ANNUAL REPORT* OF THE KODAIKANAL OBSERVATORY FOR THE YEAR 1957

General.—Sir Harold Spencer-Jones, former Astronomer Royal of England and at present Secretary-General, International Council of Scientific Unions, visited this observatory on 26-1-1957.

Intensive observations (solar, geomagnetic, ionospheric, ozone, auroral and meteorological) were commenced on 1-6-1957 in preparation for the programme of observations which this observatory is to carry out during the International Geophysical Year. Required particulars about solar observations were sent to the appropriate World Data Centres every month from 1-7-1957. Ionospheric data including f-plots for Regular World Days and Special World Intervals were prepared for transmission to the World Data Centre. Quick-run magnetic records of Horizontal Force were also made on the above days, and complete magnetic data from 1-7-1957 were kept ready for transmission to the concerned World Data Centres.

The latest recommendations of the "Special Committee on World-wide Ionospheric Soundings" on scaling of ionospheric data and use of symbols and terminology were adopted from January 1957.

The new I. G. Y. code was brought into use from June 1957 for the duration of the I. G. Y. instead of the previously used URSI code for daily broadcasts of Kodaikanal observations by the All-India Meteorological Broadcasting Centre. From the same date plain language messages relating to solar and geomagnetic observations made at Kodaikanal were sent daily for inclusion in the special broadcasts by the All-India Radio for the I. G. Y.

Final orders for a Coronagraph for this observatory were placed with Messrs. Recherches et. Etudes D' Optique et de Sciences Connexes, Paris; the construction of the instrument had made good progress by the end of the year.

Two sets of Askania Magnetic Variographs were received from the Askania-Werke, Berlin and tested for installation at the I. G. Y. field stations at Chidambaram and Trivandrum in South India.

During the year two new comets—Comet Arend-Roland and Comet Mrkos made their appearances. Visual and photographic observations of these comets were made whenever weather permitted.

An observational watch was kept during October and November for sighting the Russian Earth Satellites 1 and 2 and also for receiving the radio signals from them. The signals were received from the satellites, but the satellites were not seen.

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*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 Administration Report of the India Meteorological Department.

A list giving details (exposure, emulsion type, filter etc.) of photographs of Mars and a few sketches made at Kodaikanal during the 1956 opposition and some conclusions that could be drawn from these observations were sent to the International Mars Committee.

Abstracts of papers contributed from this observatory which have been published since the last general assembly of the International Astronomical Union were sent to the Presidents of the concerned Commissions of the I. A. U.

Scientific Co-operation.—Exchange of spectroheliograms with foreign observatories was continued as in the previous years. 68 K disc spectroheliograms for the period October 1957 to December 1957 were sent to the Cambridge University Observatories. For the period July 1956-June 1957 6 H-alpha disc and 7 K-disc spectroheliograms were received from the Meudon Observatory and 51 H-alpha disc, 60 K-disc and 82 K-prominence spectroheliograms from the Mount Wilson Observatory.

Copies of daily spectroheliograms (disc in H-alpha and K and limb in K) were supplied in fortnightly batches to the Fraunhofer Institute, Germany, for the preparation of daily solar maps.

Three photoheliograms together with the relative zero plates for certain specified days in 1957 were supplied to the Astronomer Royal, Royal Greenwich Observatory, England.

Quarterly statements relating to solar flares were sent as in previous years, to the Meudon Observatory, France and to the Royal Greenwich Observatory, England.

Periodical statements of data of solar flares, relative sunspot numbers, ionospheric parameters and sudden ionospheric disturbances, information relating to central meridian passage of prominent sunspot groups and forecasts of expected magnetic and ionospheric disturbances were supplied to a number of interested institutions in India.

The practice of supplying monthly values of F2 layer critical frequency and maximum usable frequency factor for 3000 km transmission to the Central Radio Propagation Laboratory, National Bureau of Standards, U.S.A. and quarterly statements of monthly median values of all ionospheric parameters to the above institution and to the Radio Research Station, Slough, England, was continued. Magnetic storm data were sent every quarter to Prof. John A. Simpson of the University of Chicago. Mean hourly values of horizontal force at Kodaikanal between 1500 and 2400 hrs. U. T. were sent every month, beginning from May 1957, to Prof. J. Bartels, University of Göttingen, Germany, in connection with the Equatorial Ring Current Project.

