ANNUAL REPORT* OF THE KODAIKANAL OBSERVATORY FOR THE YEAR 1953.

General:—Concrete proposals were submitted to the Government for acquiring for this observatory a Polarising Monochromator of the latest type, an 8″ Coronagraph and a large Solar Telescope and Spectrograph.

The Standing Advisory Board for Astronomy and Astrophysics in India was reconstituted by Government for another period of three years.

International Cooperation:—Exchange of spectroheliograms with foreign observatories was continued. 773 K-disc spectroheliograms for the period January 1951 to September 1953 were sent to the Director, The Observatories, Cambridge University. 8 photo-heliograms together with the relevant zero plates for certain specified dates in 1951-52 were sent to the Royal Greenwich Observatory on request. 32 H-alpha and 42 K-disc spectroheliograms for the period July 1952 to June 1953 were received from Meudon Observatory, France. 124 H-alpha disc spectroheliograms for the period January 1952 to June 1953 were also received from the Mount Wilson Observatory, U.S.A.

Quarterly statements relating to solar flares were sent as usual to Dr. L.d'Azambuja of the Meudon Observatory and to Mr. H. W. Newton of the Royal Greenwich Observatory.

The practice of broadcasting daily URSIGRAMMES relating to solar and geomagnetic activity and of issuing warnings for expected ionospheric and geomagnetic disturbances was continued.

With effect from April 1953 the Chief, Central Radio Propagation Laboratory, National Bureau of Standards, Washington D.C., U.S.A. was supplied with the monthly median values of F2 layer critical frequency and the maximum usable frequency factor for 3000 km transmission as observed at Kodaikanal. Monthly median values of all other ionospheric parameters are also supplied to him quarterly.

Instruments:—The present instrumental equipment of this 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, re-constructed by Grubb for direct solar photography. A five-inch astrographic camera is also mounted on the same equatorial.

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* This report deals chiefly with the astronomical work of the Kodaikanal Observatory. The meteorological data will be published in the India Weather Review and the administrative details will be incorporated in the annual report of the India Meteorological Department.

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

(4) 20-inch Reflecting telescope by Grubb received from the Takhtasinghji Observatory at Poona in 1912.

(5) Six-inch transit instrument and barrel chronograph made by the Cambridge Scientific Instrument Company.

(6) 8-inch refracting telescope. The telescope was assembled and is now ready for installation.

(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 a 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. The camera which was in use with the spectrohelioscope since 1949 was reconstructed during the year. With the present arrangement the camera gives a dispersion of about 3 A/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: Angular grating spectrograph 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 observations. 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 (primary mirror 7″ in diameter and secondary mirror 6″ in diameter) also constructed at the observatory.

(17) Hilger E315 Quartz spectrograph.

(18) Standardising spectrograph.

(19) Cambridge photoelectric microphotometer.

(20) Harvard Visual Sky Photometer.

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

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

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

(24) Photoelectric non-recording Sky photometer (designed and built in this observatory) for visual study of sky radiation.

(25) Three Hilger comparators for measuring spectrograms.

(26) Large Induction coil capable of giving upto 16-inch sparks.

(27) Large Dubois Electromagnet.

(28) Four mean time clocks—

(i) Kullberg M.6326,

(ii) Shelton,

(iii) Arnold and Dent,

(iv) W. Ottway and Co.

(29) One sidereal clock by T. Cooke & Sons, York.

(30) Three mean time chronometers—

(i) Kullberg No. 6299,

(ii) Frodsham No. 3476,

(iii) Mercer No. 19443.

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

(32) Cooke Theodolite.

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

(b) *Magnetic Instruments.*

(34) Kew Magnetometer No. 3.

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

(36) Horizontal Force Magnetograph (Watson type).

(37) Vertical Force Magnetograph (Watson type).

(38) Declination Magnetograph (Watson type).

(39) Dip circle (Kew pattern).

(40) La Cour, H, D and V magnetographs.

(41) Askania Magnetic Field Balance with photo-electric recording outfit.

(c) *Electronic Instruments.*

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

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

(44) Taylor Valve Tester.

(45) Avo Wide Range Signal Generator.

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

(47) Marconi Valve Voltmeter.

(48) Marconi Video Oscillator.

(49) Marconi Signal Generator Type 801A.

(50) Megacycle Meter.

(51) Dawe Pulse Generator Type 412A.

(52) Hallicrafter's Receiver type SX-62.

(53) B.P.L. Resistance—Tuned Oscillator Model L063.

(54) Dawe O-Meter type 622 C.

(55) Eddystone Receiver type 504.

(56) Browning Oscillosynchroscope—Model OL-15-B.

(57) Browning Sweep Calibrator Model GL-22A.

