

A fast Star-and-Sky Chopping Polarimeter

Polarimetric observations involve measurements of usually small differences between generally large intensities at different orientations of a polaroid analyzer. Such measurements are sensitive to variations in the sky transparency, scintillation noise, etc., assuming that the instrumental sensitivity does not change appreciably over the period of observations. The errors in measurements due to scintillations and slow variations in the sky transparency are minimized by chopping the signal at a fast rate.

A fast photometer-polarimeter has been developed in which the light due to star and the neighbouring sky is chopped every 20 ms. This is achieved by rotating an eccentrically placed aluminium plate with two semicircular slots in it just before the focal plane of the instrument. The separation between the two slots is 8 mm, corresponding to about 2 arcmin on the sky. A wheel carrying four sets of different size apertures (0.6 mm, 0.8 mm, 1.0 mm, 2.0 mm), each set consisting of a pair of identical diaphragms, defines the focal plane of the instrument. The separation between the two diaphragms in a pair is 8 mm. Two LED-phototransistor pairs placed adjacent to the chopper wheel provide indexes for the computer memory banks and references for the photon counter.

A schematic lay-out of the instrument is shown in Fig. 1, and isometric view is shown in Fig. 2. The light first enters an X-Y off-set guide which is based on the standard design of two-segments mirror. The next item

is a three-position slide which carries (i) a polaroid sheet, (ii) a clear hole, and (iii) a Lyot depolarizer (purchased from Optics for Research, USA). The provisions of retractable polaroid and depolarizer in the incident light path help in primary calibration of the instrument. The first optical element which the light encounters in actual observations is a high grade HNP'B polaroid sheet. The polaroid sheet is mounted very carefully between two teflon rings in a brass cell which is threaded onto a spur gear assembly fixed in a pair of precision angular-contact ball-bearings. This assembly is coupled through a 1:1 spur gear to a Slo-syn stepper motor. One step of the motor corresponds to an angular movement of 1.8°. Thus the polaroid sheet makes one complete rotation of 360° in 200 steps of the motor. If needed the motor can be programmed to jump a specified number of steps and complete one rotation in lesser number of steps. An LED-phototransistor pair located on the gear assembly precisely defines the (arbitrary) initial position of the motor. Subsequent steps are defined with reference to this index. The analyzer is immediately followed by a Lyot depolarizer to annul any spurious polarization and reduce the errors arising due to polarization dependence of photocathode sensitivity. The chopper and apertures, as explained earlier, follow the depolarizer. Finally, there are two filter wheels, each with the capability of carrying 6 filters. The first filter wheel presently carries the Fernie combination of U, B, V, R, I filters and a clear aperture. The second wheel carries four neutral density filters and two clear aper-

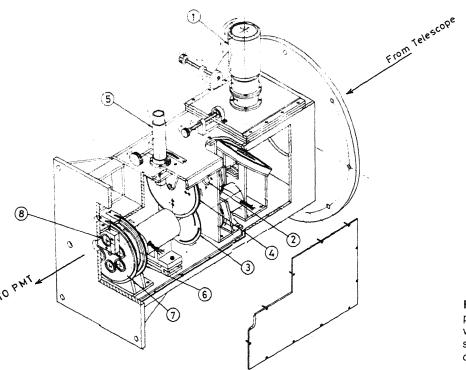


Figure 1. 1. Wide-angle eyepiece 2. Analyzer 3. Chopper wheel 4. Aperture wheel 5. Microscope 6. Filter wheel 7. Neutral density filter wheel 8. Depolarizer

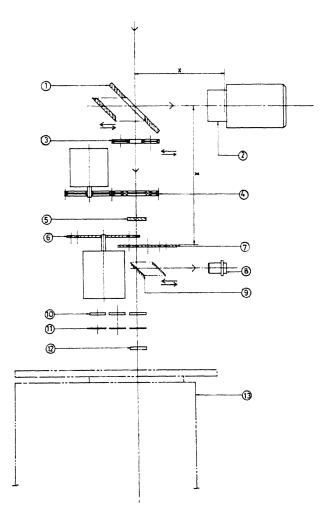


Figure 2. 1. Flat mirror 2. Wide-angle eye-piece 3. Polaroid sheet slide (clear, polaroid, depolarizer) 4. Rotating polaroid sheet 5. Fixed depolarizer 6. Chopper wheel 7. Aperture wheel 8. Microscopic eye-piece 9. Flat mirror 10. UBVRI filter wheel 11. Neutral density filter wheel 12. Fixed depolarizer 13. Photomultiplier tube housing

tures. The primary mirror of the telescope is imaged on to the photocathode of EMI 9658 R photomultiplier tube with a Fabry lens of 30 mm diameter.

