

ANNUAL REPORT* OF THE KODAIKANAL OBSERVATORY FOR THE YEAR 1966

Solar Physics

The solar magnetometer has been used to measure weak longitudinal fields on the solar surface as well as the magnetic fields over selected plage regions. The instrument has also been used in the velocity mode for the study of the quasi-oscillations in the solar atmosphere. Extended time sequence have been obtained using MgI 5172. Shorter runs have also been obtained on FeI and CI lines in the 5000Å region. Several changes are being incorporated in the electronics of the measuring system of the magnetometer. The new system operates at a frequency of 64 cycles/sec instead of the original mains frequency.

Auto-correlation measures of the coarse Ca⁺ network have been made on selected spectroheliograms obtained during the solar minimum periods of 1963 and 1964. The full width at half maximum of the normalized auto-correlation curve yields a mean value of 31400 ± 400 km. for the size of the network at the centre of the disk. Since the identity of the Ca⁺ network and the supergranulation is well established, these measures are typical of the super-granulation sizes at the minimum of the solar cycle.

Calcium spectroheliograms, white light photoheliograms and solar maps for the period covered by the IQSY were used to study the formation and subsequent evolution of selected active regions. The birth of new plages and their relationship with remnants of old plages, the formation of a spot with reference to the plage, the decay of the spot and its plage environment have been examined.

Magnetic field measures of sunspots were obtained on 80 days during the year. These were made photographically using the FeI line at 6303Å.

The sun was photographed in white light on 293 days compared to 323 days in 1965. H-alpha disc, K-disc and K-prominence spectroheliogram were secured on 274, 270 and 243 days as against 268, 290 and 272 days respectively in 1965.

*The report deals chiefly with the astronomical and allied geophysical work of the Kodaikanal Observatory. The Meteorological Data will be published in the India Weather Review, the seismological data in the Seismological Bulletin and the Administrative details in the Administration Report of the India Meteorological Department.

The mean daily areas and numbers of Calcium Prominences at the limb as obtained from Kodaikanal records are as given in the next page.

Compared to last year the figures show considerable increase in activity of both areas and numbers, the increase being 147.9% in areas and 74.2% in numbers. The distribution of areas in five degree ranges of latitude in the northern hemisphere shows a peak of activity extending from 50°-60° with a secondary maximum extending from 25°-40°. In the southern hemisphere the peak is in the latitude belt 35°-45°

The mean daily areas and numbers of hydrogen absorption markings on the disc as obtained from Kodaikanal records are as given in the next page.

Compared to the previous year there is a great increase of activity of the absorption markings judged both by areas and numbers. The increase in area amounted to 148.6 per cent whereas it is 135.5 per cent in the case of numbers. In the northern hemisphere the peak activity is in the latitude belt 20°-30° and in the southern hemisphere in the zone 35°-50°

The exchange of spectroheliograms with foreign observatories was continued. For the period July 1965 to June 1966, 38 K-Prominences, 36 K-focculii and 49 H-alpha spectroheliograms were received from the Meudon Observatory. 103 H-alpha and 111 K-disc spectroheliograms for certain days for the period 1965-66 were sent to the Meudon Observatory.

Stellar Physics

Photoelectric measures of the emission band intensities of $C_2(1,0)$ and $CN(0,0)$ of the coma of Comet Ikeya-Seki (1965f) were used to derive flux values of these bands. These measured fluxes are utilized to determine the number of molecules of C_2 and CN that contribute to the observed emission of the coma. These are 1.84×10^{30} and 1.55×10^{29} for C_2 and CN respectively.

The monochromatic measures of polarization of Comet Ikeya-Seki (1965f) obtained over a limited range in phase angle at wavelengths 3890Å, 4300Å, 4740Å and 5875Å have been analyzed. The polarization at phase angle 90° is 6.9 per cent for the $CN(0,0)$ band and 10.7 per cent for the $C_2(1,0)$ band. These values are in close agreement with the theoretical values for resonance fluorescence, thus confirming that resonance

1966	Area (Sq. minutes)					Numbers				
	N	S	E	W	Total	N	S	E	W	Total
January—June	3.43	1.01	2.08	2.36	4.44	5.17	2.68	4.09	3.76	7.85
July—December	4.97	2.46	3.90	3.53	7.43	5.45	3.93	4.59	4.79	9.38
Whole year (weighted mean)	4.10	1.65	2.88	2.87	5.75	5.29	3.23	4.31	4.21	8.52

