ECLIPSE PHOTOGRAPHY

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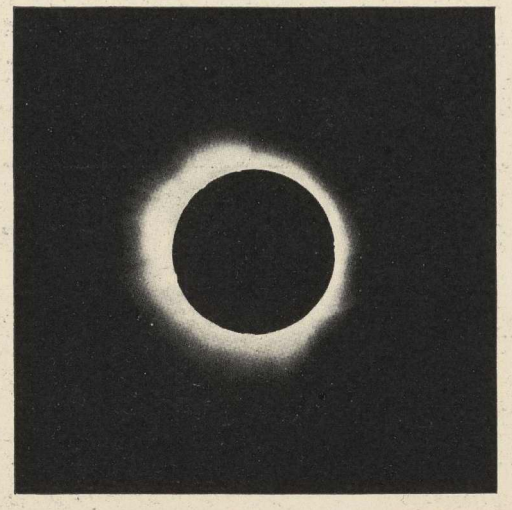
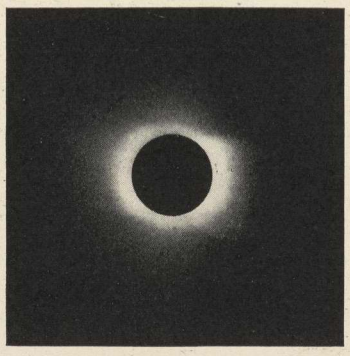
When parties are being formed to go to Labrador or abroad to observe the coming eclipse, I wish that some enterprising person would charter a cannon ball express scheduled to start from near Hudson's Bay on the morning of August 30, and that at sunrise (the conductor's "All aboard") we might speed down the track of totality in company with the moon's shadow across the Atlantic, through Spain, Tunis, and Egypt, ending our three-hour trip in Arabia at sunset, the shortest yet grandest day of our lives. Such an experience would give as much time for observation as if one had witnessed every total eclipse of the sun for a century. When contemplating the richness and importance of the results, it is hard to realize that the entire duration of totality of observable eclipses has been only about thirty minutes since photography has been actively employed. The earliest photograph of a total eclipse was a daguerreotype made by Busch at Koenigsberg in 1851, although eclipse photography is generally regarded as having begun some nine years later, in 1860. The devices employed have ranged from a kodak and a simple wooden camera propped up on the box in which it had been packed, to a telescope 135 feet long, and to what may be called the machine gun of photography, a battery of cameras, spectroscopes, polariscopes, etc., all under the control of a pneumatic commutator, by which hundreds of exposures may be made automatically during the precious period of totality, without fear that some observer will lose his head and forget to uncap his instrument.

Two of the leading features of the work on the present eclipse will be the search for an intra-mercurial planet, and a more complete study of the corona. From certain irregularities in the motion of Mercury, it has been suspected that there might be a small planet very near the sun, which would not be ordinarily visible on account of the intense light. The Lick Observatory, for example, will take photographs at three different stations, in Labrador, Spain, and Egypt, with instruments identically alike. With such instruments Professor Perrine photographed stars as faint as the ninth magnitude, at the eclipse of 1901 in Sumatra. A long, narrow strip of sky was covered with a duplicate set of plates on either side of the sun. A comparison of these plates with each other showed what objects were really celestial, while a comparison with other plates of the same regions made with the same instruments some months previous indicated the known stars. In spite of the clouds which interfered, the general result may be summed up, that for the region examined there appeared to be no planet as bright as the fifth magnitude, and for two thirds of this region none as bright as the seventh magnitude. It is hoped that the present eclipse will settle this question. It is an interesting fact that, if observations are obtained at the three stations, and a planetary body is found on all the plates, not only will the discovery be confirmed, but the lapse of time between the observations will permit the path of the new member of our system to be readily computed.

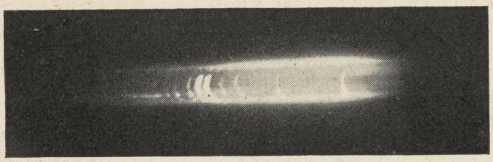
Photographs of the corona of considerable size and taken at widely separated stations will have great value in determining any change of structure which may have occurred during the



CORONA OF 1893.
HARVARD ECLIPSE PARTY, CHILI



CORONA OF 1900. MR. C. A. R. LUNDIN
AT SOUTHERN PINES, N. C.