(58) Squarewave and Pulse Generator-Cintel type 1873.

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

(60) 100 Mc/s. Radio telescope (designed and built in this observatory).

(*d*) *Workshop Machinery.*

(61) 6″ Cooke Lathe.

(62) 5″ Wilfin Lathe.

(63) 5″ Jessop Lathe.

(64) 'Victoria' Model U2 Milling Machine.

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

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

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

(68) 'Adcock & Shipley' Slitting Machine.

(69) Canedy 'Otto' Drilling Machine.

(70) 'Davla' Saw Bench.

(71) Smith's Hearth.

(*e*) *Other Instruments.*

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

(73) Milne-Shaw Seismograph (E.W component only).

(74) A complete set of meteorological instruments.

(75) Kolhörster's Cosmic Ray Recorder.

(76) Microscopes—2 Nos.

(77) Aldis Epidiascope.

A number of auxiliary instruments such as galvanometers photocells, thermorelays etc. are also available.

Weather conditions: Weather conditions during the year were less favourable for solar observations than in the previous year. Photoheliograms were taken on 296 days and visual observations of the sun were made on 295 days as against 306 and 319 days respectively in 1952. H-alpha disc, calcium disc and calcium prominence spectroheliograms were obtained on 285, 273 and 254 days respectively as compared with 301, 282 and 269 days in the previous year. Observations with the spectrohelioscope were made on 283 days.

The average definition of the sun's image on a scale in which 1 is the worst and 5 the best was 3·1 as compared with 2·8 in 1952. There were 38 days on which the definition was 2 or less and 61 days on which the definition was 4 or more.

Sunspot activity : There was a further steep decrease in sunspot activity during the year, the decrease being 60% compared with 1952. There were 142 spot-free days out of the total of 296 days of observation as against 38 spot-free days in 1952. The yearly mean latitude of all the observed spots in the northern and southern hemispheres was 9° and 8·4° respectively as against 9·5° and 9·7° for the previous year. There were 5 groups in the north and 4 in the south hemisphere within the latitude range 0° to 5°. Details of sunspot observations are given in the following table:—

Month		Jan.	Feb.	Mar.	Apr.	May	June	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Number of new spot-groups.	N	6	1	4	1	1	3	Nil	3	1	1	Nil	Nil	21
	S	2	Nil	3	2	1	1	1	1	1	3	1	2	18
Total .		8	1	7	3	2	4	1	4	2	4	1	2	39
Mean daily numbers .		2·08	0·04	0·65	1·20	0·87	1·12	0·50	1·35	0·87	0·37	0·14	0·09	0·82
Kodaikanal daily relative sun-spot No.		27·6	4·4	7·5	20·6	11·3	15·0	7·0	17·0	10·3	5·9	1·6	1·0	10·77

Solar flares : Three solar flares, all of intensity one, were observed during the period.

PROMINENCES

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

1953	Area (in sq. minutes)					Number				
	North	South	East	West	Total	North	South	East	West	Total
January–June	0·90	0·92	0·78	1·04	1·82	3·63	3·43	3·17	3·89	7·06
July–December	0·99	0·99	0·92	1·06	1·98	3·47	3·53	3·34	3·66	7·00
Whole year (weighted mean)	0·94	0·95	0·84	1·05	1·89	3·56	3·47	3·24	3·79	7·03

Compared with the previous year prominence activity as represented by areas shows a decrease of about 19% while the numbers show a decrease of about 16%.

The distribution of areas in 5° ranges of latitude shows maximum activity in the zone 35°-40° in both the hemispheres. There is a secondary maximum of activity between 20°-25° in the northern hemisphere and two secondary maxima between 10°-15° and 20°-25° in the southern hemisphere. There was very little activity beyond 45° in both the hemispheres. The east-west distribution of prominences showed that both areas and numbers were in excess on the west limb.

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

	North	South	East	West	To red	To violet	Both ways	Total
Prominences	21	7	16	12	2	1	25	28
Dark markings	12	2	8	6	..	..	14	14

The heights of 13 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	D_3	H-beta
50·1	47·0	43·1	40·8

There were 6 occasions during the year when sudden disappearances of hydrogen absorption markings on the disc or of prominences on the limb were observed.

One metallic prominence was observed during the year.

An eruptive prominence was observed on the NE limb between 0430 and 0545 U.T. on 26th February 1953. The prominence reached a maximum height of 260″ after which it disintegrated. Maximum Doppler shifts of about 6A to red were observed in some parts of the prominence. An interesting feature associated with this eruptive prominence was a synchronous radio noise burst recorded by the 100 Mc/s. Radio Telescope of this observatory (Nature, Vol. 132, pp. 446).

