A POLARIZATION-COLOR EFFECT IN THE K-CORONA

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(Received 18 June, 1971)

Abstract. An observation of the corona during the 7 March, 1970 eclipse through a Wollaston prism-red and blue filter combination was carried out for the purpose of confirming the prediction that the component of the K-corona with electric vector radial to the Sun is redder than the tangential component. An analysis of a portion of the resulting data seems to confirm this prediction, and also indicates that the method is useful for determining the three-dimensional configuration of the very inner corona. A three-dimensional configuration is suggested for a portion of the NE quadrant of the Sun, including the large NE streamer and an adjacent low-lying loop.

1. Introduction

Our observations of the 7 March, 1970 eclipse, made at Hampton, Virginia, were for the purpose of checking the prediction by Billings (1966) that the component of the K-corona with its electrical vector radial to the Sun should be redder than that with its electric vector tangential. This effect is a consequence of $E$-radial radiation being stimulated by oblique, hence limb-darkened photospheric radiation, whereas a part of the radiation scattered in the $E$-tangential component leaves the photosphere normal to the solar surface. Since the color difference is most pronounced in the lowest part of the corona and drops off very rapidly with displacement of the coronal material from the plane of the sky, a second objective of our observations was to investigate the possibility of mapping the three-dimensional configuration of the material seen near the limb—a region in which the polarization, as used by Saito and Billings (1964) for getting a three-dimensional configuration, has an ambiguous relation to the azimuth of the scattering material.

2. Observations

The results of our computation of the variation of the color effect with azimuth of the scattering material and height of the line of sight above the limb, a description of the apparatus which we used, a discussion of our method of calibration and a sample of the photographic results of our observations have already been published (Billings, 1970). Briefly, four Wollaston prisms, two covered by a red and two by a blue filter were placed in the camera, a few inches in front of the focal plane of the 9 inch cassegranian telescope at the Langley Research Center. The prisms were so located and oriented that by taking eight exposures during eclipse totality each portion of the first 100 000 km of corona directly above the limb of the Moon could be observed under four conditions: with the $E$-parallel image thrown outward and the $E$-perpendicular image inward and visa-versa, through each color filter. In our observations we succeeded in getting eight $\frac{1}{8}$ s exposures and three $\frac{1}{8}$ s exposures during totality.
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Fig. 1. A ½ s exposure of the corona through the Wollaston prism arrangement. The prisms are held together by pieces of fused quartz through which the corona has its normal appearance.

Figure 1 shows one of the ½ s exposures. The longer exposures proved to be more useful for photographic photometry.

3. Method of Analysis

We took the ratio:

$$\rho = \frac{E\text{-radial intensity, red}/E\text{-radial intensity, blue}}{E\text{-tangential intensity, red}/E\text{-tangential intensity, blue}}$$

to describe the difference in the colors of the two polarized components. From our computations we concluded that $\rho$ should be 1.10 for a coronal feature in the plane.