

INDIAN INSTITUTE OF ASTROPHYSICS

(Director, Dr M.K.V.Bappu)

(Report for year 1973 April 1 to 1974 March 31)

SOLAR PHYSICS

Spectra obtained in recent years, under very good seeing conditions, of the first four members of the Balmer series for different positions on the solar disk are currently under study for intensity fluctuations at different wavelength intervals from the line centre. Time-sequence spectra obtained here earlier of the FeI 6358·695 line had shown that the brightness fluctuations in the line wing have a high coherence with those in the continuum, but lag behind them, while the fluctuations in the line core lead those in the continuum. This phase reversal renders the correlation coefficient between the intensity fluctuations in the continuum and the line wings positive, and between those in the line core and the continuum negative, in the case of strong and medium-strong lines. Sivaraman has sought an explanation for this feature. In a collisionally controlled line, the temperature fluctuations at lower levels are coupled to those of the continuum radiation field. Near the core, the temperature changes are caused by the dissipation of the mechanical flux transported by the velocity fluctuations. This is confirmed by the results of the cross-spectral analysis of the velocity fluctuations with the intensity fluctuations.

The programme of study of the K_{232} profile in the integrated light of the Sun at different phases of the solar cycle and for different stages of activity on the visible hemisphere has progressed satisfactorily. The mean emission line profiles over restricted regions of the Sun have also been studied in terms of their relationship to the integrated profile.

The collection of basic solar data with the solar telescopes has been continued. For the year ending 1974 March 31, white-light photoheliograms were obtained on 293 days, H-alpha disk spectroheliograms on 271 days, K_{232} spectroheliograms on 273 days and K prominence pictures on 229 days. The spectrohelioscope was used for over 976 hours of observation, and 43 flares were observed. Solar data have been sent each month to various agencies in India and also to the World Data Centres.

STELLAR PHYSICS

Ultra low-dispersion spectroscopic methods currently being explored with the 102-cm reflector have continued to demonstrate effectively their capability of identifying objects of interest in a survey programme. As shown in the previous year, they are very useful for picking out quasi-stellar sources to faint limits. The procedure is well suited for discovering objects that are bright in the ultraviolet or in the red. Using microspectra for the purpose, a survey is in progress for the identification of red stars in the Large Magellanic Cloud. Forty fields covering the bar and the outlying regions have been included in the programme. Each field is a third of a square degree in area. The survey is complete to beyond the sixteenth visual magnitude.

Microspectra have also been useful in the detection of galaxies that have compact nuclei. The list of 19 such galaxies surveyed by Ekers and Ekers at 6 cm has been covered by the ultra low-dispersion technique. Many of the radio compacts are found to be optical compacts as well. In the limited sample studied, all optical compacts identified by both microspectra and direct photography are radio compacts as well, while the converse does not necessarily follow.

Spectra of the shell star Pleione have been obtained at 17 \AA mm^{-1} in the red region and 28 \AA mm^{-1} in the blue. Emission at $H\alpha$ is striking with its central reversal. The H and K lines of ionized calcium are weak but easily noticeable, and the D lines of sodium are of medium intensity. The star will be monitored over its current shell phase with different spectrographic dispersions.

The programme of evaluation of rotational velocities in the Scorpio-Centaurus association is now complete to spectral type B9. One hundred and thirteen stars have been measured for $v \sin i$ values. Determinations that are above 50 km s^{-1} have been obtained with an accuracy of $\pm 10 \text{ km s}^{-1}$. The stars of the Upper Scorpius group are seen to be fast rotators, as distinct from those of the Centaurus-Lupus and Lower Centaurus-Crux sub-systems of the association. There seems to be little difference between the $v \sin i$ values averaged according to spectral type for these sub-systems and those for the general galactic field. This is true for stars of B5 or earlier. For later types, the association members are fast-rotating. The higher rotation of members in the Upper Scorpius system is possibly due either to accretion effects that increase the angular momentum, or to interaction with the surrounding medium that causes total randomness of orientation to be non-existent.

The equivalent widths of the neutral helium lines and of $H\gamma$ and $H\delta$ have also been measured for the Scorpio-Centaurus association members. The helium intensities measured on spectra of dispersion

47 \AA mm^{-1} will supplement the values of helium abundances measured at the Institute from spectra of higher dispersion.