The mean daily areas and numbers of hydrogen absorption markings on the disk as obtained from Kodaikanal records are given below:

1953	Area (in millionths of the sun's visible hemisphere) uncorrected for foreshortening					Number				
	North	South	East	West	Total	North	South	East	West	Total
Jan.-June .	621·7	583·2	589·0	615·9	1204·9	5·96	5·73	5·86	5·83	11·69
July–Decr. .	686·3	351·7	510·2	527·8	1038·0	7·50	4·13	5·61	6·02	11·63
Whole year (weighted mean).	650·6	483·9	555·7	578·8	1134·5	6·64	5·04	5·76	5·92	11·68

Compared with the previous year's values both the areas and numbers show a decrease of 38%.

The distribution of areas in 5° ranges of latitude shows two peaks of activity in both the hemispheres, between 20°-25° and 40°-45° in the northern hemisphere between 5°-10° and 35°-40° in the southern hemisphere. There was little activity of dark markings between latitude 50°. Both areas and numbers of H-alpha dark markings show western excess.

Radio Astronomy: Recording of solar noise at 100 Mc/s. was continued with a Radio Telescope with a twin Yagi type of antenna.

Geomagnetic observations: Continuous photographic recording of H. V. and D. with Watson and La Cour magnetographs was continued. Visible recording of the horizontal force with an Askania Magnetic Field Balance was commenced in April. Absolute measurements of H and D were made once a week with a Kew Magnetometer and observations of inclination on 5 days in the week with an earth inductor.

During the year 15 magnetic storms with range in H>150 γ were recorded as compared with 25 in 1952. Of these 5 were of the sudden commencement type. No storms were recorded with ranges in H exceeding 400 γ

Ionospheric observations: Regular ionospheric observations during daylight hours with the Automatic Ionosphere Recorder were continued.

Cosmic Ray observations: Photographic recording of cosmic ray intensity was continued using a Kolhörster apparatus.

Seismology : The Milne-Shaw Seismograph (E-W component) recorded 122 earthquakes.

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

Library: 36 books and 832 periodicals were added to the library.

Research work: Under the Research Training Scheme sponsored by the Ministry of Education, Government of India, two senior and 2 junior scholars were working in the observatory.

The following problems in solar physics and geophysics were investigated during the year:—

(1) Experimental study of centre-to-limb variation in the intensity of the continuous spectrum of the sun,

(2) Measurement of the difference of temperature between the equator and the pole of the sun by spectroscopic method,

(3) Study of Radiation Flux across sunspots,

(4) Investigation of the sporadic E-layer at Kodaikanal,

(5) Investigation of very long sequences of geomagnetic activity associated with Solar M-regions,

(6) Lunar stratification of the F2 layer of the ionosphere,

(7) Variation in the D-layer absorption.

Publications: The following notes and papers were published or sent for publication during the year :—

(1) "Temperature at Pole and Equator of the Sun" *Stratton Volume,*

(2) "Temperature at Pole and Equator of the Sun" (Abstract), *Nature.*

(3) "Eruptive Prominence of 1953 February 26 and associated Radio Noise Burst", *Nature.*

(4) "Can Matter be Created out of Cosmic Radiation" *Die Naturwissenschaften.*

(5) "Radio Noise Bursts from Solar M-Regions", *Nature.*

(6) "Geomagnetic Activity and the Sunspot Cycle", *Nature.*

(7) "The Sporadic E-layer at Kodaikanal" *Journal of Geophysical Research.*

(8) "Very long sequences of Geomagnetic Activity and its annual Variation", *Nature.*

(9) "Study of the Continuous Solar Spectrum in the Visible Range", *Annales d'Astrophysique.*

(10) "Radiation Flux in Sunspot Umbrae", Paper II *Zeitschrift für Astrophysik.*

(11) "Study of Diurnal Variation of the Horizontal Component of the Magnetic Field at Kodaikanal", *Indian Journal of Meteorology & Geophysics.*

(12) "Altitude and Azimuth of the Sun" *Indian Journal of Meteorology & Geophysics.*

(13) "Kodaikanal Observatory Bulletin No. 136 for the 2nd half of 1951 giving the summary of the results of solar and magnetic observations".

(14) Kodaikanal Observatory Bulletin No. 137—"Discussion of the results of observations of solar prominences made at Kodaikanal from 1904 to 1950".

(15) "Kodaikanal Observatory Bulletin No. 138 for the 1st half of 1952 giving the summary of the results of solar and magnetic observations."

(16) "Quarterly synopsis of solar, geomagnetic and ionospheric observations made at Kodaikanal" *Indian Journal of Meteorology & Geophysics.*

(17) "Annual Report of the Kodaikanal Observatory for 1952".

KODAIKANAL :
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