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Solar observational programs and facilities at UPSO, Naini Tal

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Abstract. We present here the overview of the solar facilities at the U.P. State Observatory, Naini Tal, which have been developed over years for the observations of solar activity phenomena. The various backend instruments and the telescope are briefly described here. The selected events recorded with the help of the above instruments is presented here to show the performance of the solar facilities at UPSO.

Key words : solar telescope–solar filters–solar eclipse–CCD camera

1. Observational programs

The solar group at UPSO is also interested in the active sun namely sunspots, faculae, plages, flares and prominences with an objective to investigate the active sun using photographic, video and CCD imaging techniques. These help us in identifying such changes that lead to flare eruption and also observations revealing stretching, shearing and twisting of the magnetic field lines. The H-alpha emission (6563 A) provides spatial information very accurately to study electron time of flight information which is crucial for determining the energy release process in solar flares. Kampher and Magun (1983) and others have shown that a component of the H-alpha emission shows impulsive variations which is coincident with microwave spikes. Important electron time - of-flight effects crucial for determining the flare energy release processes should be detectable with combined H-alpha and hard X-ray observations taken at high time resolution (Kiplinger, 1988). The expected rapid onset of the H-alpha flares compared to microwave and hard x-ray emissions will help in understanding the physical processes in flares during flare triggering. With this view, the observational programs at UPSO are as follows.

1. Registration of preflare, during flare and post flare changes on the filtergrams during the course of evolution of a flare.
2. Registration of evolution of sunspot groups and to search for situations leading to flare eruption.
3. To study in detail the evolution of quiescent and eruptive prominences and the mechanism

thereof.

4. To collect data covering the solar cycle, as far as possible.
5. To observe H-alpha solar flares with high time resolution.

2. Observational facilities and results

For carrying out the above said observational programs we have two small Coudé refractors of 15 cm diameters (focal length = 225 cm). The refractor forms about 21 mm size image of the Sun, which is enlarged to 42 mm by a barlow lens when Bernhard Halle H-alpha filter is used. Fig. 1 shows the schematic diagram of the telescope and backend equipments. Heat rejection filter is placed in front of the objective.

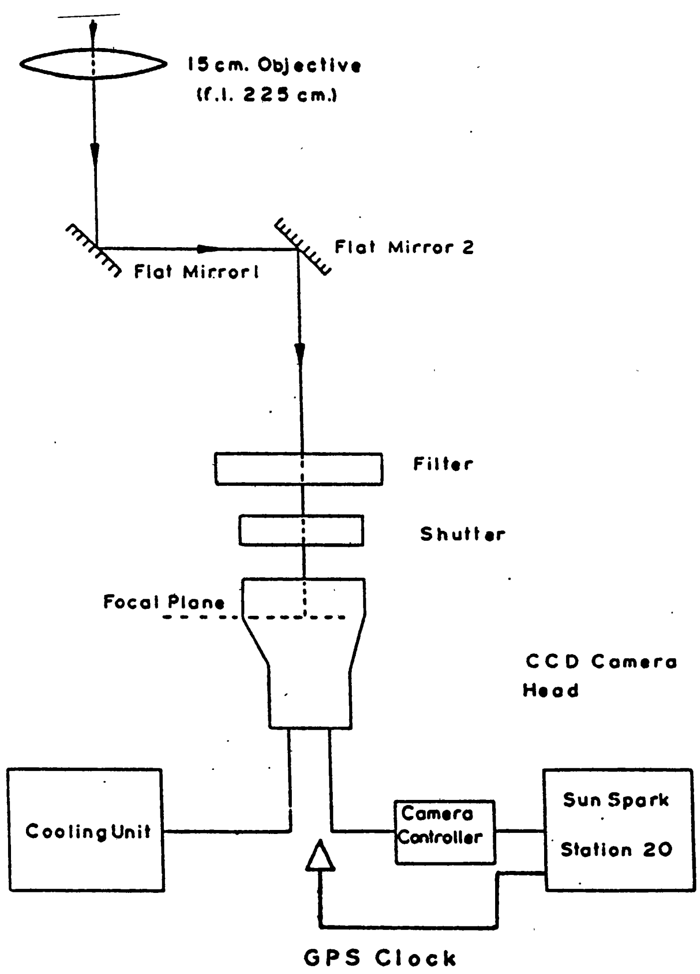


Figure 1. 15 cm Coude refractor telescope and backend instruments for solar activity observations.

For acquiring filtergrams we have the following filters :

1. Two Bernhard-Halle H-alpha filters (pass band 0.5 or 0.7 Å, central wavelength 6562.8 Å). The filter can be tuned to ± 1.0 of central wavelength in steps of 0.1 Å. For prominence observations, and to record fainter features pass band of 0.7 is selected.

