

INDIAN INSTITUTE OF ASTROPHYSICS

(Annual Report for the year 1972 April 1 to 1973 March 31)

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SOLAR PHYSICS

Isophotes obtained by equidensitometry techniques from four exposures of the March 7, 1970 corona have been used for derivation of intensity distributions along the equator, poles, streamers and dark 'gaps' in the visible corona. The composite of isophotes has 23 contours covering values of r ranging from 1.1 to 3.5, r being the distance from the sun's centre in units of the solar radius. Microphotometer scans along two diameters enabled the assignment of intensity values to each contour. The tie-up to absolute intensities was possible with the aid of Gulyaev's data obtained at the same eclipse. The polar and equatorial distributions differ from those given by van de Hulst for a maximum corona. The Kodaikanal measures agree well with the NRL measures of the outer corona made from a rocket coronagraph and together provide data from $1.2R_{\odot}$ to $8.0R_{\odot}$ along the solar equator. The intensity of coronal brightness along the streamers are in general higher than the equatorial intensity while those in the 'gaps' are lower; but the intensity gradients in the streamers and in the gaps are almost alike.

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Radial intensity gradients for different position angles together with the Ludendorff parameters obtained characterize this corona as typical of the solar maximum.

Time sequence spectra covering the $H\beta$ region were obtained at the solar tower to study the velocity oscillations at the mean level of formation of $H\beta$ in the chromosphere.

Integrated spectra of the sun were obtained on several days to enable measurement of K line width and K_{232} line profile representative of the sun as a star.

Several sunspot spectra were obtained in the Zeeman insensitive line $4912\overset{\circ}{\text{A}}$ to study the fine structure of Evershed flow.

Modifications of the solar magnetometer were made during the year to enable operation soon in the multichannel mode. The 4.3 metre spectroheliograph has been moved to the solar tower to enable its use with the larger image.

The solar telescopes at Kodaikanal continue to gather basic solar data which are utilised in research projects at the Institute and elsewhere. For the year ending 1975 March 31, whitelight photoheliograms were obtained on 297 days, H-alpha disc spectroheliograms on 285 days, K_{232} spectroheliograms on 279 days and K prominence

spectroheliograms on 241 days. The spectrohelioscope was used for 988 hours of observation and 86 flares were observed. Of these 26 were of Class I, 9 of Class II and 51 were subflares. World Data Centres continue to get these observations regularly.

STELLAR PHYSICS

The principal highlight of the year has been the commissioning of a new 102 cm Cassegrain-coude system built by Carl Zeiss of Jena. The normal Ritchey-Chretien Cassegrain focus of $f/13$ aperture ratio provides a $45'$ of arc field, where photography is possible on flat plates with the aid of a quartz field flattener. An $f/6$ transformation system attached to the Cassegrain focus gives the same extent of field at higher speed; its greatest use is in relatively fast photography. An $f/2$ transformation system following Meinel's first proposal renders the overall combination with great speed and versatility. In this system one can obtain slitless spectra of different dispersions with both grating and prism or use interference filter or Fabry Perot etalon on faint extended surfaces. Two additional features of the telescope are the provision for photoelectric guiding and a built-in computer device for rapid change in a programmed way from star to star of the members of a cluster.

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The Cassegrain spectrograph with 600 lines/mm grating and 155mm focus camera has been used on the 102cm reflector for a study of selected binary systems. For gamma Velorum, a whole set of plates in the blue have been obtained on high contrast emulsion to determine the O star orbit. In the yellow region spectra obtained on III-F emulsion enable the derivation of the Wolf-Rayet star orbit from the CIII 5696⁰Å line. An interesting result has been the presence of sharp 5876⁰Å violet shifted when 3888⁰Å shows a similar behaviour. There is also much fine structure in the emission band at 6560⁰Å.

Other binaries whose spectra have been observed are b Persei, HD 37756, HD 65041, HD 107325, ξ Cr A and γ Centauri. The reduction of spectrograms of b Persei is complete. A change in λ of the order of 6^o.8 per year suggests an apsidal motion period of 53 years. Changes in some of the orbital elements from those derived earlier may be due to the distortion of the radial velocity curve by gas streams present in the system. In view of the flaring radio emission detected from this system and the variations of the orbital elements, it appears that the close binary system is in an active mass transfer phase.

New elements of the binary system γ Centauri have been derived from spectra obtained during the year. An

interesting result has been the finding that one component is a Beta Canis Majoris variable with a likely period of 0.275 days.

