it in an air-tight box as soon as it was finished, and to open the box only a few days before the eclipse. Petitdidier had much difficulty in polishing the lens, owing to the fact that it oxidized so rapidly. He found after much experimenting, a solution that would remove the oxidation without affecting the surface. It was with some misgiving that we shipped the lens, but we found on opening it that it had not tarnished in two months, and the surface on the day of the eclipse was as perfect as the day the lens was finished. The air was very humid on the days following the eclipse, and the boro-silicate flint had begun to tarnish slightly when the lens was packed for shipment home.

This camera was mounted horizontally and fed with a coelostat. A light-tight tube, the outer and inner walls of which were of white canvas and building paper respectively, and which were separated four inches, led from the objective to a dark room in which the plates were exposed. Neither the plates nor the lens was in contact with the tube. The entire instrument was covered with an A tent of white canvas. The plate-holders containing the plates were fastened to a large hexagon, which the operator could revolve at will upon an axis which was parallel to the earth's axis. It was provided with a stop which enabled the operator to bring the plates for the successive exposures quickly and accurately into position. All the slides had been drawn from the plate holders before totality began. The hexagon as well as most of the mechanical parts of

the coelostat, were designed and constructed by Professor Cogshall. Six exposures were made in this camera, of duration one-half second, two seconds, forty seconds, one minute, fifteen seconds, and one-half second. The plates used were Seed's 27, gilt edge, heavily backed.

If there be intra-mercurial planets, and if they, as do all other bodies of the solar system, move in the plane of the equator of the body around which they are revolving, and, if they are from the sun about the distance

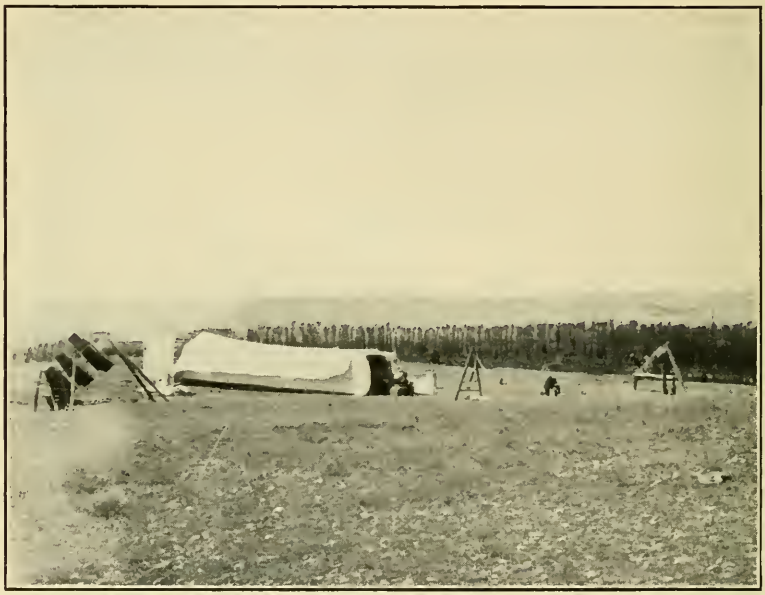

Fig. II. General view of the camp. Intra-Mercurial cameras to the left, the sixty-foot camera in the center and short focus cameras to the right.

required by Bode's Law, the major axis of their apparent paths as seen from the earth on the day of the eclipse should have subtended an angle of 23° and the minor axis about 3°. We decided to photograph this region in duplicate. For this purpose we used six cameras of 136 inches focal length, four of which had an aperture of $3\frac{1}{2}$ inches and were made by Petitdidier, and two of which had an aperture of 3 inches. These were built by the Alvan Clark and Sons Corporation. These lenses were corrected for the minimum focus $\lambda = 4750$, which is well within the region for which the Seed 27 plates, which we used, are most sensitive. All

the cameras were mounted on the same polar axis. They were mounted in pairs, each pair covering in duplicate six and one-half degrees, so that the three pairs covered in duplicate a region along the sun's equator twenty degrees long and six degrees wide. By a series of experiments we had found that a plate exposed in one of these cameras for three minutes and forty-five seconds, at a time when the sky was as dark as

