Polarization Study of the Solar Corona Using Double Polarigraph

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Abstract

The Double Polarigraph, used in the total solar eclipse of 16th Feb. 1980 to study the Polarization of Corona at two wavelengths, is described briefly. The negatives are being studied and the results will be published in due course.

The light of the solar corona is highly polarized. This polarization is due to Thomson scattering of the photospheric light by the free electrons present in the corona. Many attempts have been made to determine the polarization and thereby caclulate the electron densities. [von Kluber (1958), Koutchmy and Schatten (1971), Khetsuriani (1972), Saito and Hata (1964), Pepin (1970), Nikoloskii and Sazanov (1970), Ney et al (1961), Durst (1976) etc.] A general model for the electron densities is given by van de Hulst (1950). But the complexities and the discrepancies in this data indicate the necessity of additional work.

The polarization of corona during the total solar eclipse of February 16, 1980, was studied. A double polarigraph was designed and fabricated entirely at the Nizamiah Observatory, Hyderabad. This was successfully used during the total solar eclipse of February 16, 1980.

INSTRUMENT

The essential feature of the instrument is that the polarization data can be obtained at two wavelengths and thus the variation of polarization with wave length can be studied. In addition to the polarimetric studies, the instrument can simultaneously be used for the photometric study of the corona.

The instrument consists of two lenses having equal aperture of 10 cm and focal lengths 150 cm and 130 cm. These are fixed side by side in a wooden box (Fig. 1), the distance between their centres being 15 cm. Two filters, one red and the other blue, are placed before the lenses. The filters are chosen to be at two extremes of the visible spectrum. The peak transmissions of blue and red filters are at 4200Å and 7000Å respectively.

Camera : The camera is fixed at the end of the box, such that the film is placed exactly at the focal plane. This detachable camera can be loaded with two 120 size films simultaneously and at any instant, these two films can phtograph the corona through the two filters. A centralized gear system with a knob is used to move both the films at the same time. The motion of the central knob itself will give an indication of how much the film is to be moved between the exposures.

The shutter is placed just in front of the film. This consists of a metal sheet, which is to be operated manually. The inside of the camera is shown in the Fig. 2.

Polaroid disk : Just in front of the camera a polaroid disk is placed. This disk has four holes, three of them are fitted with polaroids and the fourth one is kept empty for the direct photograph. The arrangement of polaroids is shown in the Fig. 3. The disk is so arranged that at any instant, any two diagonal holes will be in the path of the light beam. By turning the disk through 90° the other two will be in the path. Thus starting with one position and turning the disk successively through 90°, the whole sequence is completed in one rotation. During this time each film will photograph the corona four times-three of them through the polaroids oriented 120° apart with each other and the fourth one direct. These can be compared to get polarization and also electron densities in the corona.

All these parts are fitted in a wooden light tight box of size 183 cm x 38 cm x 12 cm. All the movable parts i.e., polaroid disk, shutter and motion of the film, can be operated from outside the box.

The inside of the box is painted black with matt paint to reduce the scattering and baffles are placed for both the beams. A small finder telescope is fitted to the side of the instrument. The projected image of the Sun from the finder on a ground glass and the image of the Sun through the main instrument are aligned. The finder telescope was a great help in bringing the solar image at the centre of the field of the main instrument and also to check whether the object remains at the centre.

This instrument was attached to the 48-inch telescope of the Japal-Rangapur Observatory from where the eclipse photographs are taken.

The instrument was tested by taking the photographs of the moon and also the Sun. After taking

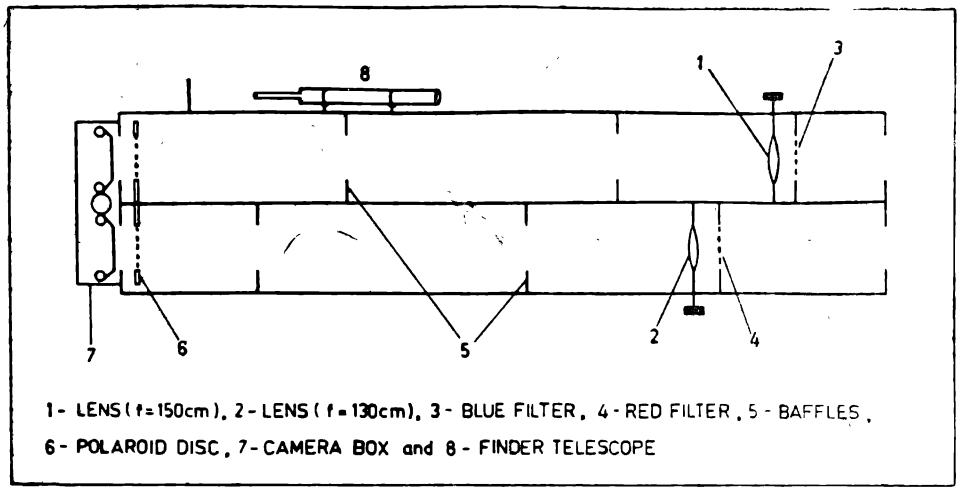

Fig. 1. Schematic diagram of the Double Polarigraph.

