Observations of Coronal Velocity Field, Flash Spectrum and Shadow Bands During Total Solar Eclipse 1980

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Abstract

Observations using a multislit spectrograph at 5303Å Fe XIV line were obtained during the 16 February, 1980 total solar eclipse, for velocity field determination in the solar corona. A colour movie film of the flash spectrum was obtained using an objective prism coupled with a telephoto lens and the intensity fluctuations of the shadow bands have been photolectrically observed.

INTRODUCTION

During the total solar eclipse of February 16, 1980, the following three experiments were conducted from Japal-Rangapur Observatory campus:

(1) To determine the coronal velocity field using a multislit spectrograph,

(2) to obtain a movie of the Flash spectrum in colour, and

(3) to determine the period and intensity fluctuations of shadow bands.

DETAILS OF EXPERIMENTS

(i) Coronal Velocity Field.

An improved knowledge of the coronal velocity field is basic to an understanding of the dynamics of the Sun's atmosphere. Observations made so far indicate, that the velocity field is made up of two components—a rotational velocity and a random velocity. The picture that emerges is of an inner corona rotating as a solid extension of the photosphere with outward streaming elements. This experiment was designed to measure the line of sight component of the coronal velocity field using the 5303 Å line of Fe XIV.

A multislit Littrow spectrograph with 5 slits was constructed for taking simultaneously spectra in the coronal line of 5303 A, extending to 1 to 2 solar radii around the Sun. A 200 A passband filter centered at 5300 Å was placed in front of the slit to act as a blocking filter to isolate the 5303 Å emission line. The linear dispersion of the spectrograph was 5.2 Å/mm near 5303 Å in 2nd order. The light of the Sun was directed from a 8-inch coelostat to a 6-inch aperture f/13, horizontal telescope, forming a 20 mm diameter solar image on the multislits separated by 15 mm. Out of the 5 slits, two slits were blocked to decrease the scattered light in the spectrograph. The solar image was centered, so that one of the slits crossed almost parallel to Sun's E-W line and one slit near the Sun's northern hemisphere and the other beyond the southern limb of the Sun in the corona. Only one spectrum during the totality, with an exposure of 120 second was obtained on II-a-D Eastman Kodak plate and a comparison spectrum of mercury lamp was given, so that the green line at 5461 Å acts as a standard line for Doppler shift (velocity) measurements. The plate was intensity calibrated using a standard Hilger step wedge.

Figure 1, shows a print of the spectrum. The coronal emission line 5303 Å was recorded only on two slit positions, one crossing the Sun's disk near the disk centre and other near the northern limb. The third slit was unfortunately positioned too far out in the corona and therefore did not record the 5303 Å line. On this spectrum, the coronal line appears upto a maximum of about 1.5 solar radii from the limb. Detailed measurements of the coronal velocity field is in progress.

(ii) Flash Spectrum Colour Movie.

During the few seconds before the second contact and after the third contact the flash spectrum of solar chromosphere is visible.

We have obtained a movie of the flash spectrum, on Eastman colour negative film, at a rate of 24 frames/second, using a 60 degree objective prism and a 210 mm focal length f/4.0 lens to yield a dispersion of nearly 80 A/mm at Hγ in the range from 6563 Å upto 3900 A. A total of 300 good spectra have been obtained before and around the second contact. Flash spectrum was missed after the totality (3rd contact) due to delay in starting the movie camera. A frame by frame analysis of the movie film is in progress, to determine, at high spatial resolution, the height variation of the length of arcs of emission lines. The colour movie sequence gives a spectacular view of the appearance of the chromospheric emission lines.

(iii) Photoelectric Photometry of Shadow Bands.

Just before the totality, conspicuous bright and dark bands have been observed on the ground, these shadow bands are known to travel randomly at high speed. Several attempts have been made in the past to photograph these shadow bands, but due to high speed and low light level, it has not been possible, except for one photographic record on the wing of an aircraft. Our attempt was to measure the light fluctuations using photocells and recording at high speed.

Three photocells were placed on the ground to form an equilateral triangle, each separated about 45 cm apart and were connected to a four channel fast strip chart recorder, with a built in amplifier. A chart speed of 50 mm per second was used to record the intensity fluctuations of the shadow bands. Out of the three channels, one performed very well, while the other two did not during the eclipse. A record of the light intensity variation in one channel is shown in Figure 2. Preliminary analysis of the record indicates that the frequency of the shadow bands was about 4 bands per second. Visual observations by several observers at Rangapur, indicate that the shadow bands were wavy in appearance and traveled extremely fast from north-west direction and were separated approximately by about 8 to 12 inches. The bands were quite conspicuously visible on dull brownish gravel ground and also on white surfaces.

This experiment was conducted in collaboration with Prof. R.V. Bhonsle, of the Physical Research Laboratory, Ahmedabad.

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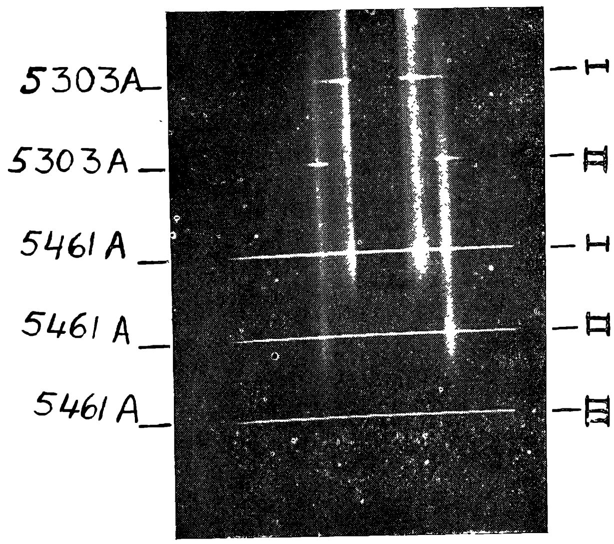

Fig. 1: Multislit coronal spectrum in 5303 Å line and comparison spectrum of Hg 5461 Å: The 3 slits are marked on the top as I, II and III.

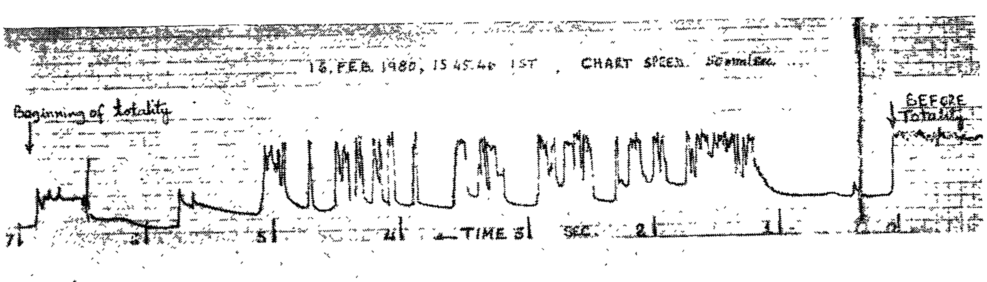

Fig. 2: Photo-electric tracing of the intensity fluctuation of shadow bands.