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1966	H-alpha dark marking area (in millionths of the Sun's visible hemisphere uncorrected for foreshortening)					Numbers				
	N	S	E	W	Total	N	S	E	W	Total
January—June	2291	287	1469	1109	2578	16.89	2.62	9.98	9.53	19.51
July—December	3852	664	2341	2175	4516	27.22	6.81	17.70	16.33	34.03
Whole year (weighted mean)	2946	447	1835	1558	3393	21.24	4.38	13.23	12.39	25.62

effects stimulated by solar radiation are responsible for the cometary band emission. The polarization value of the continuum is 24.7 per cent at phase angle 90° , while for the same phase angle, a measure of polarization in the tail, 3' away from the head is 13.6 per cent. The continuum from the cometary head can be explained in terms of a mixture of icy spheres of $n=1.2$ and iron particles. The tail is likely to be mostly of iron particles, in agreement with our concept of cometary debris as derived from shower meteor spectra.

Objective prism and objective grating spectra of Comet Ikeya-Seki were used to derive isophotes of the coma in the light of the CN (0, 0) emission band and Na 5893. The heliocentric distance of the termination point of Na emission is shown to be dependent on the varying nature of the interplanetary medium properties at different phases of the solar cycle. The effects of a solar wind on the different parts of a comet are examined in terms of the observations obtained of Comet Ikeya-Seki (1965f). The solar wind contribution to the formation of the scattering agencies in the cometary nucleus is shown to be negligible.

Slit and slitless spectra of Comet Ikeya-Seki (1965f) have been measured for wavelengths and intensities. The emission spectrum shows besides the normal molecular bands of CN, CH, C_2 and NH_2 , the D lines of sodium and the forbidden oxygen line at 6300\AA . The spectrum of the continuum shows the absorption lines of H-alpha and H-beta of sunlight reflected by the particles of the cometary halo. The sodium tail has been traced out to about 2° .

From a plot of $\log L^3$ versus $\log S^2$ (L and S being orbital and spin angular momenta of the planets in the solar system, including minor planets) it is found that all the points lie very nearly on a straight line with a gradient of nearly unity showing that L^3/S^2 is very nearly constant and equal to about 10^{60} gm cm^2/sec . This constant is seen to agree numerically and dimensionally with L_g , the orbital angular momentum of the planetary system as a whole around the centre of the Galaxy.

Light curves have been completed for the eclipsing systems UW Canis Majoris and YY Eridani. Observations through a narrow pass band filter at 4700\AA are also complete of the eclipsing system VV Orionis.

Low dispersion spectra of the Wolf-Rayet binary Gamma Velorum have been analyzed for orbital elements. These spectra

have been obtained with the 5 cm. camera of the new Bhavnagar spectrograph with a dispersion of $125\text{\AA}/\text{mm}$. The period of the binary system has been found to be 78.5 days. Both spectra of the components are seen. The spectral type of the companion determined from a single Mount Stromlo coude spectrogram is O7.5. The values of $m\sin^3i$ of both components have been derived.

Mount Wilson spectra of the Wolf-Rayet binaries HD 193576, HD 193928, HD 186943 and HD 211853 have been remeasured and revised orbital elements derived.

New values of excitation temperature for stars of the Wolf-Rayet carbon sequence have been calculated using the hydrogenic transitions of CIV. The line intensities for selected lines of CIV have been measured from high dispersion spectra ($10\text{\AA}/\text{mm}$) of the northern Wolf-Rayet stars. The temperatures are 56900° for HD 165763 (WC6), 51600° for HD 192641 (WC7) and 38000° for HD 192103 (WC7). A study of the nucleus of Campbell's hydrogen envelope star yields a value of 24000° . A similar analysis using the (4-n) series of HeII for stars of the WN sequence yields a value of 32400° for the star HD 192163 (WN7). The irregularities in the Pickering decrement show the effects of a slight contamination by the Balmer series of hydrogen.

Geomagnetism, Ionospheric Physics and Solar-Terrestrial Relationships

The task of obtaining the ionospheric effects of proton flares using ground-based observations is normally difficult since all strong flares are normally associated with complete fade-outs. The proton event of July 7, 1966 was, however, favourable for Kodaikanal as the flare occurred when the sun was just above the horizon, thus facilitating the obtaining of ionospheric data without much absorption. True height profiles have been derived from 15 minute interval ionograms obtained at flare occurrence as well as on a suitable number of control days. Using a suitable model atmosphere, production rates are calculated for the X-ray and ultra-violet spectral regions. A synthetic flare spectrum is then computed for the high frequency region that would produce the observed effects. The analysis showed that the X-ray flux during the flare experienced a manifold enhancement.