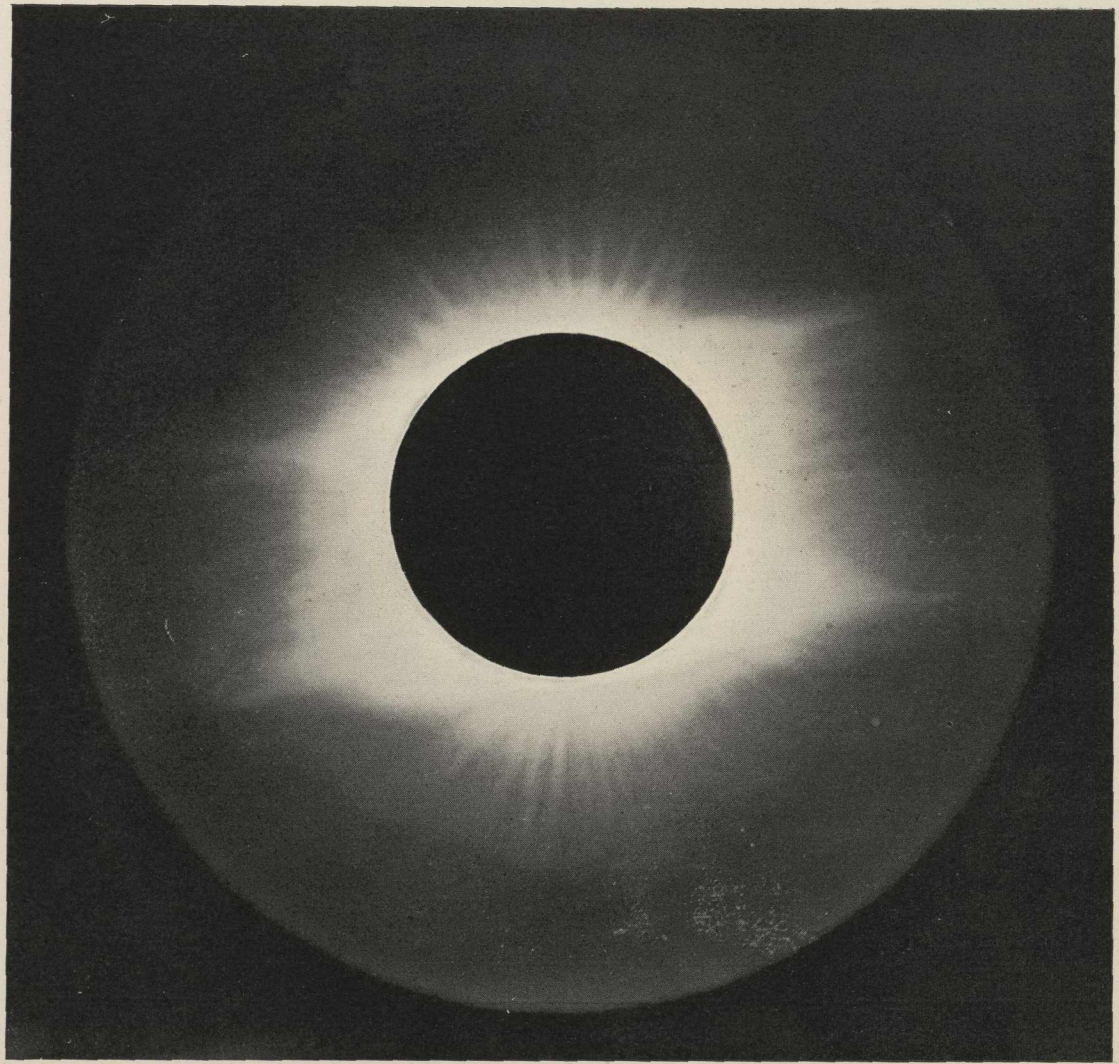


FLASH SPECTRUM OF 1893.
HARVARD ECLIPSE PARTY, CHILI

intervening hours, or in detecting any general movement, such as a rotation with the sun. It has been suggested that photographs thus taken with similar instruments might advantageously be studied with the stereoscope, which would give a plastic effect. That the form of the corona does change materially in time is shown by the photographs obtained at different eclipses. It appears to bear a distinct relation to the eleven-year period of sun spot frequency. At the maximum of sun spots the form is nearly circular, and the streamers are more equably distributed, as in the eclipse of 1893; while near the sun spot minimum the equatorial streamers are much more prominent and long wings appear extending out from the zone of sun spot activity, as in 1889 and 1900. It may be expected that the present eclipse will be similar to that of 1893, and that there will be no long streamers.

Ordinarily no one photograph can do the corona adequate justice, as a short exposure will give details only near the edge of the moon, while an exposure of sufficient duration to show the extension of the long rays completely obscures the inner structure. A perfect photograph should be a composite, or should have the length of exposure automatically graduated to correspond to the distance from the sun. The latter plan is that of Mr. Charles Burckhalter of the Chabot Observatory, California. At the eclipse of 1900, by means of a system of revolving diaphragms placed in front of the plate and centered at the point occupied by the moon's image, he obtained the most beautiful photographs of the corona as a whole that I have ever seen.