A 3° quartz prism in combination with the f/2 system gives ultra low dispersion spectra of objects over a 45' field. The spectra measure 250 μ in length from the near UV to the red and facilitates study of objects until magnitude nineteen. Use of this prism on quasi-stellar objects shows up in a striking manner the peculiar energy distribution in the object. In combination with the Eastman 103aE emulsion, the arrangement promises to be a very effective means of identifying quasi-stellar objects. Microspectra of 42 quasi-stellar objects having z values ranging from 0.02 to 2.7 have been obtained to establish the selection criterion. Six of these have been of radio quiet objects. UV excess objects or those rich in red light can be picked out with great ease. The superiority of the technique over that of U, B, V photography lies in the economy of exposure together with versatility of information.

Spectra of fainter members of the Scorpio-Centaurus association down to magnitude 8.5 have been obtained with the grating spectrograph for the study of rotational velocities. This completes the rotational velocity

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survey in the association, commenced earlier with the 51cm reflector. Satisfactory progress has been made in measurement of line intensities and the rotational velocities.

Direct photographs of some globular clusters have been obtained through a yellow filter and the f/6 camera. The plates are being used for derivation of isophotes in the cluster by the Sabattier technique. The ellipticities and intensity distributions thus derived are likely to have a dependence on other evolutionary parameters of the cluster.

Direct photography of selected fields in Monoceros, Puppis and Vela has been commenced as part of a programme of detection of spiral tracers. During the year several photographs were obtained for the detection of variable stars. Microspectra will also be obtained of these fields to enable the detection of very early type stars.

THE SOLAR SYSTEM

The occultation of the eighth magnitude star SAO 186800 by the Jovian satellite Ganymede, was successfully observed with photoelectric techniques and the 102cm telescope at Kavalur. The photometer signal, recorded through a Wratten 89B filter by a cooled RCA 7102 photomultiplier

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was amplified by a General Radio 1230 A electrometer and displayed on one of the four traces of a Tektronix 533A oscilloscope. The other three channels served as time markers. Both immersion and emersion light curves have been observed. The principal characteristic of the data obtained is that the fall and subsequent rise in intensity appear to be gradual rather than abrupt, thus indicating the presence of an atmosphere on Ganymede. The Kavalur observations together with similar ones made at Lembang serve to show that the Ganymede atmosphere has a surface pressure greater than 10^{-3} millibar. The two occultation durations yield a diameter of the satellite to be 5270 kilometers and thus the mean density is 2.0 grams per cube centimeter.

THE 230cm TELESCOPE PROJECT

The Governing Council has authorized the Institute to include in its immediate development plans the proposal to fabricate and place in operation a 230cm aperture telescope. The figuring of the mirrors will be at the new optics laboratory of the Institute commissioned at Bangalore during the year.

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RADIO ASTRONOMY

Observations with high resolution on the time, frequency and polarization structure of solar decameter radio bursts have been continued. The east-west positional data obtained previously are being analysed. Preliminary results indicate that the positions of the two components in a double burst can sometimes be different by a few minutes of arc. The data are being scrutinized for possible instrumental errors, ionospheric refraction effects etc., and it is hoped that positional information on at least one hundred double bursts will be available. The dynamic spectra data are also being analysed for time and frequency structure information on the newly discovered Type III-b radio bursts.

Analysis of the data obtained during June 1971 on the occultation of the radio source in the Crab Nebula by the solar corona is complete. These data were obtained with the interferometer with a 30 wavelength base line operating at a frequency of 25 MHz. During the occultation period i.e. from June 10, 1971 to June 25, 1971 fringes due to the Crab Nebula were recorded on nine days free from the contamination due to solar radio bursts and terrestrial interference. From the relative fringe amplitudes the apparent increase in the angular diameter of the radio source is calculated for each day.

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The construction of an antenna system operating at a wavelength of 6M is complete. It consists of two broadside arrays on an E-W base line. The eastern array has 128 half wave dipoles spread in 16 E-W rows of 8 dipoles each. The western one has 16 E-W rows each with 6 dipoles. The separation between the two arrays is about 6 wavelengths. The design and construction of a multiplying type interferometric receiving system is also complete. It is found that with this instrument it is possible to obtain a signal to noise ratio of better than 3 on sources with flux densities of about 150 flux units. The interferometer is at present being used for studying the interplanetary scintillation of the small angular diameter component of the Crab Nebula radio source. The instrument will be used for studying the properties of solar wind using the technique of interplanetary scintillations of point sources like 3C 273, 3C 161 etc.