The chopper is rotated at 25 Hz (*i.e.*, 40 ms for one complete rotation) with a synchronous motor. At the end of each complete rotation of the chopper, a pulse is received at the computer so that it advances the stepper motor by a predetermined number of steps. At each step, the number of PMT pulses which are proportional to starlight are recorded for 15 ms in each of star and sky channels. Signal-to-noise ratio can be built up by recording pulses for several revolutions of the stepper motor. Once the stepper motor completes the predetermined number of revolutions, the raw photon counts are displayed on the terminal as a function of the polaroid positions. This will be a double sinusoidal distribution if the star is polarized; otherwise a straight line distribution with the usual scatter will be seen. A

UNICORN microcomputer controls all the operations of the instrument, acquires the data, and does the final computations of the degree of polarization and position angle.

With some experience and care, the polaroid holding cell can be removed and the instrument can be converted into a fast photometer.

This polarimeter was tested on telescope in Kavalur on the night of 1989 January 30-31. It has since been used for regular observations both at VBO, Kavalur and UPSO, Nainital. Several standards as well as program stars were observed during these runs. For example, observations of unpolarized standard β Vir show a degree of polarization of $0.08 \pm 0.02\%$ whereas polarized standard HR 6353 shows a degree of polarization of $3.66 \pm 0.07\%$ in the V band.

S. K. Jain & G. Srinivasulu

from the director

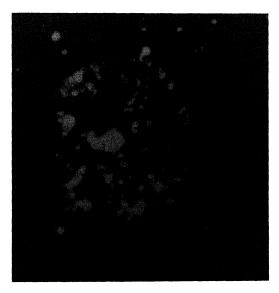
A series of bay disturbances has badly affected the observing conditions almost throughout January.

February saw the end of a frustrating period for the observers at the Vainu Bappu Observatory. The two CCD cameras at the focal planes of the two main telescopes obtained a rich haul of faint sky objects, reaching the sky background limit. The fields included star clusters, planetary nebulae and faint extra-galactic objects.

The CCD camera was also used in the focal plane of the coudé echelle spectrograph of the one metre Zeiss telescope with fantastic results. High dispersion spectra which used to take full night's exposure were obtained in a matter of minutes.

First experiments on the new idea of fixed telescope with CCD scanning for survey work was carried out on two spells in February and March on the Vainu Bappu telescope. To match the faster motion of the image, software modification of the original program was carried out, and clear pictures of the faint objects obtained.

J. C. Bhattacharyya



Unprocessed CCD image of the shell of nova GK Persei 1901, observed through an $\text{H}\alpha + [\text{N}\,\textsc{ii}]$ interference filter of 160 Å bandpass. Observed on 1988 December 8 at the Cassegrain focus of the 1-metre Zeiss reflector using the Photometrics CCD. Integration time: 30 minutes. North is at the top, and west is to the right.

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A New double-pass Monochromator for Solar Research at Bangalore

The application of a double-pass system in a spectrograph with a view to increase the spectral resolution two-fold is a technique commonly employed in the field of laboratory spectroscopy. Another advantage exploited mainly by astronomers is the reduced scattered light within the spectrograph when used in the doublepass mode. The necessity of reducing the scattered light to a minimum possible level becomes all the more important when studies concerning the profiles of solar absorption lines and the subtle changes in them are attempted photoelectrically.

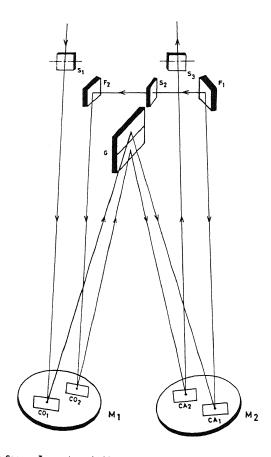
A double-pass system spectrograph was set up at the Indian Institute of Astrophysics, Bangalore campus, by Raheem and Sivaraman more than a year ago, with a view to monitor the Ca II K-line profiles in the integrated sunlight with high photometric accuracy as an extension of the ongoing programme at the Kodaikanal solar tower. The main intention was to procure these profiles with the minimum level of scattered light as possible and look for short-term changes in them through the years of the forthcoming solar maximum. Jayarajan and Kariyappa have considerably refined this system and brought it to a level of performance originally planned and now the spectrograph in the scanning mode can provide line profiles with high photometric accuracy.

The optical set up uses the Czerny-Turner system in the double-pass mode. A schematic representation of the system and the optical path are shown in the figure. M₁ & M₂ are two identical off-axis parabolids of aperture 20 cm and focal length 570 cm. G is a Bausch & Lomb plane grating of size $10.8~\text{cm}\times13.0~\text{cm}$ with $1200~\text{grooves mm}^{-1}$. The dispersion in the third order K-line region in the double pass mode is ~ 5 mm Å⁻¹. A two mirror coelostat of 20 cm aperture directs a beam of sunlight on the entrance slit S₁ and this beam continues and strikes the collimator mirror M₁ forming the patch CO₁. Since the purpose is to use integrated sunlight, there is no image forming optics before S₁ although the sunlight can be imaged on S₁ at the choice of the observer. The spectrum of the first pass falls on M2 at CA₁ and this is passed through the intermediate slit S₂ by the flat mirror F₁. The flat mirror F₂ collects the spectrum and starts the second pass. The light passing through the intermediate slit S2 contains a narrow band of the spectrum around the centre wavelength of interest besides the scattered light of other wavelengths. In the second pass, the grating separates the scattered light from the centre wavelength band. We have placed a Schott filter (BG 25) in front of the intermediate slit S₂ to cut off the overlapping orders and the associated scattered light within the spectrograph.