Using beacon satellite data from Explorer-22 recorded at Kodaikanal over the sunspot minimum period, total columnar

electron content from ground level to height of satellite as a function of position and time have been studied for the equatorial ionosphere.

From the ionospheric data for sunspot maximum and sunspot minimum years, the spectral characteristics of the solar ionizing radiation have been studied. Electron production rates at different heights have been calculated both for the sunspot maximum and sunspot minimum years. The results indicate that while the background radiation does not show significant change in spectral distribution over the sunspot cycle, that from solar active regions have different spectral characteristics.

Continuous recordings of H, D and Z elements of the Earth's magnetic field with Watson and La Cour magnetographs and Askania field balances have been continued. Absolute values of H, D and Z have been determined weekly with a set of QHM and BMZ instruments. During the year, 15 geomagnetic storms including 8 of the sudden commencement type have been recorded at Kodaikanal with ranges in Horizontal force between 130γ and 332γ .

Regular vertical incidence soundings of the ionosphere and registration of short-wave field strengths have been continued. Regular observations of Faraday fading of 40 and 41 Mc/s transmissions from the Beacon satellite, Explorer 22, have been made.

Monthly median values of foF2 and (M3000) F2 have been supplied to the Central Radio Propagation Laboratory, Boulder, U.S.A. Quarterly statements of monthly median values of all ionosphere parameters have been sent as in previous years to Radio Research Station, U.S.A. Periodical statements of Observational data concerning ionospheric characteristics, geomagnetic storms and ionospheric disturbances have been supplied to several interested institutions. Daily message in IGY codes relating to solar magnetic and ionospheric observations at Kodaikanal have been sent to New Delhi for inclusion in the AIMBC broadcasts.

Radio Astronomy

The dynamic radio spectrograph in the range (20-100 Mc/s) has been completed and tested. The log periodic aerial for use with this spectrograph has also been designed and constructed.

The 3000 Mc/s radiometer has been brought into regular operation on a tracking 2 metre paraboloid.

The recording of sporadic radio emission from Jupiter at 22.2 M/cs has been continued. The observations made at Kodaikanal as well as at Boulder have been analyzed to study the influence of the Jovian satellite Io in producing the decametric radio emission.

Optical Workshop

The construction of a 36 cm. cassegrain telescope has been completed. The primary mirror is an f/3.5 paraboloid which in combination with the hyperbolic secondary provides an effective focal ratio of f/12 at the cassegrain focus.

An image slicer has been constructed for use with the large solar spectrograph and magnetometer.

The primary mirror (aperture 31 cms, radius of curvature 124 cms) for a Schmidt camera was ground, polished and figured.

Miscellaneous Observations

Routine Ozone, Meteorological, Seismological and radiation observations have been carried out as in previous years. Three long period and three short period seismographs installed under a cooperative arrangement with U.S. Coast and Geodetic survey are in continuous operation.

General

Shri K. S. Ganesh, Senior Research Scholar, Ministry of Education, submitted a thesis entitled "Spectroscopic Studies of Wolf-Rayet Stars" for the Ph.D. degree of the Karnatak University.

The Director attended the Seventh International Space Science Symposium held at Vienna from 10th May to 19th May. He also attended meetings of the Indian National Committee for Astronomy held at New Delhi in July and December and the Indian National Committee for Space Research held at Bombay in July.

Four members of the staff of the Observatory attended the Summer School of Relativistic Astrophysics and Cosmology held at Bangalore in July. They also participated in a symposium on "Active Solar Regions" convened under the auspices of the Indian Academy of Sciences at Madurai in December.

Visitors

Two Russian Scientists, Prof. V. Stepanov from Irkutsk and Dr. M. Roudina from Alma Ata visited the Observatory under the INDC-USSR Cultural Exchange arrangement scheme with INCOSPAR as local sponsors.

Publications

Bhargava, B. N. Kasiviswanathan, G. A.	A Proton Precession Magnetometer— Indian Journal of Meteorology and Geophysics—Vol. 17, No. 3, July, 1966.
Bhargava, B. N. Subrahmanyam, R. V.	Some features of Geomagnetic storm sudden commencements following Cosmic Ray flares. Planetary and Space Science—Vol. 14, 1966.
Bhatnagar, A	Variation in continuum brightness and Equivalent width of lines in sunspot Penumbrae. Zeitschrift fur Astrophysik, 64, 1966.
Kasiviswanathan, G. A.	See Bhargava, B. N.
Subrahmanyam, R. V.	See Bhargava, B. N.

Kodaikanal Observatory

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