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Development of an Instrument Based on a Fibre-Bonded CCD Camera for Prominence Observations

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Abstract. We have devloped and tested an instrument based on a fibre-bonded CCD camera for observations of solar prominences. To record faint prominences we have used a solid aluminized glass cone which reflects bright solar disc light outside the telescope tube. The prominence monitor is installed at the back end of a 15-cm f/15 coude refractor telescope after the H-alpha filter. This prominence monitor is capable of recording prominence images at an interval of 5 sec, but during prominence eruptions it can record images at an interval of 2 sec.

1. Introduction

The term prominence is used for a large variety of objects which are characterized by their occurrence in the chromosphere and/or in the corona, by their greater density than the coronal surroundings and by temperatures ranging from about 10^4 K to coronal values at the interface to the corona. They appear as bright (cool and dense) features above the solar limb (Tandberg-Hanssen 1977). High resolution photographs of prominences show that they are made up of fine thread-like structure (Tandberg-Hanssen 1974). The observation of such fine structure in the presence of solar disc light is difficult. Solar prominences are faint coronal features and are best observed through H_α filters of passband 2 to 3Å. The formation and disappearance of solar prominences are not well understood because of the lack of homogeneous data on them. Prominences arouse considerable interest and are generally photographed by means of a prominence attachment or coronagraph. It is possible to construct a prominence attachment or coronagraph for prominence observations as described by Mazereau and Bourse (1985), Volker (1994) and Lille (1995). To reduce bright solar disc light solar observers are using a metallic stop at the prime focus and then reimaging with another lens system. Using the technique described above, coronagraph or prominence attachment systems have been developed by solar scientists at the National Astronomical Observatory, Japan; High Altitude Observatory, Boulder, USA; Mauna Loa Observatory, Hawaii; National Solar Observatory, Sunspot, NM, USA and other places. In the present paper we report on an instrument that has been developed at at the Uttar Pradesh State Observatory (UPSO) in NainiTal, India for the observations of solar prominences.

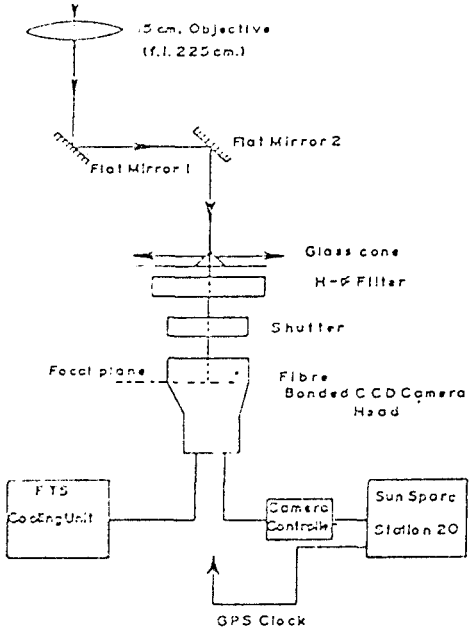

Figure 1. Schematic diagram of 15-cm Coude refractor telescope and back end instrument.

2. Design and Specifications of Prominence Monitor

The schematic diagram of the 15-cm f/15 Coude refractor telescope and back end instrument for prominence observations is shown in Figure 1.

The CCD camera system employs a thermoelectrically cooled FTS probe camera head (ambient temperature −42°C) with a TK 1024 CCD class I chip (pixel size 24 × 24 μ). The fibre-bonded CCD instrument is installed at the focus of the 15-cm Coude refractor telescope and yields a pixel size of 58.8 × 58.8 μ and gives a plate scale of 5 arcsec/pixel. The camera controller of the system has a variable readout rate of 0.5–1.0 Mpixels/sec with 12 bit resolution. The software, which controls the working of the camera controller, is installed on a Sun Sparc Station 20, 50 Hz computer having 7.3 GB disk capacity and a 14 GB cartridge tape drive. A GPS (Global Position System) clock is connected to the computer to record time with an accuracy of 1 ms in the header of prominence images. The Sun computer and software help us to record prominence data at high readout rates. The readout rate of the camera controller was set at 990 K pixels/sec because at this readout rate the CCD's dark current was found to be minimum. In Table 1 we show the salient features of the prominence monitor developed at the UPSO.