2. Two Day Star H-alpha filters with 0.5 Å pass bands and tunable to ± 1.0 Å.

3. Ca II K filter with 1.2 Å pass band central wavelength at 3933 Å and tunable to ± 1.0 Å.

4. CN (cynogen) filter with 1.0 Å passband central wavelength at 3883 and tunable to ± 1.0 Å.

5. Heat rejection filters to minimize heating in the telescope tube and a set of neutral density filters for reducing the solar image intensity.

The filtergrams can be obtained photographically on the Kodak Tech Pan 2415 film with the help of 35 mm DN22 Robot recording camera and /or 35mm Olympus camera bodies. The DN 22 Robot recorder (camera) has a script generator which allows us to set date, time, exposure time, time interval between two frames, number of required frames and observer's code number. The camera thus enables us to have time lapse filtergrams with time imprints. The fastest allowed frame rate is 4 frames/ second. One of the events recorded with this camera is shown in Fig. 2.

In recent years, we have acquired the following CCD imaging systems for solar activity registration :

1. Peltier cooled CCD camera system.

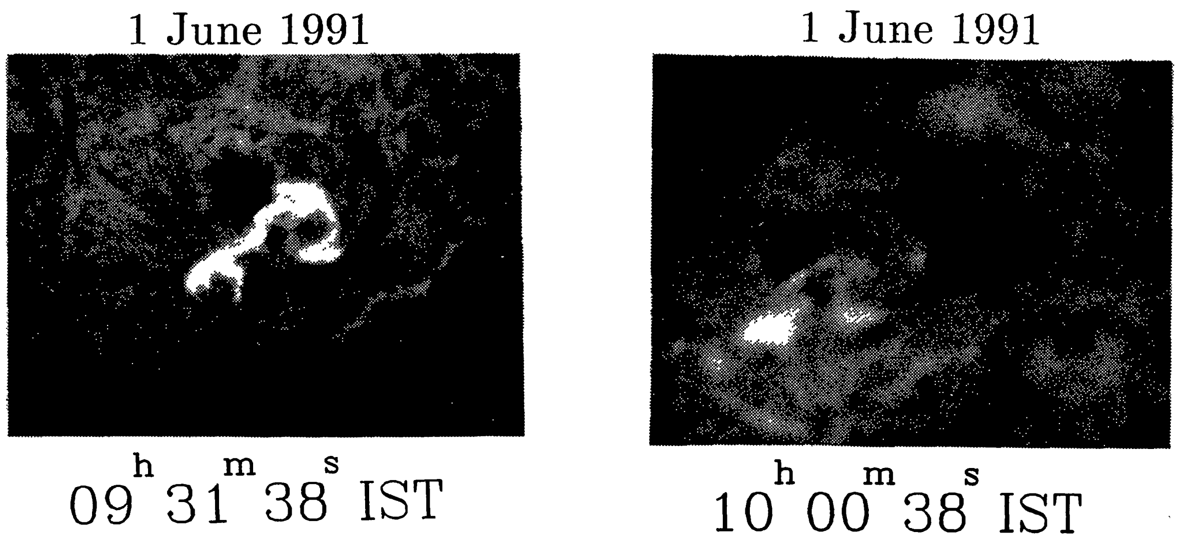
This CCD imaging system has EEV 385 × 578 pixel CCD chip (type P86231) with a pixel size of 22 × 22 microns, MK2 camera electronics and front illuminated chip with coating for extended UV response. Both full frame readout and frame transfer modes are possible. Full frame image area 8.47 × 12.7 mm corresponds to 6.3 × 9.5 arc minutes on the Sun with Bernhard Halle H alpha filter. The spatial resolution per pixel corresponds approximately to one arc second (the diffraction limited spatial resolution of the telescope). PCAT with 80386 processor running at 33 MHz, 80387 coprocessor, VGA color display unit, 4 Mbyte RAM, 600 Mbyte hard disk drive, 5.25 inch floppy disk drive, 16 bit image board, ATI software, operating system MS-DOS, 1600/3200 bpi magnetic tape drive and data storage in FITS format are other features of the system. Images or filtergrams can be obtained with time resolution of more than a second. The typical filtergram obtained from this system, shows an active region (Fig. 3).

2. Photometrics PXL High Speed Modular CCD Camera System.

This system has two camera heads for two systems. One of them can be used at a given instant.