Instruments.—The present instrumental equipment of the observatory can be broadly classified under the following heads:—

(*a*) *Astronomical and spectroscopic instruments*

(1) Six-inch Cooke Equatorial with a grating spectroscope attached for observing prominences.

(2) Six-inch Lerebours and Secretan Equatorial, reconstructed by Grubb for direct solar photography. A five-inch astrographic camera is also mounted on the same equatorial.

(3) Six-inch stellar telescope by T. Cooke and Sons, York.

(4) 20-inch Reflecting telescope by Grubb.

(5) 8-inch Refracting Telescope.

(6) Six-inch transit instrument and barrel chronograph.

(7) 4½-inch refractors—2 Nos. (one by Cooke and another by Grubb).

(8) Spectroheliograph made by the Cambridge Scientific Instrument Co., with an 18-inch Cooke siderostat and 12-inch Cooke photovisual lens of 21-ft. focal length, used for photographs in the K line.

(9) An auxiliary spectroheliograph using a 6-inch Anderson grating designed and built in this observatory is attached to the above for taking spectroheliograms in the H-alpha line.

(10) Hale spectrohelioscope together with a five-inch coelostat kindly loaned by the Mt. Wilson Observatory. A camera is attached to the instrument for photographing the spectra of solar flares, prominences, etc. simultaneously with their visual observation. The camera gives a dispersion of about 3A/mm. in the 3rd order.

(11) Spectrograph I : With 3½-prisms in Littrow mount and about 14 ft. focus, designed and built in this observatory. This is fed by a 12-inch Foucault siderostat in conjunction with an eight-inch lens.

(12) Spectrograph II : 10 ft. concave grating in Rowland mounting designed and built in this observatory. A 10-inch polar siderostat designed and constructed in this observatory feeds this spectrograph independently. The polar siderostat is working temporarily with a 6-inch mirror until a mirror of appropriate size becomes available.

(13) Spectrograph III : 20 ft. plane grating spectrograph in Littrow mount using a 6¼-inch Michelson grating, designed and built in this observatory. The spectrograph is so constructed that the grating can be quickly moved aside by turning a handle and a system of 3½ prisms can be brought into use in its place.

The spectrograph is fed by the 18-inch Foucault siderostat in conjunction with the 21-foot Cooke photovisual lens and an auxiliary mirror. Alternatively it can also be fed by a 12-inch coelostat, designed and built at this observatory in conjunction with a 40 ft. lens.

(14) Spectrograph IV : Grating spectrograph in angular mounting with collimator lens of about 7 ft. focus and camera lens of about 14 ft. focus using a 3¼ inch Rowland plane grating, designed and built in this observatory.

The spectrograph is fed by the 18-inch Foucault siderostat in conjunction with either an 18-inch parabolic mirror of 10 ft. focal length or an 8-inch lens of 10 ft. focal length.

(15) Spectrograph V: 20 ft. concave grating spectrograph, in Eagle mount designed and built at the observatory.

The spectrograph can be fed either by the 18-inch Foucault siderostat and 21-foot Cooke photovisual lens or by the 12-inch coelostat and the 40 ft. lens.

(16) Spectrograph VI : With 1½ prisms in Littrow mount and 6 feet focal length, designed and constructed at the observatory specially for eclipse observation. The spectrograph has been constructed so as to be capable of rotation about the optical axis. Sunlight is fed into the spectrograph from a coelostat also constructed at the observatory.

(17) Hilger E315 Quartz spectrograph.

(18) Standardising spectrograph.

(19) Cambridge photoelectric microphotometer.

(20) Harward Visual Sky Photometer.

(21) Dobson Ozone Spectrophotometer.

(22) Two monochromators to work in conjunction with solar spectrographs (designed and built in this observatory).

(23) Direct Recording Photoelectric Spectrophotometer (designed and built in this observatory) for solar line-contour work.

(24) Large Lummer Interferometer (Quartz) by Hilger.

(25) Fabry-Perot Etalon.

(26) Photoelectric non-recording sky Photometer (designed and built in this observatory) for visual study of sky radiation.

(27) Three Hilger comparators for measuring spectrograms.

(28) Large Induction Coil capable of giving up to 16-inch sparks.

(29) Large Dubois Electromagnet.