SOLAR TERRESTRIAL RELATIONSHIPS

Regular soundings of the Ionosphere by the CRPL automatic ionospheric recorder type C-3 were continued at Kodaikanal. A SWF recording instrument at 6.2 MHz was operated during day light hours in close co-ordination with the optical and radio flare patrol units at Kodaikanal. Two sets of La Cour and Watson variometers were operated for continuous registration of the three geomagnetic elements.

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These units collaborated with other geophysical research groups in India in several projects carried out during this period that pertain to the equatorial ionosphere.

The investigational activities during this period were mainly concentrated on analysis of some past data. Balakrishnan et.al completed the study of horizontal field variations in low latitude stations during the Geomagnetic Storm of March 8-10, 1970. From the records of a number of stations situated in the low latitude belt, periodicities and coherence of the oscillatory components of the storm time fluctuations were completed. Joseph succeeded in computation of solar fluxes during a flare using a semi-analytic method from information available from ionospheric data. Rastogi investigated the conditions of disappearance of equatorial type Sporadic E over Kodaikanal.

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- Sivaraman, K.R. 1973 - Coherence and Phase Spectra of Velocity and Intensity Fluctuations, Solar Physics, Vol. 33 No.2, pp 333-340.

STAFF

Academic staff in position during the year are as follows:-

1. M.K.V.Bappu, A.M., M.Sc., Ph.D.,F.A.Sc., F.N.A.	Director
2. J.C.Bhattacharyya, M.Sc., D.Phil.,	Associate Professor
3. K.R.Sivaraman, M.Sc., Ph.D.	Reader.
4. Ch.V.Sastry, M.Sc., Ph.D.	-do-
5. A.P.Jayarajan, M.A.,	-do-
6. K.C.Abdur Raheem, B.Sc.,	Research Associate.
7. T.K.Balakrishnan, M.Sc.,	-do-
8. Julius Joseph, M.Sc.,	-do-
9. V.Natarajan, B.Sc.(Hons)	-do-
10.R.Rajamohan, M.Sc.,	-do-
11.M.Parthasarathy, M.Sc.,	-do-

The Technical, Administrative and non-technical maintenance staff numbered 73.

Sarvasbri T.K.Balakrishnan, V.Natarajan, and Julius Joseph were transferred back to the India Meteorological Department later in the year. In addition, 18 technical, administrative and non-technical staff were also transferred to the India Meteorological Department.

EXERCISE OF OPTION

In terms of Rules 25.2 of the Rules and Regulations of the Institute, options were exercised by 65 members of staff; out of these 52 opted for service in the Indian Institute of Astrophysics and the remaining 13 for reversion to the India Meteorological Department.

BUILDINGS AND GROUNDS

A hutment to be used as a kitchen and dining hall by the visiting Astronomers and residents on the campus at Kavalur has been completed.

About 5 acres of land was acquired at a cost of Rs.1,35,900 at Koramangala from the City Improvement Trust, Bangalore for the construction of the Optics, Electronics and Data Analysis Centre. A sum of Rs.19,200 was deposited with the C.P.W.D. for fencing this area.

For constructional works at Kavalur an amount of Rs.3,30,000 was deposited with the C.P.W.D.

COUNCIL MEETINGS

The Governing Council of the Institute met thrice during the year, twice at New Delhi and once in Bombay. The Finance Committee met once during the year.

MEETINGS AND SYMPOSIA

Dr.M.K.V.Bappu attended the meetings of the Executive

Committee of the I.A.U. held at Copenhagen in his capacity as Vice President of the Union.

He also participated in I.A.U. Symposium number 54 on "Problems of Calibration of Absolute Magnitudes and Temperatures of Stars" held in Geneva.

WINTER SCHOOL

A Winter School on "Astronomical Spectroscopy" was held at Kodaikanal and Kavalur between 26-12-1972 and 11-1-1973 in which twenty five persons from Universities and Research Institutions participated.

LIBRARY

The number of books purchased totalled 268. 100 journals were on the subscription list. Exchange of publication with other Observatories and Institutions was continued.

VISITORS

Prof.W.N.Christiansen, School of Electrical Engineering, Sydney University, Dr.E.Kharadze, Akastumani Astrophysical Observatory, U.S.S.R., Dr.Joseph Smak, Institute of Astronomy, Polish Academy of Sciences, Dr.Andrej Trautman, Instytut Fizyki Teoratyeczny, Warsaw and Dr.Donald J.Wentzel, University of Maryland visited the Institute.