I. Fibre bounded CCD camera system :

Thermoelectrically cooled FTS cold probe camera head has TK 1024, Class I, CCD chip (pixel size 24 × 24 microns). Each pixel of the chip is connected to a window by fibre optics in such a way that one pixel receives light from 2.45 times larger area at the window. Thus the camera head window (6.2 × 6.2 cm area) acts as 58.8 micron sized pixel with a spatial resolution of approximately 5 arc seconds. The camera controller



(a) (b)

Figure 2. (a) H-alpha flare at line center and (b) H-alpha filament eruption in blue wing.

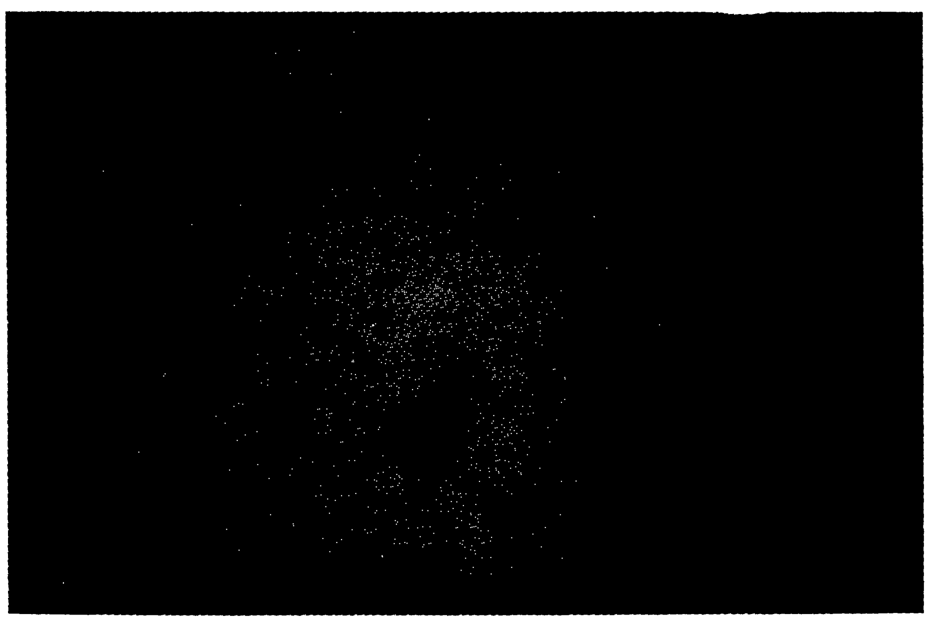


Figure 3. Active region, showing several sunspots, bright plage and fibril structure, taken on 23rd Jan. 1994 with the help of ATI CCD system.

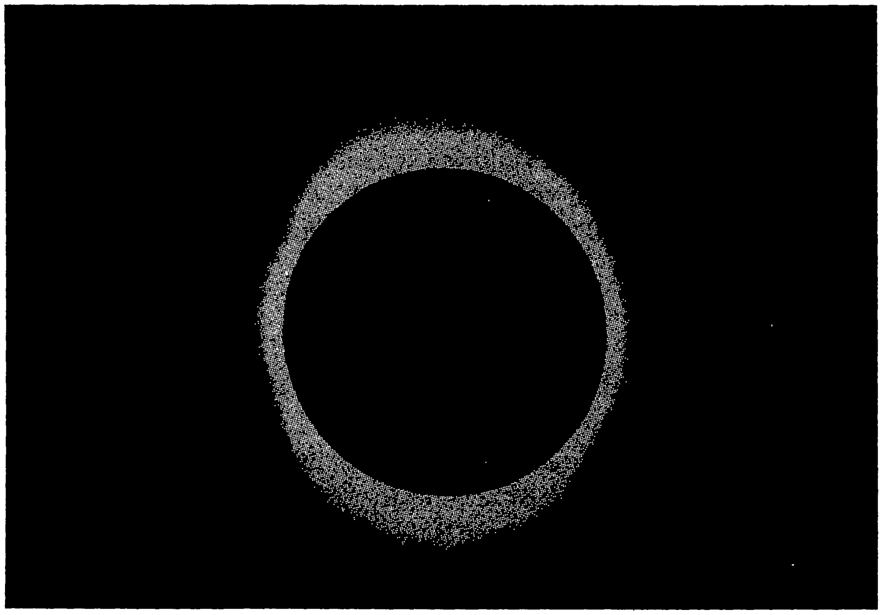


Figure 4. Corona, during total solar eclipse of 24th Oct. 1995 recorded by Photometrics TK 1024 CCD Camera.