(30) Four mean time clocks—

(i) Kullberg M. 6326,

(ii) Shelton,

(iii) Arnold and Dent,

(iv) W. Ottway and Co.

(31) One sidereal clock by T. Cooke and sons, York.

(32) Three mean time chronometers—

(i) Kullberk No. 6299,

(ii) Frodsham No. 3476,

(iii) Mercer No. 19443.

(33) Two tape chronographs, one by Fuess and the other by Breguet.

(34) Cooke Theodolite.

(35) Meridian Circle (by Troughton & Simms) belonging to the old Madras Observatory. It is at present dismantled.

(b) *Magnetic Instruments*

(36) Kew Magnetometer No. 3.

(37) Earth Inductor (No. 46, Wild pattern) by Schulze of Potsdam.

(38) Horizontal Force Magnetograph (Watson type).

(39) Vertical Force Magnetograph (Watson type).

(40) Declination Magnetograph (Watson type).

(41) Dip Circle (Kew Pattern).

(42) La Cour H. D. and V. Magnetographs.

(43) Askania Magnetic Field Balance with photoelectric recording outfit.

(44) La Cour Quartz Horizontal Magnetometer.

(45) La Cour Magnetometric Zero Balance.

(46) Quick-run Recorder for use with Askania Magnetic Field Balance.

(c) *Electronic Instruments*

(47) Multi-Frequency Automatic Ionosphere Recorder C. R. P. L. Model C-3.

(48) Dawe Universal Impedance Bridge Model—314A.

(49) Taylor Valve Tester.

(50) Avo Wide Range Signal Generator.

(51) Cossor Double-beam Oscilloscope—Model 1035.

(52) Marconi Valve Voltmeter.

(53) Marconi Video Oscillator.

(54) Marconi Signal Generator—Type 801 A.

(55) Megacycle Meter.

(56) Dawe Pulse Generator—Type 412 A.

(57) Hallicrafters Receiver—Type SX-62.

(58) B.P.L. Resistance—Tuned Oscillator—Model Lo63.

(59) Dawe Q-Meter—Type 622 C.

(60) Eddystone Receiver—Type 504.

(61) Browning Oscillosynchroscope—Model GL-22A.

(62) Browning Sweep Calibrator—Model GL-22A.

(63) Squarewave and Pulse Generator—Cintel-Type 1873.

(64) R. F. Impedance Bridge with Oscillator-detector Unit.

(65) 100 Mc/s. Radio Telescope (designed and built in this observatory).

(66) Three Hammarlund Communication Receivers.

(67) Avo Electronic Testmeter.

(68) Nagard High Gain D. C. Amplifier.

(69) Absorption Wavemeter (E.M.I.).

(70) 10 Cm. Solar Radiometer—Model J. 76.

(71) Marconi Noise Generator—Type T. F. 1106.

(72) Measurement Corporation Model 80 Standard Signal Generator.

(73) Sorensen Voltage Regulator Model 1000 (manufactured by Messrs. J. Langham Thompson, England).

(74) 200 Mc/sec. Radio Telescope (designed and built in this observatory).

(d) *Workshop-machinery*

(75) 6″ Cooke Lathe.

(76) 5″ Wilfin Lathe.

(77) 5″ Jessop Lathe.

(78) 'Victoria' Model U2 Milling Machine.

(79) 'Cooper' 24-inch Shaping Machine.

(80) 'Cobra' 9-inch Hacksaw Machine.

(81) 'Cruickshank' Combined Grinding & Buffing Machine.

(82) 'Adcock & Shipley' Slitting Machine.

(83) Canedy 'Otto' Drilling Machine.

(84) 'Davla' Saw Bench.

(85) Smith's Hearth.

(86) Adcock & Shipley Optical Centring Lathe.

(87) Arc Welding set with Welding Transformer Type TR 260.

(88) Westalite Oil Immersed Rectifier Set Type LOP12/125.

(e) *Other Instruments*

(89) Small dividing engine by the Cambridge Scientific Instrument Co., Ltd.

(90) Milne-Shaw Seismograph (E-W component)

(91) A complete set of meteorological instruments.

(92) Kolhörster Cosmic Ray Recorder.

(93) Microscope 2 Nos.

(94) Aldis Epidiascope.

(95) 16 mm. cine Projector.

(96) Leica M3 Camera.

(97) Prado 35 mm. Projector.