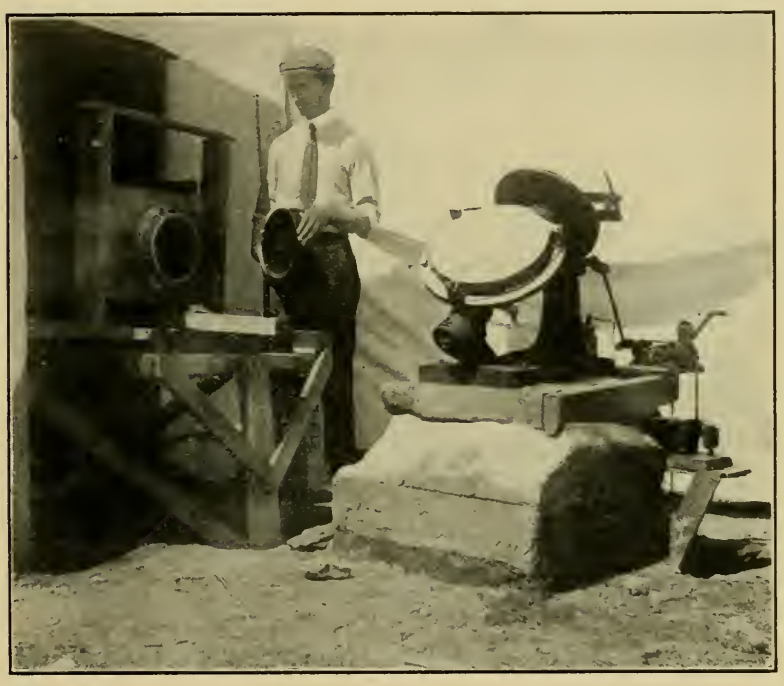

Fig. III. The coelostat and nine-inch lense of the sixty-foot camera.

it was estimated it would be at the time of totality though fogged somewhat by the skylight would show more and fainter stars than if exposed for a shorter time. We had made exposures varying from one to four minutes in the vicinity of Regulus when it was near the meridian beginning when Polaris was just visible to the unaided eye. We decided to expose the plates for the intra-mercurial planet for three minutes and twenty seconds.

The weather on the day of the eclipse was disappointing. For two hours before totality the entire sky was covered by light, though unbroken, clouds. At the time of totality, however, the clouds in the immediate vicinity of the sun appeared to break away, and the inner corona shone through light, drifting clouds. No clear sky was visible, however, within several degrees of the sun, neither Mercury nor Regulus could be seen from this station. During the morning a moderate wind prevailed, the general direction being W. N. W. The first contact was, neglecting seconds, at 11:41. The weather conditions during the eclipse, as observed and recorded by Mr. Thompson were as follows:

Local M. Time.	Temperature.	Direction of Wind.	
11:41	First contact	.....	Very slight wind.
12:00	18°5 C.	N. W.	Very slight wind.
12:15	18.2	N. W.	Very slight wind.
12:30	17.1	W. by S.	Wind dying away.
12:45	16.1	No wind.	
12:59	Totality	began.	No wind.
1:03	Totality	ends.	No wind.
1:06	15.0	S. W.	Very slight wind.
1:15	15.0	W.	
1:30	15.5	W.	
1:45	16.0	W. N. W.	Wind increasing.
2:00	16.5	W. N. W.	Brisk wind.
2:15	17.2	W. by N.	Brisk winds.
2:21	Eclipse	ends.	

Considering the weather conditions, our plates are very satisfactory. The shortest exposure, showing the prominences, suffered very little. The very bright group on the eastern edge of the sun is particularly well defined, and the negatives made of it with the long-focus camera hold a wealth of detail. The longer short exposures with the long-focus as well as the short-focus cameras show considerable coronæ detail, while the longest exposures have that part of the corona uncovered by the clouds much overexposed, while the clouds made it impossible to register any extended streamers. All the plates lack the definiteness that would have

resulted from good seeing. The longest extension of the corona that we obtained was about three-fourths the sun's diameter.

