ANNUAL REPORT* OF THE KODAIKANAL OBSERVATORY FOR THE YEAR 1962

Solar Physics

The modification of the solar tower to facilitate solar observations soon after sunrise was completed and the solar telescope was re-erected and adjusted.

Regular observations with the Lyot Monochromatic heliograph have been continued and filtergrams have been obtained of the disc and prominences on 224 days. Photoheliograms were taken on 332 days compared to 309 days in 1961. H-alpha disk, K-disk and K-prominence spectroheliograms were secured on 229, 299 and 256 days against 235 305 and 264 days respectively in 1961. The total number of exposures of each kind was as follows :

1.	Photoheliograms	..	398
2.	H-alpha spectroheliograms	..	602
3.	K_{232} spectroheliograms	..	1046
4.	K prominences	..	548
5.	K_{232} and K prominences combined	..	101

Observations with the spectrohelioscope were made on 297 days covering a total duration of 1163 hours of patrol. Seventy-four solar flares were observed during the year, one of importance 2+, three of importance 2, four of importance 1+, eighteen of importance 1 and forty-eight of importance 1—.

The average definition of the sun's image was 3 on a scale of 5. There were two days of seeing 5, thirtyfive days of seeing 4 and 181 days of seeing 3. The total rainfall recorded was 1482.1mm which was about 207mm less than the annual normal. The total number of hours of sunshine was 1643·4.

Sunspot activity continued to be on the decline during the year. The mean equatorial distance of the northern hemisphere spot groups was 10°.3 and of the southern hemisphere spot groups 10°.5 as against 10°.9 and 10°.3 in 1961. Details of sunspot observations are given in the following table :

		Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total /mean
No. of new spot groups	N	8	6	7	9	7	4	4	4	7	6	4	8	74
	S	2	5	3	2	4	8	1	2	4	2	4	6	43
Mean daily No. of spot groups.		1.6	2.1	2.3	2.2	2.4	2.3	1.2	0.8	2.4	1.9	1.8	1.4	1.9
Kodaikanal daily relative sunspot numbers.		25.3	39.7	35.1	39.6	40.1	37.6	15.2	14.4	43.3	29.2	29.0	24.6	31.1

*This 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 Administrative Report of the Indian Meteorological Department.

The mean daily areas and numbers of calcium prominences at the limb as derived from photographs obtained at Kodaikanal are given below :

Prominences 1962	Area (in square minutes)					Number				
	N	S	E	W	Total	N	S	E	W	Total
January—June	1.74	1.33	1.57	1.50	3.07	4.76	4.04	4.43	4.37	8.80
July—December	1.18	0.77	0.81	1.14	1.95	3.60	2.70	3.00	3.30	6.30
Whole year (weighted mean)	1.53	1.12	1.29	1.36	2.65	4.33	3.52	3.87	3.98	7.85

The figures show a considerable decrease in the prominence activity from the previous year, the decrease in area being 47.3% and in numbers 23.7%. The distribution of area in the northern hemisphere in five-degree ranges of latitude showed a broad peak of activity extending from 5°–15°. There was a secondary maximum in the latitude belt 35°–40°.

In the southern hemisphere, the maximum activity was in the zone 20°–30°.

Three sudden disappearances of dark absorption markings were observed during the period.

The mean daily areas and numbers of hydrogen absorption markings on the disc as obtained from Kodaikanal records were as follows:—

1962	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	1252	933	1070	1115	2185	10.1	6.6	7.8	8.9	16.7
July—Dec.	1488	635	1027	1096	2123	9.8	4.8	7.3	7.3	14.6
Whole year (weighted mean)	1297	787	1016	1068	2084	9.97	5.88	7.60	8.25	15.85

Compared to the previous year, there was a decrease in the activity of the absorption markings judged both by areas and numbers. The decrease in area amounted to 36·3% while the numbers showed a decrease of 30·2%. In the northern hemisphere, the peak of activity was in the latitude belt 20°–25° with a secondary maximum in the zone 10°–15°. In the southern hemisphere the maximum activity was in the zone 20°–30°.

The exchange of spectroheliograms with foreign observatories was continued. For the period July 1961 to June 1962 86 H-alpha disc, 98 K disc and 91 K Prominence spectroheliograms from the Meudon Observatory and 20 H-alpha disc, 10K disc and 16K prominence spectroheliograms from the Mount Wilson Observatory were received. 41 H-alpha disc, 15 filtergrams and 141 K disc spectroheliograms for certain days for the period 1961-62 were sent to the Meudon Observatory on request. Copies of daily spectroheliograms were supplied regularly to the Fraunhofer Institute, Germany for the preparation of solar maps and of K232 spectroheliograms to the Arcetri Observatory.

2 photoheliograms together with the relevant zero plates for certain days in 1961 were supplied to the Astronomer Royal Greenwich Observatory, England. Central meridian passage of important sunspots were communicated to interested institutions in india. Quarterly statements relating to solar flares were sent as in previous years to the Royal Greenwich Observatory. The despatch of solar data to the World Data Centres was continued during 1962. Monthly solar data were regularly supplied to the usual recipients in India and abroad.