Weather Conditions.—Weather conditions were less favourable during 1957 for solar observations than in the previous year. Photoheliograms were made on 282 days and visual observations were possible on 278 days as compared to 309 and 305 days respectively in 1956. H-alpha disc, K-disc and K-prominence spectroheliograms were secured on 261, 259 and 258 days as against 301, 293 and 267 days respectively in the previous year. Observations with the spectrohelioscope were made on 253 days.

The average definition of the sun's image on a scale in which 1 is the worst and 5 the best was 3. There were 39 days on which the definition was 4 or better.

Sunspot Activity.—Sunspot activity continued to be on the increase during the year. The mean latitude (for the year) of all the observed spotgroups in the northern and southern hemispheres was 19·2 and 18·9 respectively as against 24·6 and 21·0 for the previous year. Details of sunspot observations are given in the following table :

1957 Months		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
No. of new spotgroups	N	16	13	17	20	9	10	13	13	12	28	16	23	190
	S	13	15	17	19	17	11	12	22	17	15	14	24	196
TOTAL		29	28	34	39	26	21	25	35	29	43	30	47	386
Mean daily number of spotgroups.		7·52	6·81	7·32	8·27	6·76	6·87	7·89	7·33	7·37	10·17	9·50	9·79	7·79
Kodaikanal daily relative sunspot number.		122·9	101·0	114·5	126·4	109·4	122·4	123·0	123·4	171·3	210·8	198·4	202·5	143·8

Solar Flares.—24 solar flares were observed during the year, 16 of intensity 1 and 8 of intensity 2.

Prominences.—During 1957 prominence activity continued to be high, although there was a slight decrease compared to 1956. The mean daily areas and numbers of calcium prominences at the limb

as derived from photographs obtained at Kodaikanal were as follows :—

1957	Area in Sq. minutes					Numbers				
	N	S	E	W	Total	N	S	E	W	Total
January–June	2·72	2·32	2·48	2·56	5·04	4·91	4·19	4·36	4·74	9·10
July–December	3·22	2·06	2·24	3·04	5·28	4·68	3·68	3·77	4·59	8·36
Whole year (weighted mean)	2·92	2·23	2·39	2·76	5·15	4·82	4·00	4·13	4·69	8·82

This shows that since 1956 prominence activity as represented by areas and numbers had slightly decreased, the decrease in area being 13% and that in numbers 7%.

The distribution of areas, in the northern hemisphere in five-degree ranges of latitude showed two peaks of activity in the zones 35°-40° and 60°-65° with a secondary maximum at 10°-15°. In the southern hemisphere the maximum activity was at 35°-45°. The activity in the southern hemisphere continued to be less than in the northern hemisphere. The eastern preponderance in prominence area observed last year has changed into a western preponderance during 1957.

Doppler displacements of the H-alpha line in prominences and absorption markings observed with the prominence spectroscope and the spectrohelioscope are summarised below :

	North	South	East	West	To Red	To Violet	Both ways	Total
Prominences	119	101	110	110	..	..	220	220
Dark Markings	7	14	9	12	..	1	20	21

The heights of 47 fairly tall prominences were measured in H-alpha, D3 and H-beta lines with the prominence spectroscope. These were compared with the corresponding heights in the K line as obtained from the spectroheliograms. The average heights were :

K	H-alpha	D3	H-Beta
85″·1	71″·4	56″·1	49″·6

12 instances of sudden disappearance of disc absorption markings and limb prominences were observed during the year.

The mean daily areas and numbers of hydrogen absorption markings on the disc as obtained from Kodaikanal records are given in the following table :—

1957	Area in millionths of the sun's visible hemisphere (uncorrected for foreshortening)					Number				
	North	South	East	West	Total	North	South	East	West	Tota
January–June	2567	2558	2368	2757	5125	13·77	13·59	13·04	14·32	27·36
July–December	2377	2334	2237	2674	4911	15·50	13·96	13·91	15·55	29·46
Whole year (weighted mean)	2572	2469	2316	2725	5041	14·49	13·75	13·41	14·83	28·24

Compared with the previous year, the activity as judged by areas showed a slight increase of 3% while the numbers showed a decrease of 6%. The peaks of activity, according to the areas, in both the hemispheres were at 35°—40°. The activity as judged both by areas and numbers of absorption markings was less in the southern hemisphere. The western preponderance in area shown by limb prominences is also evident from the area of absorption markings.

