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Facilities for solar optical observations at IIA

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Abstract. Existing and planned facilities for solar optical observations in IIA are briefly described along with the data services, the recent results and the future prospects.

Key words : sun, instruments, observations, data-service

1. Introduction

Majority of the optical observational facilities for solar research in IIA are at the Kodaikanal Observatory which is located at an altitude of ~ 2340*m* in the Palani hills in south Tamilnadu. The latitude of the place is 77° 28' 07" *E* and the longitude is 10° 13' 15" *N*. The sky is more often cloudy than clear, but the Sun can be observed with angular resolution of a few arc-seconds on upto 300 days, (average 200-250 days) in a year. Spells of a few minutes of excellent seeing of $\lesssim$ 1" follow many showers during the winter.

The observatory was established in 1900 by Mickey Smith. In 1909 John Evershed made the sensational discovery of the material flow in the penumbrae of sunspots. A glorious tradition of solar optical observations yielding valuable data and scientific results was kept up by its Directors. In 1950's to 60's most of the senior solar physicists of the present day, (J.C. Bhattacharyya, A. Bhatnagar, K.R.Sivaraman, A.Raheem, A.P. Jayarajan, to name a few) contributed to solar research at Kodaikanal under the inspiring guidance of M.K.V.Bappu who established the Indian Institute of Astrophysics in 1971. J.Singh, P.Venkatakrishnan, S.P.Bagare, S.S.Gupta, R.Srinivasan, A.K.Saxena and many other colleagues have maintained the existing instruments for continued acquisition of the traditional data and are establishing modern facilities for the current and future research. What I am describing here in my words is the outcome of the dedicated efforts of all these scientists.

2. Facilities for solar optical observations

2.1 *Tower telescope and tunnel spectrograph*

This facility was built by Grubb Parsons, UK, in 1959 and is operational since 1962. It has the following components. The tower telescope has a coelostat consisting of two fused-glass mirrors of 61 cm aperture with a mechanical drive on the top of an 11 meter tower. At the base of the tower a third mirror of the same size reflects the incoming solar beam horizontally into the tunnel, on to an achromatic objective of 38 cm aperture with a 36 meter focus (or to an optional similar objective of 20 cm aperture). This forms a solar image of 34 cm diameter, corresponding to an angular resolution of about 5.5 arcseconds per millimetre, on the entrance slit of the main spectrograph in the tunnel.

The main spectrograph consists of the following components in a Littrow arrangement : a 20 cm objective (Hilger achromat) of 18.3 meter focus, a 20cm × 20cm Babcock grating with 600 lines per mm blazed at 5000 Å in fifth order. The original grating has recently been replaced by an identical new one. The spectral resolution is as high as upto 9mm per Å.

Another spectrograph built by A. Raheem of IIA is also installed in the tunnel. It is in Littrow arrangement with a lens of 4.3 meter focus and a 1200 lines per mm grating blazed at 7500 Å in the first order. It yields a resolution of 1mm/Å near Balmer H_α

2.2 *Double spectrograph*

This spectrograph is housed in the building where John Evershed made his famous discovery of the plasma outflows in the sunspot penumbrae, and has been in use for obtaining spectroheliograms in the CaII-K and Balmer H_α lines. It is based on the following technique invented by the famous astromoner Hale. The whole spectrograph is moved in such a way that the entrance slit scans a stationary solar image and, simultaneously, the exit slit exposes successive areas of a stationary film to the light from successive portions of the image.

The stationary image is of 60 mm diameter and is obtained using a gravity driven mirror of 46 cm diameter (Foucault siderostat) and 30 cm Cooke triplet lens.

One of the two spectographs has two prisms in Littrow arrangement giving a dispersion of ~ 7 Å/*mm* near 3930 Å. The slit passes 0.5 Å centred on the CaII-K232 line at 3933.6 Å. The exit slit of the other spectrograph passes ~ 0.35 Å centred on the Balmer H_α line 6562.8 Å.

2.3 *Hale spectrohelioscope*

This was gifted by Mt.Wilson observatory in 1933. It has a 3-inch mirror, a grating of 600 lines per mm giving a resolution of ~ 0.75 Å at Balmer H_α and an Anderson prism to rotate the view.

This has been in use for flare patrol since 1933.

2.4 *Photoheliograph*

This consists of a 15 cm refractor and a wide band filter which produces a 20 cm image of the sun in white light, and a plate holder for photographic recording of the image.

2.5 *Equipment for observations at other sites*

Optical and other equipments for site-testing expeditions, and also for expeditions for observations from Eclipse sites and from Antarctica. These include Daystar filters for CaII-K and Balmer H-alpha lines.

2.6 *Latest equipment*

1. Linear array (Fairchild CCD 1991) has been recently installed at Raheem spectrograph at Kodaikanal observatory.

2. Two 24.6 *cm* × 24.6 *cm* (1024 × 1024 pixel) Peltier cooled photometric CCD systems have been acquired for (a) modernization of spectroheliograms and (b) high spectral and spatial resolution studies of solar phenomena using the main tunnel spectrograph in Kodaikanal observatory.

3. Data and data services

Kodaikanal observatory has one of the longest records of synoptic solar observations and solar data services in the world.

The plate vault at the Kodaikanal Observatory contains the following synoptic observations on all clear days :

1. Daily white light photoheliograms since 1904.
2. CaII-K spectroheliograms and pictures of limb prominences since 1907.
3. Hydrogen-alpha spectroheliograms since 1912.

The data service provided to national and international data centres consists of :

1. Daily and monthly sunspot numbers and flare data.
2. Data on ionospheric F-regions and geomagnetic field components.

4. Important recent researches from solar observations at Kodaikanal observatory

A review of facilities should be followed by a summary of important scientific results obtained therefrom. Here is a short list of important results obtained from solar observations at Kodaikanal

in the following areas :

1. Studies of chromospheric rotation and its periodicities.
2. Variation of supergranulation cell size with solar cycle.
3. Migrations of magnetic neutral lines during solar cycles (especially the cycles before developments of magnetograms).
4. Variations of the CaII-K line profiles from the whole sun with the solar cycle.
5. Highly accurate studies of solar rotation from accurate measurements of sunspot locations (Indo-US project).
6. Relations between movements of filaments and flares.