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Broad Band Photometry of Solar Corona during the Total Solar Eclipse of October 24, 1995

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Abstract

A 30 cm coelostat, a red broad band filter, and a 15 cm objective providing an f/15 beam were used to obtain high resolution pictures of the white light solar corona. In one of the frames, the presence of a loop structure is recorded with its top around 2 R_O, in the near north polar region. The nearest YOHKOH soft X-ray picture shows the presence of a coronal hole with its border apparently beneath the loop structure. The preliminary results are discussed.

Key Words : Total solar eclipse, White light corona, Polar coronal loop

Introduction

Observations using satellite borne telescopes in EUV and X-rays have revealed an entirely new scenario of the highly structured and 'dynamic' solar corona (Kahler, 1992). White light coronagraph observations have been carried out by Skylab, Solar Maximum Mission and Spartan satellites adding to the diversity of phenomena observed (Fisher and Guhathakurta, 1994). However, ground based observations in optical region during total solar eclipses continue to attract the solar observers to study the structures in corona and correlate them with photospheric and chromospheric features on the solar disc.

The sky condition at Kalpi in Northern India (longitude : 79° 44' E, latitude : 26° 07' N) during the period of totality was photometric. High resolution broad band photometry was one of the four major experiments set up at the camp site. The expected duration of totality at Kalpi was 52 sec starting 03 06 23 UT (Singh, 1995). However, due to the exceptionally long durations of the spectacular diamond rings, the actual duration turned out to be around 48 sec only. As a result of this, the frames obtained towards the beginning and ending phase of totality recorded the diamond ring. However, three excellent frames could be obtained during totality. In this paper, the details of observation and reduction procedure of the data are discussed and the preliminary results are presented.

Linear polarization measures during the totality were obtained by Srikanth *et al.* (1997) from a different location. It is proposed to combine our intensity estimates with their polarization values to derive the electron density distribution in the corona during the eclipse.

Observation and results

An independent 30 cm coelostat and second mirror system was set up and aligned at site to track the Sun onto a 15 cm achromat. The f/15 beam provided a 2 cm image which could be photographed on 70 mm film using a film transport. A broad band red (RG 2) filter was used near the objective and the image was recorded on Kodak 2415 film. Calibration exposures were obtained on the previous day and the day of eclipse using ND filters. The films were later processed at the Kodaikanal Observatory. The 1/2, 2 and 10 sec exposures were digitized using the PDS system at Bangalore. The NOAO / IRAF software package was used for image processing and analysis.

The solar minimum corona with equatorial bulges is immediately evident in all the frames and also striking are the polar plumes and coronal streamers. The heliocentric angular extent of the streamer / plume dominated region is significantly high with a range of about 110° in the North and about 75° in the South around the polar regions. The 1/2 sec exposure gives the inner details while the 2 sec exposure goes to about 1.8 $R_\odot$ (i.e., 0.8 $R_\odot$ above the limb) in polar region and upto 2.5 $R_\odot$ in the equatorial region.