Miss Subrahmanyam has completed the investigation of the motions characterising the eruption of eight prominences. It is found that all parts of a prominence adhere to a general pattern of motion, on which are superposed small, but significant individual deviations. It is suggested that an eruptive prominence has a compound magnetic field, consisting of a stable weak field and a momentary strong component.

Sequences of H-alpha spectroheliograms covering nine solar flares have been examined by Bhatnagar and Punetha for flare-associated optical phenomena. A case of sudden disappearance of a dark filament observed in the flare sequences of February 22, 1926, suggests that Doppler displacements caused by a motion of the filament is the cause of its disappearance from the normal H-alpha spectroheliogram. The incidence of solar flares both with respect to the spot life time and its spatial form have also been studied.

Bappu, Bhatnagar and Punetha have completed the study of the influence of super flares on the H-alpha striation pattern. It is found that superflares, observed in the light of H-alpha are associated with a phenomenon of obscuration of the neighbouring region. Due to this obscuration, the fine details of striation pattern around the active region become indistinct. The area of the indistinct region increases as the flare rises and decreases as the flare subsides. Such obscuration is interpreted as due to the overlying ejecta from surges, which are found to be associated with the two cases of superflares studied.

Ramanathan has studied the Greenwich data for sunspots for six sunspot cycles (1889-1954) to investigate the movement in longitude of zones of maximum activity in different latitude belts. It has been found that the drift is very little and that the sunspot activity integrated over a cycle shows meridional structure.

The following investigations are in progress with the 60 foot spectrograph :

1. Evershed Effect in sunspots.
2. High resolution studies of solar granulation in the solar spectrum.
3. Spatial distribution of magnetic fields in sunspots.

Other investigations in progress are:—

1. Analysis of the corona photographs obtained during the eclipse of 1898.
2. Some aspects of East-West asymmetry of sunspot activity.
3. Distribution of various types of prominences during a sunspot cycle with respect to latitude.

Stellar Physics

The construction of a photo-electric photometer for use with the 8–inch Madras Refractor was completed.

The measurements of the absorption lines were completed and the orbital elements of HD214419 were derived from radial velocity curves of NIV and He II. Radial velocity measures of all red plates of the system were completed.

An analysis is in progress of the wavelengths and intensities of HD184738.

Radio Astronomy

Regular recording of solar noise flux at a frequency of 100 Mc/sec has been continued. An improved converter for the 100 Mc/sec. radiometer has been constructed using a new G. E C. low noise triode. Construction of an interferometric aerial for use with 200 Mc/sec radiometer has been in progress. Work has been started for the development of an improved converter for use with 200 Mc/sec radiometer. Radio star scintillation observations of Cygnus A and Cassiopeia have been made at 100 Mc/sec whenever possible.

Under a joint Kodaikanal-Yale project, recordings of radio radiation from Jupiter at a frequency of 22·2 Mc/sec have been started using a phase switching interferometer.

Geomagnetism and Ionospheric Physics.

Continuous photographic recordings of the earth's magnetic elements H, D and Z using LaCour and Waston Magnetographs and visible recordings of H and Z with Askania Field Balances have been continued. Absolute values of H, D and Z have been determined every week with a set of QHM and BMZ instruments. Absolute measurements of H with a Kew Magnetometer have also been made once in every month. Scale value determinations of these magnetographs have been done twice a month. During the year 22 magnetic storms which include 9 storms of sudden commencement type have been recorded with ranges in horizontal intensity between 131γ and 206γ.

Routine ionospheric soundings have been made at 15-minute intervals. Shortwave field intensity recordings have also been made during day-light hours on all days of the year. Shortwave radio fadeouts of Dellinger type have been recorded on eleven occasions. Round-the-clock recordings of cosmic noise at 29 Mc/sec have been made daily; SCNA has been recorded on one occasion.

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 ionospheric parameters have been sent as in previous years to the Radio Research Station, Slough, England and to C.R.P.L., Boulder, Colorado, U.S.A. Periodical statements of observational data concerning ionospheric characteristics, geomagnetic storms and ionospheric disturbances have been supplied to several interested institutions. Daily messages in I. G. Y. code relating to solar, magnetic and ionospheric observations at Kodaikanal have been sent to New Delhi for inclusion in the AIMBC broadcasts.

Bhargava and Subrahmanyan have made a study of the characteristics of the blanketing type sporadic E-layer over Kodaikanal and its association with the Far East Anomaly. Using the data obtained from Kodaikanal ionograms for a six-year period, 1956 through 1961, they have examined the diurnal, seasonal and solar cycle variations in this type of E_s. The results suggest that blanketing type E_s occurs at Kodaikanal 3 to 5 times more frequently than at stations of similar magnetic latitudes in the American zone. The occurrence of blanketing type E_s has been found to be inhibited by the equatorial electrojet. Lunar effects in the time of the appearance as well as in the strength of blanketing E_s have also been found to exist. F-layer changes resulting in reduced thickness and increased ionic densities as well as a sizable reduction in horizontal intensity of the earth's magnetic field have also been found to occur during the incidence of this type of E_s layer over Kodaikanal. The authors ascribe the formation of blanketing E_s to the effect of wind shear in ionospheric E region through internal atmospheric gravity waves and conclude that this type of E_s seems to be associated with the equatorial stratospheric wind fluctuations which are known to extend to ionospheric heights, at least, in the Far East.