Radio-astronomy.—Work in connection with the installation of a 10 Cm radiometer was in progress.

Geomagnetic Observations.—Continuous photographic recording of H, Z and D with Watson and La Cour Magnetographs and visible recording of H with an Askania Field Balance were continued. Values of H, Z and D were determined weekly with QHM Nos. 254, 255 and 256 and a BMZ. Absolute measurements of H with the Kew Magnetometer and those of inclination with an earth inductor were also made once every month.

During the year under review 32 magnetic storms including 25 storms of SC type were recorded with ranges in H.F. between 165 γ and 708γ.

Ionospheric Observations.—Round-the-clock ionospheric observations and the recording of field-intensity on two frequencies were continued. Intensive ionospheric observations were also made according to I. G. Y. schedule.

Cosmic-ray.—Photographic recording of cosmic-ray intensity was continued using a Kolhörster Cosmic-Ray Apparatus.

Ozone.—Regular observations of atmospheric ozone were made with the Dobson Spectrophotometer.

Seismology.—The Milne-Shaw Seismograph (E-W component) recorded 127 earthquakes.

Meteorology.—Meteorological observations with all the visual and self-recording instruments were carried out as usual.

Library.—138 books and 1914 periodicals were added to the library.

Research work.—Under the Research Training Scheme sponsored by the Ministry of Education, Government of India, four Senior Research Scholars were working in this observatory.

The following problems in Astrophysics and Geophysics were under investigation :—

(1) Determination of the absolute values of the wave-lengths of solar spectrum lines in order to determine how much of their red-shifts can be accounted for by the Theory of Relativity.

(2) Determination of "Deuterium" on the sun.

(3) Study of the distribution of intensity in the various features of the sun's disc with the help of a Moll thermo-couple and a thermo-relay.

(4) Simultaneous measurement of the temperature and the magnetic field of sunspots.

(5) Distribution of calcium flocculi on the sun's disc.

(6) Further study in scattering of radio-waves by ionospheric F-layer and some related geomagnetic phenomena.

(7) The behaviour of night-time sporadic E-layer at Kodaikanal.

(8) Disturbances in the ionospheric F2 layer associated with Geomagnetic Storms.

(9) The relationship of ionospheric F2 layer ionic density with various features of solar activity.

(10) On causes of time-lag between ionospheric sunrise and F-layer sunrise effect.

Publications.—The following papers and notes were published or prepared for publication :—

(1) "Comet Arend-Roland (1956 h)"—Journal of Scientific and Industrial Research.

(2) "Does Magneto-hydrodynamics explain certain solar phenomena better than classical Dynamics?"—To be presented at the symposium on Magneto-hydrodynamics held under the auspices of the Atmospheric Research Committee.

(3) Observations of Spread Echoes from the F-layer over Kodaikanal—A preliminary study—Indian Journal of Meteorology & Geophysics.

(4) Quarterly synopses of results of solar, magnetic and ionospheric observations—Indian Journal of Meteorology and Geophysics.

(5) Annual Report of the Kodaikanal Observatory for 1956.

(6) Kodaikanal Observatory Bulletin No. 145—Summary of results of solar and magnetic observations for the first half of 1955.

(7) Kodaikanal Observatory Bulletin No. 146—Summary of results of solar and magnetic observations for the second half of 1955 and summary of ionospheric observations from September to December 1955.

(8) Kodaikanal Observatory Bulletin No. 147—Summary of results of solar, magnetic and ionospheric observations for the first half of 1956.

(9) Kodaikanal Observatory Bulletin No. 148—Summary of results of solar, magnetic and ionospheric observations for the second half of 1956.

(10) Kodaikanal Observatory Bulletin No. 149—"Centre-limb variation of solar excitation temperature as derived from Ti I lines".

(11) Reports to the Royal Astronomical Society London on—(a) The work of the Kodaikanal Observatory, and (b) Prominence activity for the year 1956.

(12) Observations of Mars during the 1954 and 1956 oppositions —To be published as a Kodaikanal Observatory Bulletin.

(13) Magnetic Field of Venus—To be published as a Kodaikanal Observatory Bulletin.

(14) Results of Mars Observations—Indian Journal of Meteorology & Geophysics.

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KODAIKANAL OBSERVATORY,
May 1958.

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