The exposures of one-half second with the 60-foot lens showed the prominences overexposed, while the exposure of two seconds was too short to register more than a suggestion of the inner corona. The exposures given in the 50-inch camera, viz., 24 seconds, 29 seconds, 184 seconds, and 25 seconds, were about right, and the results obtained with this

Manuel, The Carpenter.

lens are more satisfactory than any others with the short-focus lenses. The exposures given in the portrait lens, viz., 2, 24, 29, 84, and 16 seconds, were too long. All plates exposed except the fourth in the portrait lens, which was a lantern slide, were Seed 27, and all were heavily backed to prevent halation. Of the small cameras the negatives of portrait lens, suffered most, because the part of the corona that we hoped they might contain was covered by the clouds. The negatives made with the fifty-inch camera are particularly good and hold a wealth of complex detail. An examination of these negatives shows that the coronal struc-

ture is more complex than in 1900. In particular that the polar streamers instead of being radial, are bent and interlaced, and in every case long coronal streamers are above the prominences.

The plates exposed for the intra-mercurial planets are heavily fogged, as one would expect from a sky covered with bright clouds, but not so badly as to obscure faint star-images. I believe that a plate of the sensitiveness of the Seed's 27, which we used, can be exposed three minutes

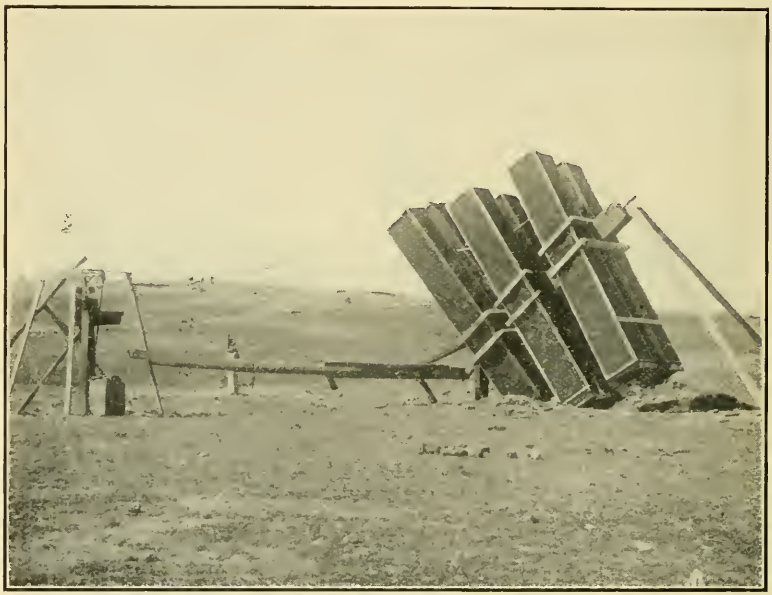

Fig. IV. The Intra-Mercurial Planet Cameras.

without serious fog at a time of a total solar eclipse. Our sky was so cloudy that it is unreasonable to expect star-images on these plates. We examined two of them hurriedly (the ones on which Regulus should have appeared), but found no star-images. The photograph of the corona on one of the intra-mercurial plates showed longer extension than on any other plate we exposed—due perhaps to the shifting of the clouds during the long exposure.

The corona impressed me as being brighter than in 1900. The effect on the clouds of the light from the eclipsed sun was peculiarly striking, and from a spectator's point of view was very beautiful.

The indescribable deep blue of the great clouds, bordered with what any one but an eclipse observer would call a silver lining, was totally unlike anything I have ever seen, and was strikingly beautiful.

The expedition is under many obligations. The Indiana University, The Indianapolis News and the Reader Magazine bore the expenses of the expedition. While the authorities of the university and the managers of the News gave kindly counsel and aid, Professor Cogshall, conjointly with the writer, worked incessantly for the success of the undertaking from the beginning to the end. Messrs. Slipher, Crull and Bulleit were with us three weeks before the eclipse occurred and rendered daily and indispensable assistance; while the entire staff of observers contributed materially to the success of our plans. The Spanish government admitted our instruments free of duty, the alcalde (mayor) of Almazán rendered timely and efficient aid in the selection of the site for our camp, and in the protection of our instruments. Benj. H. Ridgely, American Consul-General at Barcelona, manifested in every way a kindly and intelligent interest in the work of the expedition.

Corona of August 29, 1905, exposure in the Kirkwood 50-inch camera, magnified.