In the photograph of the corona of 1893 there may be seen near the edge of the moon certain bright masses that differ materially from the fleecy structure of the corona. These are what are called the prominences, scarlet masses of glowing hydrogen gas, which, with the silvery white of the corona, make the phenomenon of a total eclipse so beautiful. Until 1868 the prominences, as well as the corona, could only be observed at total eclipses. By means of the spectroscope, however, it is possible to separate the light emitted by these "red flames" from the light of the sky, and in this way they may be seen or photographed on any clear day without an eclipse. Many have been the attempts to do the same with the corona. While the outer parts apparently shine by reflected light, those nearer the sun shine more or less by their own light,



CORONA OF 1889 HARVARD ECLIPSE PARTY, WILLOWS, CALIFORNIA

and exhibit a bright green line in the spectrum. The best hope appears to be the effectual separation of this line from other light. Experiments have been made with the spectroscope, with special light filters and screens to cut off the intense glare of the sun, and at stations located on high mountains where the atmosphere would be less troublesome, but to date there has been no assured success.

For the observation of such a phenomenon as the "flash" spectrum, lasting only a few seconds, photography is peculiarly fitted. The spectrum of the sun as usually seen consists of a band of colored light crossed by dark lines, but at the moment when the moon has just covered the photosphere, or the luminous part of the sun which we ordinarily see, a sudden transformation takes place, and the lines, hitherto dark, become bright on a darkened field. This was first seen by Professor Young in 1870, and is due to what is called the "reversing layer," a thin stratum of incandescent gases overlying the photosphere. The phenomenon will be studied not only by plates exposed in a fixed position for the period of its manifestation, but by moving plates which will record all changes as they transpire. In the accompanying illus-

CRESCENT SUNS ON PAVEMENT DURING ECLIPSE OF 1898 AT BOMBAY

tration of the "flash" spectrum it is seen that the lines are curved. This will be explained when we remember that, as no slit is used in the spectroscope, they will necessarily take the form of the crescent of light at the edge of the moon.

Another interesting application of photography to eclipse work is the observation of the progress of the phenomenon, including the record of the contacts. The Smithsonian party at the eclipse of 1900 used a lens reduced to a very small aperture for this purpose. The images were received on a plate that was moved every second, and thus they furnish a complete record of the advance of the moon over the sun's disk. The result is very striking — the line of crescent suns growing thinner and thinner until they disappear at the total phase, to reappear about two minutes later in inverse order. Such an instrument is within the reach of almost every one, with the exception perhaps of the automatic device for moving the plate. It is not really necessary to use a lens, as a mere pinhole will answer. In fact the trees on the streets furnish us with myriads of natural pinhole cameras, every interstice between the leaves forming crescent-shaped suns on the ground and pavements. A photograph of a surface covered with crescents makes a pleasing contrast with one having the round images that are seen on other occasions. Moreover we do not need to go far from home for this observation, as even here in New England the moon will cut into the sun's disk by about three quarters of the diameter.

A feature of the partial phases is the sharpness of the shadows. This is the necessary result of the decrease in the area of the illuminating surface. Shadows in views taken under such circumstances have something of the appearance of those made by an arc light. Straight lines cast shadows according to their inclination to the crescent, ranging from sharp to diffuse, an interesting form being at an oblique angle, when there is a dark nucleus found with a penumbra of unequal width on either side.

A photographic record of the eclipse, whether total or partial at the place of observation, can be made by exposing a sunshine recorder to the sun for a period covering the entire duration of the phenomenon from full brightness to full brightness. The recorder can be made very easily out of cardboard after the Pickering pattern. It is really a small pinhole camera and consists essentially of a half cylinder about two inches in radius and about five inches long. On the inside a sheet of blue-print paper should be placed against the curved surface; the pinhole is made in the flat surface opposite. The box is set so that the axis of the cylinder will point approximately to the pole star, and then rotated on this axis to such a position that the image

R. DUEHRKOOP

THE IRIS BORDER

of the sun will fall on the center of the blue-print paper at the middle of the eclipse. These experiments may be made several days previous, and the box fixed firmly in the correct position. A blue-print having been exposed throughout the eclipse, the trace of the sun's image on the print will indicate the variation in the light, and when fixed will be a permanent record. If it is desired to mark the time, it is only necessary to cover the pinhole for two minutes and make a corresponding record, which may be written later opposite the intermission produced in the trace of the sun.