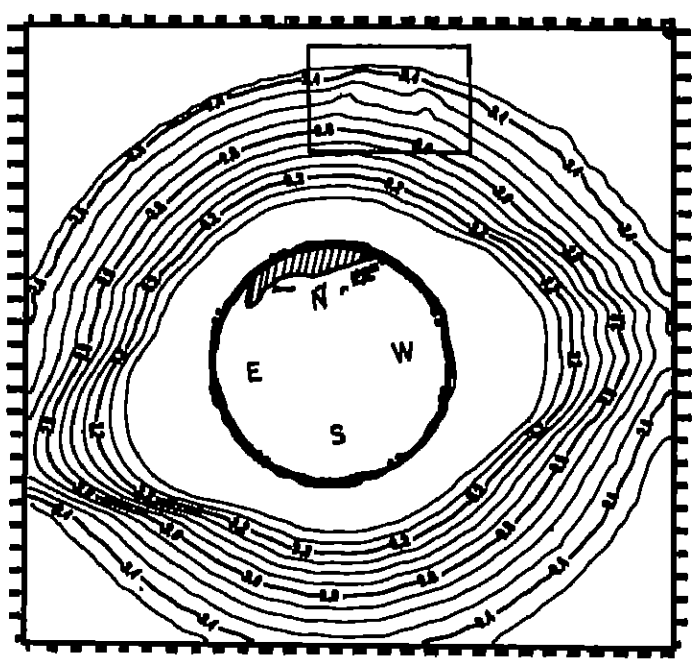

Figure 1. White light isophotes of 24 Oct. 1995 corona observed from Kalpi at 03 07 UT. The polar loop structure shown by the isophotes is highlighted in a box. The shaded portion is a coronal hole seen by YOHKOH. 'xxx' marks the H-alpha filament observed at Kodaikanal Observatory. The remaining filament markings are from Sacramento Peak Observatory data for the following day.

In the 10 sec frame, the corona extends to about 2.2 R_O in polar region and to about 3.0 R_O in equatorial regions. One of the white light isophote frames is shown in Figure 1. The N-S and E-W directions are marked in the Figure and the equatorial bulges along E-W are evident. An interesting loop feature seen in the North polar region is highlighted in a box. The loop is visible at heights of approximately 2.2 to 2.8 R_O. The isophote frame with log density range suitable to display the loop structure is shown in the Figure 1. Isophotes of white light corona extending upto 6 R_O are shown by V. Rusin (1997 *et al.*) in Figure 2 of their paper in this proceeding.

We have looked at the activity and features in the solar atmosphere which may perhaps be related to the loop structure. These have been marked in Figure 1. The shaded portion in the North polar region gives the approximate location of a long lived X-ray coronal hole recorded by YOHKOH at 08 40 UT on 24 Oct. 1995, and published in the Solar Geophysical Data (Volume 616, Part I) of December 1995. The 'xxx' mark indicates the location of an H-alpha filament observed from Kodaikanal Observatory at 14 12 UT on 24 Oct. 1995. It must be mentioned here that the relative locations and sizes of the features shown are approximate but the accuracy is sufficient for the purpose of this study.

Discussion

Our 10 sec exposure was perhaps fortuitously right to record the loop structure highlighted in Figure 1 since it was revealed after a careful examination of the intensity frames and isophotes. A longer exposure would have saturated the region and a lower exposure could have missed it. The presence of a loop structure in the near polar region was unexpected and we looked for any such reported observations in the literature, both in the white light and in X-rays, for a comparative study.

On 12 Nov. 1991, Tsuneta *et al.* (1992), using the YOHKOH Soft X-ray Telescope, observed gigantic faint loops standing up successively from East end of a coronal hole to its West end like a propagating wave with velocity of about 100 kms and height of about 2 R_O. The event surprised the observers and it was later confirmed that the region had a faint polar dark filament and also that it was actually not a unipolar coronal hole region (Uchida, 1993).

It can be seen from Figure 1 that the circumstances of solar phenomena during our observations were significantly similar to those observed by Tsuneta *et al.* (1992). The Northern polar region had a coronal hole extending East to West and a filament was lying close to the boundary of the hole on the day of eclipse. Further, on the following day, a row of filaments appear to line up bordering the hole (making due allowance for the geometrical projection effects and uncertainties in marking the features). By projecting the loop legs onto the limb and disk, we may surmise that it was probably a reconnection event across the neutral line bordering the coronal hole. We therefore conclude presently that the North polar loop structure we see is probably the white light counterpart of the SXT arcade loop seen by YOHKOH on a different occasion.

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References

Fisher R. and Guhathakurta M. 1994, Sp. Sci. Rev. 70, 262.

Kahler S.W. 1992, Ann. Rev. Astron. Astrophys. 30, 113.

Srikant R., Sharma M. and Rajaguru S. 1997, KOB (This issue).

Singh J. 1995, Bull. Astron. Soc. India 23, 3.

Rusin V., Klocok L., Minarovjech M. and Rybansky M. 1997, KOB (This issue).

Tsuneta S., Takahashi T., Acton L.W., Bruner M.E., Harvey K.L. and Ogawara Y. 1992, Publ. Astron. Soc. Jpn. 44 (5) L 211.

Uchida Y. 1993, in Physics of Solar and Stellar Coronae eds. J.F. Linsky and S. Serio, Kluwer Acad. Press, p. 97.