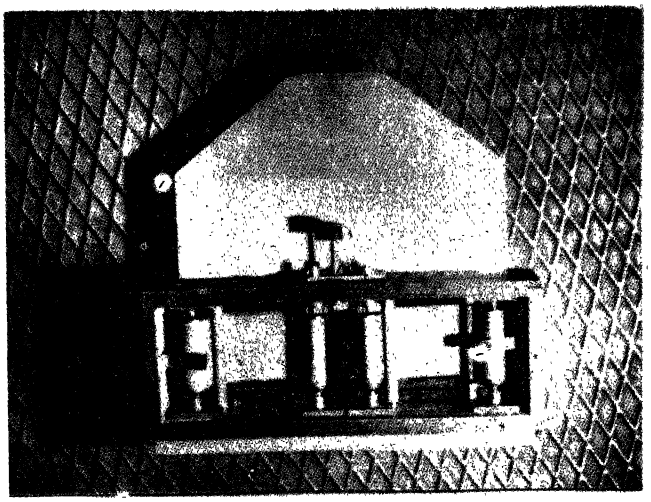

Fig. 2. Photograph of the Camera.

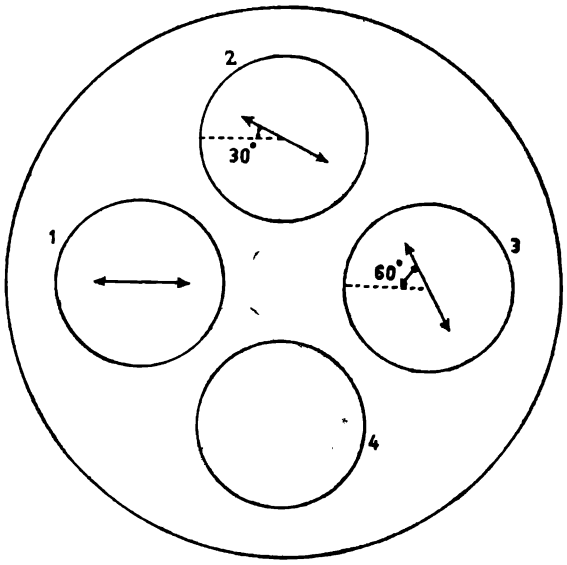

Fig. 3. Arrangement of Polaroids in the polaroid Disc.

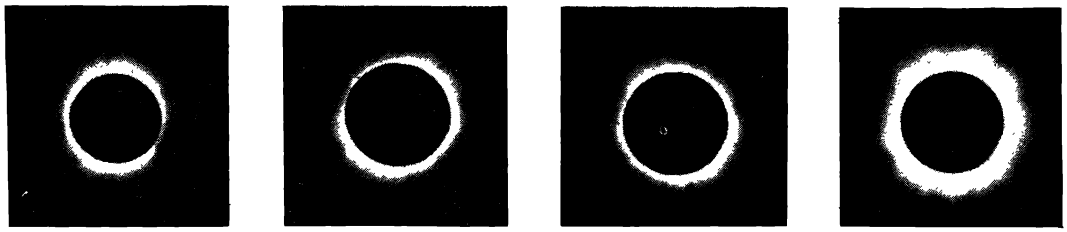

Fig. 4. Photographs of the Solar Corona with polaroids (1,2,3) and without polaroid (4).

several test exposures the suitable exposure times for photographing the corona were obtained. It was found that a series of 4 sec exposures would be sufficient to study the inner corona and 10 sec for the outer corona.

Focussing was done a day earlier to the eclipse. Rough adjustment was done visually and the final adjustment was done by the photographic method, by photographing the Sun at various positions of the lens. Thus best focus position was obtained.

The calibration was done by using a 20 step wedge. The Sun, whose brightness was reduced by a known amount using neutral density filters, was photographed through the step wedge, under the identical circumstances. The above exposure times and the same optical system were used for the calibration also.

The day started with clear skies, but in the afternoon many clouds could be seen. Fortunately, during the totality the sky was absolutely clear around the eclipsed Sun and the whole sequence of operations went on as planned.

The eclipse films and calibration films were developed on the 17th and we obtained good photographs of the corona (Fig. 4). The negatives are being studied by using a Joyce Loebl microdensitometer of Regional Research Laboratory of Hyderabad and the results will be obtained within the next few months.

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