Subrahmanyan has compared the geomagnetic effects associated with relativistic flares (flares during which solar protons of energy greater than 1 Bev were observed on the earth's surface) with those of non-relativistic flares. All flares accompanied by magnetic crochets in the horizontal intensity of the earth's field observed in Kodaikanal magnetograms during a 6-year period 1956 through 1961 have been classified into two types. The times of occurrence, amplitudes, durations and impulsive nature of the geomagnetic effects associated with these two types of flares are found to be different in their characteristics. Subrahmanyan has discussed these features in terms of highly enhanced D-region ionization caused by a burst of X-radiation of solar origin in the spectral range 1-8 A° during relativistic flares.

Bhargava and Subrahmanyan have examined the annual mean diurnal variations on quiet and disturbed days respectively of the horizontal and vertical intensities of the earth's magnetic field for sp. min (1953-1954) and sp. max. (1957-1958). They have found that the diurnal ranges in H and Z at Kodaikanal on disturbed days are almost the same as those observed on quiet days. Using H and Z data of Kodaikanal for about a solar cycle (1952-1961), S_D H and S_D Z variations have also been computed by them. Seasonal and solar cycle changes in S_D H and S_D Z have been found to exist. Their analysis confirms the findings of Akasofu and Chapman that the equatorial electroject strength is maintained by the reinforcement through the return current associated with auroral electrojet on disturbed days to mask the effect of main phase decrease (Ds t H) by the ring

current. Their analysis also suggests that on disturbed days an increase takes place in the width as well as in the movement of the equatorial electrojet north or south of the magnetic equator.

Miscellaneous observations.

Meteorological observations with the visual and self-recording instruments have been carried out as usual.

The Milne-shaw seismograph recorded 61 earthquakes. Regular observations of atmospheric o zone with the Dobson Ozone Spectrophotometer have been made on 246 days.

Instrumentation

A second Babcock grating was received on loan from the Mount Wilson & Palomar observatories. A 6·5 metre all mirror solar spectrograph arrangement has been tried out with this grating for which a mount has been fabricated. The performance of the system has been found exceedingly satisfactory.

The fabrication of a new microphotometer to accommodate 18″×18″ plates of the solar corona of 1898 eclipse was completed.

An aluminizing plant has successfully been brought into operation in the optical shop of the observatory. The present unit is capable of aluminizing flats and mirrors upto 10-inches in diameter.

General

The Director attended the 49th session of the Indian Science Congress and meetings of the Indian National Committee for Space Research and the Indian National Committee for the International Quiet Sun Year.

The observatory held 14 colloquia during the year. Speakers from outside included Dr. Bok, Director, Mount Stromlo Observatory and Dr. Bhabha, Director, Tata Institute of Fundamental Research.

Publications.

Bappu, M. K. V., Chandra, S., Sanwal N.B., & Sinvhal, S. D. — "Photoelectric measures of Hydrogen-line absorption in early-type stars" —Monthly Notices of the Royal Astronomical Society Vol. 123, No. 6 (1962).

Bappu, M. K. V., Punetha L. M. — "Calcium faculae and Solar flare effects"— The Observatory Vol. 82 No. 929 (1962).

Bappu, M. K. V., Bhatnagar, A., and Punetha, L.M. — "The Influence of Superflares on the H-alpha striation pattern" —The Observatory Vol. 82 No. 930 (1962).

Bhargava, B.N., & Subrahmanyan, R. V. — "F-region changes associated with the solar flare of 23 February 1956" —Journal of Atmospheric & Terrestrial Physics Vol. 24 April (1962).

Bhargava, B.N., & Subrahmanyan, R. V.	"The influence of disturbed conditions and increased solar activity on geomagnetic distortion of the equatorial Ionospheric F2 region" —Proceedings of the Indian Academy of Sciences—Vol. LV. No. 6 Sec. A (1962).
Ramanathan A. S.	"Distribution of sunspots in Heliographic Longitude" —The Observatory, Vol. 82 No. 931 (1962).
Ramanathan, A. S. and Jayanthan, R.	"Distribution of sunspots in Longitude"— Kodaikanal Observatory Bulletin No. CLX (1962).
Bhatnagar, A	See Bappu, M.K.V.
Jayanthan, R.	See Ramanathan, A.S.
Punetha, L. M.	See Bappu, M.K.V.
Subrahmanyan, R. V.	See Bhargava, B.N.

Quarterly synopses of results of solar, magnetic, ionospheric and ozone observations made at Kodaikanal were published in the Indian Journal of Meteorology and Geophysics. The Monthly Notices of the Royal Astronomical Society published a report of the work done at Kodaikanal Observatory during 1961 as well as on the prominence activity during the same year.

Kodaikanal Observatory,
December, 1963.

M. K. VAINU BAPPU,
Director.

GIPN—S5—3 D.AB.Kodi./63—6-7-64—400.