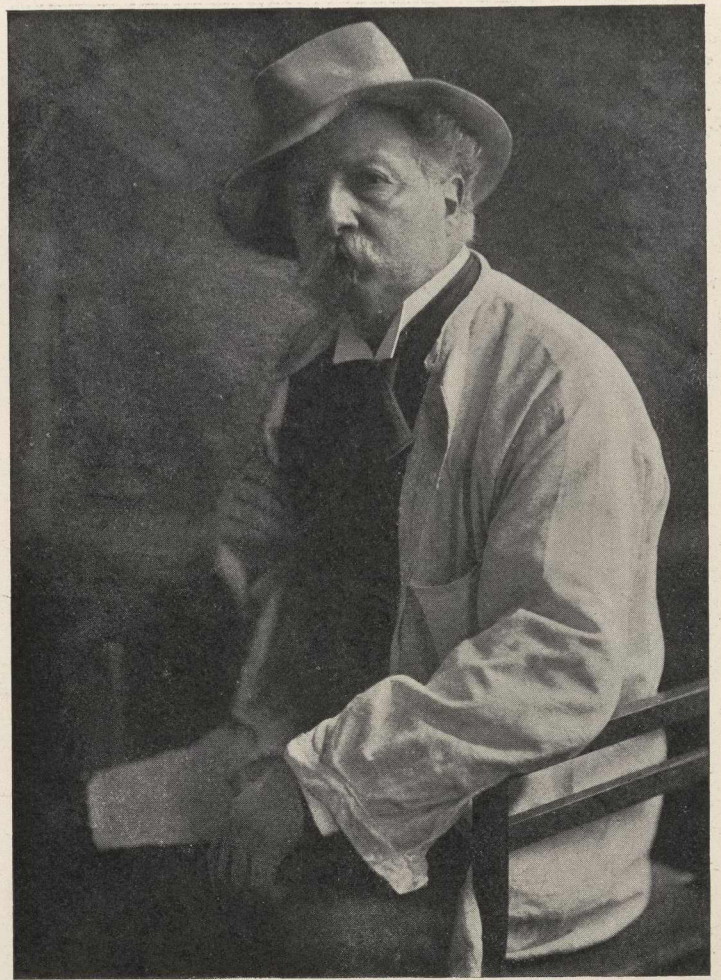
To the amateur who goes abroad, I would say first of all, enjoy the eclipse. Nevertheless, as a souvenir of the occasion would be pleasant, I would take some pictures, no matter how small might be my camera. In some cases small cameras may do more than large ones, provided they have ample angular aperture. For example, Mrs. Maunder at the eclipse of 1898, with a lens of $1\frac{1}{2}$ inches aperture and 9 inches focal length, obtained a photograph of the corona which showed a streamer extending about $6\frac{1}{2}$ diameters of the moon from the moon's limb. At the same eclipse a camera of 0.8 inches aperture and 8.8 inches focal length, exposed for fifteen seconds in a fixed position showed a streamer of 5 diameters of the moon in length, in addition to showing the planet Venus on the same plate. In the present eclipse Mercury will appear as a crescent near the sun, and may be possibly photographed. If the camera has considerable focal length, the exposure must be shorter, unless one has an equatorial mounting and a driving clock, as the movement of the image on the plate due to the diurnal motion will destroy the definition. If one is an enthusiast, it might be possible to improvise a mounting. The head of a turning lathe has been pressed into service at out-of-the-way stations, and I have felt that much might be done with the steering gear of a bicycle. In general, however, I should set my camera up in a fixed position, and give exposures from 5 to 20 seconds. In all cases have

R. DUEHRKOOP AT THE WINDOW

a definite plan made out in advance, and practise to see if you can make the necessary changes of holders, etc., in the required time. It is more expeditious not to draw the plate slides completely, but to leave them in position to thrust home quickly. Care should be taken not to get "rattled," and it is here that force of habit comes to one's assistance. At the eclipse of 1889 an accident at the beginning of totality disconcerted me, and after the eclipse was over, I could not remember whether I had drawn a single slide. Yet on development I found that all the plates had been properly taken. Now a word about plates, — any good brand will answer, but it would be well to have them "backed," and to develop them for contrast.

The risk of failure on account of clouds should be considered from the start. In fact, it is so great a risk that many do not care to spend their money for eclipse work. Harvard, for example, is not sending out an expedition, but is assisting others by the loan of apparatus. If, then, the day is cloudy, try to take it philosophically, remembering that the science of meteorology does not yet permit the "weather man" to make his predictions so far ahead or with the accuracy of the astronomer. Moreover, fate is kind; we shall have a total eclipse of the sun right here at home in New England, — in 1925.

R. DUEHRKOOP
IN THE GARDEN



R. DUEHRKOOP AN ARTIST