

PHOTOGRAPH OF SHADOW BANDS

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Reprinted for private circulation from
THE ASTROPHYSICAL JOURNAL, Vol. LXIII, No. 3, April 1926

PRINTED IN THE U.S.A.

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By A. E. DOUGLASS

ABSTRACT

The author's earlier experiments in *photographing heat-currents and atmospheric waves* indicated that the apparatus could be used also for photographing the *shadow bands* at a *total solar eclipse*. This was accomplished on *January 24, 1925*, at Middletown, Connecticut, with the author's apparatus, under the auspices of the expedition from the Harvard Astronomical Laboratory.

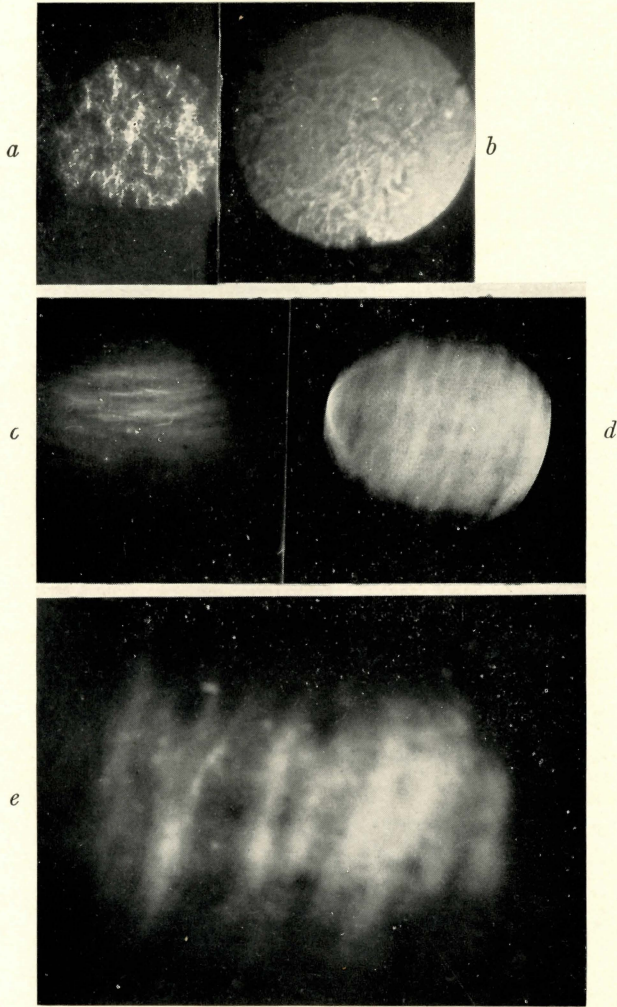
Some years ago the writer made extended studies of atmospheric currents. As this work progressed, attempts were made to photograph the waves or nodules of varying density in the atmosphere. A very faint impression was obtained by direct exposure of a plate to a distant locomotive headlight, using a crude focal-plane shutter. A device was then arranged for increasing contrasts, and successful photographs were made of heat currents over candle, lamp, etc., and of the atmospheric waves in daytime under full sunlight (Plate XIa). This apparatus consisted essentially of a concave silver-on-glass mirror of 12-, and later, one of 13-inch diameter. The beam from an arc light was reflected by the mirror and brought to a focus, and was then allowed to pass some inches beyond to the photographic plate. Close in front of the plate, or at the focus, was placed the shutter. This combination produced an out-of-focus image of the source of light, and in this image the heat currents were reproduced with greatly increased contrasts.