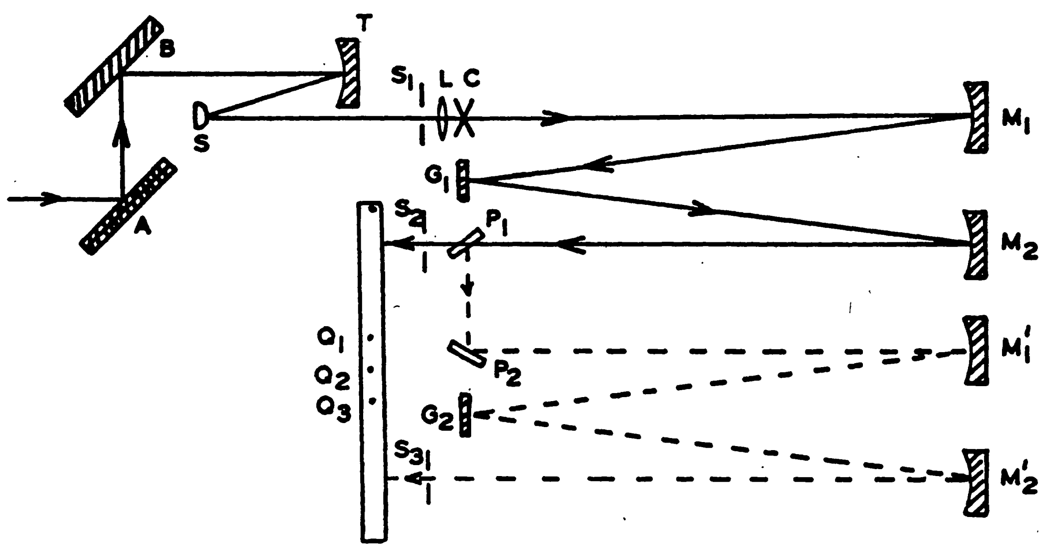


Figure 5. The principal components and features of the optical scheme adopted for the spectrograph are shown schematically.

with 12 bit digitizer has variable readout rate from 0.5 to 1 Mega pixels per second.

The system can be run by a SUN SPARK 20, 50 MHz computer having 7.3GB hard disk, 14GB cartridge drive and a sun interface software. An electro-machanical shutter, through an interface card fabricated at the observatory is used for computer controlled exposure times at the chosen instants and at the desired time intervals. The system was successfully used during the total solar eclipse of 24 October, 1995. Fig. 4 shows the image of the corona at the total solar eclipse. We have plans to use this system for prominence observations.

II. High speed CCD camera system for flare Observations :

The other camera head has EEV37 CCD chip (512 × 512 pixels, class 1, pixel size 15 × 15 microns) with a facility of frame transfer mask. Same camera controller, Sun computer software etc., are used to obtain H alpha images of the solar flares. Liquid circulation unit for cooling the camera head upto - 25C and shutter allows one to obtain solar pictures at faster rates. With 100 × 100 pixels area, solar images can be obtained with a time resolution of about 25 milliseconds or at the rate of 40 frames per second (Verma et al. 1996). Full frame images can be obtained at the rate of 5 frames/second. A GPS (Global Position System) clock is connected to Sun Spark 20 computer to record time on the header of the picture frames with an accuracy of 1 ms.

For full disk H-alpha CaII K and white light recording of the images we also have two video cameras. One of them can be connected to GPS clock for accurate time display.

A photoelectric Sun tracking telescope can be used with one of the Coudé refractors for the automatic guiding of the refractor. This automatic guider is equipped with 50 Hz servomotors for correcting both R.A. and declination axes. Attainable tracking accuracy is 1 arc sec.

A 52 cm reflector, which has two foci Nasmyth (f/13) and Coudé (f/75), is presently being used for stellar observations. The telescope has a differential drive system for stellar and solar observations. The size of the solar image is 35 cm out of which a part of the image (3 minutes of arc about 3.25 cm) has uniform illumination and can be used for observations. The spatial resolution of this telescope is 0.7 arcsecond. We have plans to modify this telescope into a vacuum solar telescope.

The observatory also possess three coelostates (15 cm, 25 cm and 46 cm aperture). The largest coelostat illuminates a 27 cm, f/66, 6 off axis skew Cassegrain telescope which forms 18 cm solar image on the slit of horizontal solar spectrograph. Fig. 5 shows schematically the telescope and the spectrograph. In single pass spectrograph the dispersion in the first order at 2.5 micron is 1.2 A/mm.

References

Kampher N., Magun A., 1983, ApJ, 274, 910.

Kiplinger A., etal. 1988, in Flare Research at the Next Solar Maximum, R. C. Canfield & B. R. Dennis, p.214.

Verma V. K., Gaur V.P., Uddin W., 1996, Proc. 7th Asian-Pacific regional meeting of the IAU, Pusan National Univ. Pusan, Korea. in press.