The programme for the redetermination of orbital elements of spectroscopic binary systems of interest is well underway. Observations are complete for HD 65041, HD 37756, HD 107325, ϵ CrA, HU Tauri and δ Librae. The reductions are in progress. The orbital characteristics of the Wolf-Rayet star in the γ Vel system have been derived from measures of 5411 \AA . These differ from the earlier values derived for 4686 \AA , indicating the unsuitability of 4686 \AA for providing orbital information on these systems. A complete discussion awaits measures of the O-component orbital parameters, which is currently in progress.

The β Cephei aspect of ν Centauri has been established by measures from rapid-sequence spectra obtained on one night. The inferred value of period of such variation is 0.175 day. Further confirmation of this result awaits photoelectric photometry.

The programme of direct photography with the $f/6$ focal reducer of regions in Monoceros, Puppis and Vela has been continued in an effort to locate possible spiral tracers. Four fields of the 15 chosen in the first phase were covered well for a variable-star survey. Several variables have been discovered in these fields with the aid of the blink comparator. Additional plate material is needed for the study of light curves of these stars to enable categorization. Microspectra to faint limits are also available for these selected fields.

The surface photometry of globular clusters has progressed well during the year. Photographs through a V filter have been obtained for 30 clusters. Isophotes for 17 clusters have been obtained by the Sabattier technique.

PHYSICS OF THE INTERSTELLAR MEDIUM

The observed colours and polarization of a reflection nebula have been compared with theoretical models of the nebula assuming a plane parallel slab structure. Earlier expressions for the nebular intensity have been dimensionally incorrect, the error having been caused by lack of proper normalization of the size distribution function. Such an error can introduce serious difficulties while considering the multivariate size distribution functions. The results obtained include $(B-V)$, $(U-B)$ colour differences between the star and nebula as well as the results on polarization of the radiation admitted by the U, B, V filter bands.

COMETARY PHYSICS

A series of direct photographs through wide and narrow-band filters with both $f/2$ and $f/6$ focal reducers has been obtained of Comet

Kohoutek at different heliocentric distances along its orbit. Much fine structure in the ionized tail is seen that changes in form from day to day. The behaviour of the forms of the ionized tail correlate well with the behaviour of sodium emission in the cometary coma. Spectra of the comet were obtained on a regular basis with the 102-cm reflector to study the behaviour of the sodium emission in the coma and its dependence on the solar wind. The appearance and disappearance of the sodium emission follow well the predictions made on the basis of our earlier studies of other comets. Of particular interest is a slitless spectrum obtained on January 9 that enables the study of the intensity gradients in the coma separately for D₁ and D₂ of sodium. The resulting intensity distributions are typical with the flattening on the sunward side and an extension of the coma in the direction of the tail.

RADIO ASTRONOMY

Activity in this field has been principally oriented to the large antenna system proposed to be constructed at Gauri Bidanur and analysis of the high time resolution solar data obtained at Kodaikanal. The design of the basic broad-band dipole element, and the feeder system, etc., are complete. Work on the fabrication of the east-west portion of the antenna is to commence shortly.

Kodaikanal data with a high-resolution polarimeter and spectrometer of solar decameter radio bursts are being analysed to detect fast changes in the polarization characteristics of storm bursts. Significant time differences of the peaks of polarized and total radiation are seen.

INSTRUMENTATION

A star-changing device has been incorporated in the control electronics of the 102-cm reflector. The device enables a programmed sequence of operation that facilitates changeover from star to star in a restricted field with accuracy of about a second of arc. Of great use in programmes that call for frequent changes from star to star as in photometry of variables or in clusters, this addition adds considerably to observer comfort and performance.

A TDC-12 computer has been acquired for on-line functioning in conjunction with the 102-cm reflector. Associated hardware for rapid spectrum scanning and fast photometry is being planned.

The first phase of construction of the coudé spectrograph is well under way. Work is complete on the optical bench to support all elements in the vertical form. The optics of one of the Schmidt cameras is almost complete. This consists of a 51-cm primary and 35-cm

diameter corrector plate with a focal length of 61 cm. The grating is one of 400 grooves per millimetre blazed at $12\ 000\ \text{\AA}$ in the first order. The collimator characteristics are chosen so as to have the beam slightly overfill the grating.

Besides the above, the optics and electronics laboratory at Bangalore has been engaged in several projects involving the development of accessories and electronic systems of data handling and control.