It was recognized at that time that shadow bands could be photographed in this manner. The writer had observed that phenomenon in previous total eclipses, and had noted its relationship to the direction of the solar crescent. Its explanation as an atmospheric phenomenon modified by the shape of the source of light seemed probable. To test this a photograph of artificial shadow bands was made. The solar crescent was represented by a suitable crescent cut in black paper. The diameter of the artificial sun was 1 foot and its distance was 100 feet from the photographic apparatus. The illumination came from a large mirror, behind the crescent, reflecting sunlight. The concave mirror and photographic plate were

placed in a room darkened as much as possible. A lighted lamp was placed under the beam of light. When the source of light was very small, for example, a quarter-inch circle, the heat currents over the lamp appeared just as they had been photographed; but, when the long thin crescent was used, the currents were modified so that they appeared lengthened in a direction parallel to the crescent, and much other detail was lost. Plate XI*b* shows the heat currents over the lamp taken in this way, and *c* shows the result on using the thin crescent. The heat current in the latter contained undoubtedly the very same sort of waves as before.

That experiment years ago fixed the writer's opinion as to the atmospheric origin of the shadow bands, but the actual shadow bands had not been photographed, and after the eclipse of 1923 it was recognized that there was still some doubt of their cause in the minds of some astronomers. Accordingly, in January last, on return from an eastern trip, I prepared an apparatus which used a 13-inch mirror in the manner described above. This mirror, with its mounting, was forwarded to Middletown, Connecticut, to Dr. H. T. Stetson, of the Harvard Astronomical Laboratory. It was placed by him in charge of Mr. David P. Mann, chief mechanic of the Jefferson Physical Laboratory, who was assisted by Mr. Gell. Mrs. Stetson did the counting of time during the eclipse. A dozen exposures were made in the five minutes including the total phase, four of these during totality. The only one showing shadow bands was made immediately before totality, when the diminishing crescent of the sun was approximately 40° long (Plate XI*d* and *e*). Exposures, when the crescent was 70° and 100° long and over, did not show the bands. It is evident that the interval for obtaining good results is short, and one must seize just the right moment while the solar crescent is thin and short. Of course, as the source of light is disappearing, the quantity is decreasing with the greatest rapidity, and at the same moment the definition and contrast of the bands are improving with equal speed. Evidently this method could be nicely adapted to a moving-picture camera in which the speed of very rapid exposures can be fully controlled. A moving-picture of shadow bands would give a very full record of them and supply meteorological data of unusual kind.

PLATE XI



- a*, Atmospheric currents in full sunlight (1901)
- b*, Heat waves over a lamp (1901)
- c*, Artificial shadow-bands (1901)
- d*, Shadow-bands photographed at Middletown, Connecticut, January 24, 1925
- e*, Enlargement of *d*, showing about 9 inches of width

Figure 1 shows the apparatus as arranged for photographing shadow bands. The full aperture of the mirror is exposed to the sun, and the film box is in its outside position so that the actual focus comes at the front (right) end of the box. A very crude homemade shutter was used at this point. The film was of the ordinary type for a small camera, and was mounted so as to turn from the outside. A small telescope was fixed to the top of the camera box to serve as finder. A screen was placed near its eye-end so that the sun's image

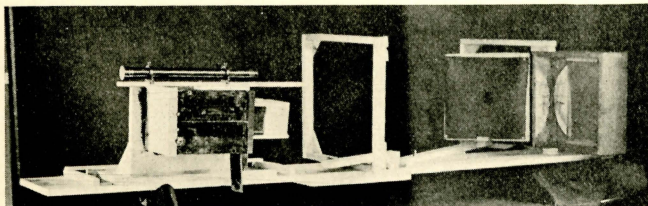


FIG. 1.—Shadow-band camera, 1925. At the right is the 13-inch concave mirror in the box, with movable 3-inch diaphragm near it. At the left, film box with finder attached.

could be watched. As soon as totality began, the aperture of the mirror was reduced to 3 inches by a movable diaphragm, and the film box was moved nearer the mirror so that the film itself was at the focus. In this position a picture of the corona was obtained. When totality was half over, the apparatus was returned to the shadow band arrangement.

Mr. Mann and his associates had only one day before the eclipse for going over the voluminous directions for setting up and operating this apparatus and for practice with it. It was due entirely to their skill that a picture of these very faint bands was obtained.

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October 27, 1925