 CO_2 and CA_2 represent the spectrum falling on the mirrors M_1 and M_2 during the second pass and the final spectrum reaches the exit slit S_3 behind which is a IP21 photomultiplier followed by a Lecroy D.C. amplifier and a recorder. The most attractive feature of this system is that the mirrors M_1 and M_2 are tilted so that light is sent to the flat mirrors F_1 and F_2 off the plane of the system and the beams belonging to the first and second passes

fall on the upper and lower half of the grating. Thus the beams of the first pass and the second pass are completely separate from each other. With a system of baffles we have segregated the first and second pass optical paths completely from each other and this eliminates any cross talk between them. It is this feature which makes this instrument superior to other double-pass spectrographs associated with solar telescopes elsewhere.

The profile of any line can be scanned by rotating the grating. The residual intensities measured for the Na $\colon D_1$ line and the H β line profiles with this spectrograph show

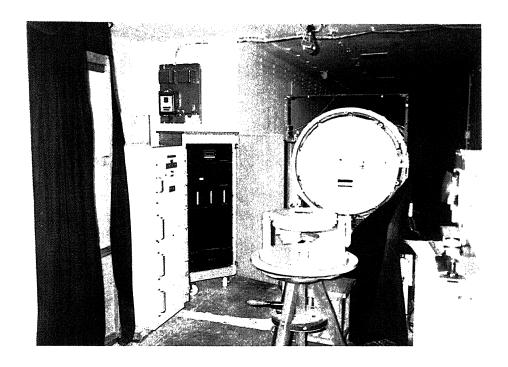


The Czerny-Turner type double-pass monochromator with very low level of scattered light for solar work at Bangalore.

that this is a good near-scatter-free system. We have made several scans and obtained the Ca $\scriptstyle II$ K line profiles, and we plan to monitor the Ca $\scriptstyle II$ K-line profiles of the sun using this instrument in the years of the forthcoming solar maximum.

K. R. Sivaraman

A Solid-State Drive System for Telescopes



An all-solid-state coelostat drive system for three phase AC synchronous motors has been developed in the Electronics Laboratory of Indian Institute of Astrophysics. The novel feature of this drive system includes a digital approach to sine wave synthesis and a digitally programmable frequency setting. The amplitude stability is obtained from a stable temperature compensated reference source and the frequency stability is derived from a crystal source.

The three-phase sinusoidal waveform is obtained through the data stored in three EPROMs, driven by a programmable period generator. The digitally obtained sinusoidal output is boosted in power level using solid-state Power amplifiers (Type E M- 1812 00B of Inland Motor). The Power amplifier outputs are coupled to the three-phase synchronous motor through suitable coupling network.

The major building blocks of the system include: (a) Programmable period-generator (b) Three-phase waveform generator (c) Power amplifier and coupling circuits.

The system has been installed to drive the first stage motor of the coelostat system at our Tunnel Telescope at Kodaikanal and is operational since December, 1988. Initially during installation the monitoring of the solar image was carried out for 5 days, during different times of the day. The value of the frequency was adjusted during the day, so that the solar image remains steady in the E-W direction for more than 10 minutes. The value of the thumb wheel switch setting indicates that same frequency is required during the same part of the day to keep the image steady in E-W direction. For example, a setting of 47.19 HZ is needed at 10 hour (IST) to keep the image steady in E-W direction. While monitoring the solar image, any N-S drift is controlled by a guiding system which adjusts the second mirror, to keep the image steady in N-S direction.

R. Srinivasan, Jagdev Singh & K. S. Ramamoorthy

IAU Symposium 142 on Basic Plasma Processes on the Sun, 1989 December 1-5, Bangalore, India

The Symposium is being sponsored by IAU Commissions 10, 12, 40, 49, Indian National Science Academy, Indian Institute of Astrophysics, (Bangalore), Raman Research Institute, (Bangalore), Physical Research Laboratory (Ahmedabad), Institute for Plasma Research (Ahmedabad) and Indian Space Research Organization (Bangalore). The response to our announcement from various parts of the world is overwhelming. At present, about 25 top-ranking solar physicists have confirmed their participation. In addition, we have also received applications for participation from a large number of our young colleagues.

The Symposium will be held at the Banquet Hall of Hotel Ashok, Bangalore. Most of the participants are being accommodated at the same hotel. We are also planning tours to the exquisitely carved stone temples at Belur and Halebid, about 150 km from Bangalore. The second circular will be sent to all participants by July 1, 1989.

Last dates for receipt of hotel reservation and registration forms, is 1989 September 15 and for abstracts, 1989 October 15.

Contact: V. Krishan, IAU Symposium 142, Indian Institute of Astrophysics, Bangalore 560034, India Telex: 845-2763 IIAB IN Tel: 569179, 569180, 569702

Editors: T. P. Prabhu & A. K. Pati Editorial Assistant: Sandra Rajiva

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