In the Table, R is the radius of the Sun and the pixels of the CCD chip are square. In Figure 2 we show the prominence monitor which includes the Sun computer, CCD camera head, H_α filter having passband 3Å and aluminized glass cone attached to the back end of the telescope. This telescope forms a 20.6 mm image of the Sun's disk at the chip of the fibre-bonded CCD having an area

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Table 1. Salient Features of the Prominence Monitor

Features	Specifications
Telescope	15-cm f/15
Wavelength	6563Å
Passband	3Å
FOV	5.8 R x 5.8 R
Plate Scale	5.0 arcsec/pixel
Fibre-bonded CCD Chip	1024 x 1024
Pixel size	58.8 micron
Size CCD chip	60 mm
Read out rate	990 kHz
Time accuract	1 ms
Computer	Sun Sparc 20

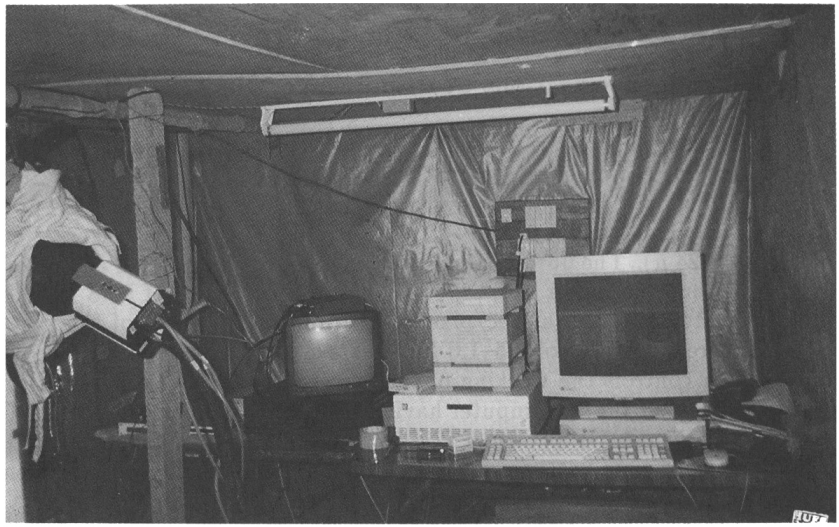

Figure 2. Prominence monitor attached to the telescope.

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60.2 mm × 60.2 mm. Therefore, each image recorded by the computer gives us a view of a prominence's extension in the corona equal to the diameter of the sun. During initial testing we could see good prominence features, but during the later stage of testing with the CCD camera head, one of the cards was damaged, therefore, we are unable to show actual photograps taken with the prominence monitor. In Figure 3 we show a photograph taken by the Fibre-bonded CCD camera during the total solar eclipse of October 24, 1995. Testing with the repaired camera head is in progress, and we are hopeful that by October 1997 we will be able to begin observations with the prominence monitor.

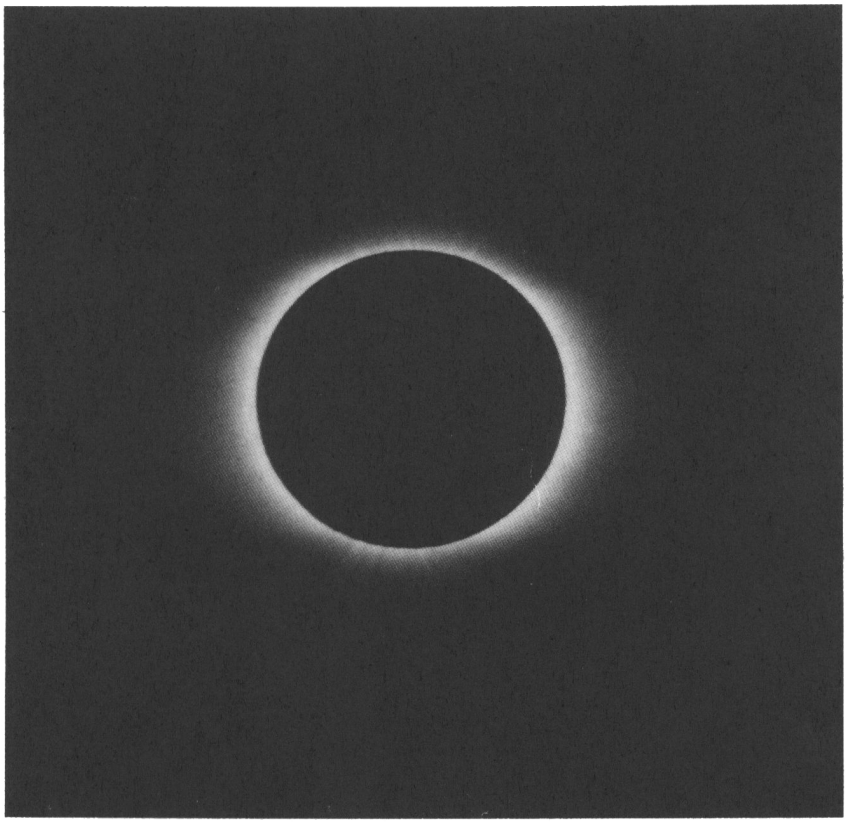

Figure 3. A photograph taken by the Fibre-bonded CCD camera during the total solar eclipse of October 24, 1995.

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