ANNUAL REPORT* OF THE KODAIKANAL OBSERVATORY FOR THE YEAR 1952

General :—The Director attended the 8th General Assembly of the International Astronomical Union held at Rome in September and participated in the meetings and deliberations of the Assembly. Later he visited a number of astrophysical institutions in Europe and U. K. in order to see the latest developments in astrophysics, particularly on the instrumental side.

International co-operation :—Exchange of spectroheliograms with foreign observatories was continued as before. 74 H-alpha flocculus and 69 calcium disc spectroheliograms taken at Kodaikanal during the years 1945, 46 and 47 were sent to Dr. L. d'Azambuja, Director, Meudon Observatory, France, on request. 650 photographs of K-prominences at the limb pertaining to the years 1943-50 obtained from Mt. Wilson Observatory were sent to the Director, Arcetri Observatory, Florence, Italy. 40 H-alpha and 53 K_3 disc spectroheliograms relating to the period July 51-June 52 were received from the Meudon Observatory, France. Periodical solar flare statements were sent as usual to Dr. L. d'Azambuja of Meudon Observatory and Mr. H. W. Newton of the Royal Greenwich Observatory.

The practice of broadcasting daily URSIGRAMMES relating to solar activity and of issuing warnings for expected ionospheric and geomagnetic disturbances, was continued as in the previous year. From June 1, 1952 broadcasting of URSIGRAMMES relating to geomagnetic activity (based on Kodaikanal observations) was begun ; these URSIGRAMMES are broadcast daily along with solar URSIGRAMMES.

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, 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 received from the Takhtasinghji Observatory at Poona in 1912.

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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.

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

(6) 8-inch refracting telescope—to be mounted.

(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. A camera is attached to the instrument for photographing the spectra of solar flares, prominences etc. simultaneously with their visual observation.

(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 $1\frac{1}{2}$ prisms in Littrow mount and 6 feet focal length, designed and constructed at the observatory specially for observing the total eclipse of the sun on February 25, 1952. 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—15B.

(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, photo-cells, thermorelays etc. are also available.

Weather conditions :—Weather conditions during the year were more favourable than in the previous year both as regards the number of days of observation and the quality of definition. Photographic observations were possible on 306 days while visual observations could be made on 319 days as compared with 298 and 311 days respectively during 1951. The average definition of the sun's image estimated on a scale in which 1 is the worst and 5 the best was 2·82 compared with 2·76 in 1951. There were 71 days on which the definition was 2 or less and 40 days on which it was 4 or more.

Routine observations :—Observations with the photoheliograph, prominence spectroscope, spectrohelioscope and the spectroheliographs were carried out as before. Photoheliograms were obtained on 306 days, H-alpha and calcium disc spectroheliograms on 301 and 282 days respectively and calcium prominence photographs on 269 days, as compared with 298, 292, 285 and 276 days respectively in the previous year. Visual observations and drawings of sunspots were made on 319 days as against 311 days in 1951. Observations with the spectrohelioscope were possible on 309 days during the year compared with 299 days in 1951.

Sunspot activity :—There was considerable decrease in sunspot activity during the year. The details are given below :

Month		Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Number of new spot-groups.	N	12	1	2	6	1	6	5	7	3	3	3	4	53
	S	5	5	7	3	4	7	4	4	3	3	2	4	51
Total .		17	6	9	9	5	13	9	11	6	6	5	8	104
Mean daily no. of spot-groups.		2·8	1·6	1·5	1·6	1·5	2·7	2·3	3·2	1·9	1·3	1·3	2·2	1·99
Kodaikanal mean relative sun-spot number.		38·6	21·7	20·6	25·6	19·5	32·5	30·0	44·8	25·0	18·3	19·5	32·6	27·4

Compared with 1951, the decline in activity was steep, the decrease being 51 percent in the total number of new groups, 50 percent in the mean daily number of spotgroups and 55 percent in the relative sunspot number. There were 38 spot-free days out of the total number of days of observation during

the year as against none in 1951. The yearly mean latitude of all the spot-groups in the northern and the southern hemispheres separately was 9°·5 and 9°·7 respectively as against 11°·1 and 10°·1 for the previous year. There were 30 groups (15 in the north and 15 in the south) within the latitude range 0°–5° and three groups (two in the north and one in the south) whose mean latitude was more than 20°.

The largest spotgroup of the year traversed the disc between the 16th and the 27th November. Its total area, corrected for foreshortening, was 1100 millionths of the sun's visible hemisphere as measured on the photobeliogram of November 21, the day of its central meridian passage.

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

1952	Area (in sq. minutes)			Number		
	North	South	Total	North	South	Total
January-June	1·15	1·20	2·35	4·15	3·23	7·38
July-December	1·15	1·13	2·28	5·19	4·34	9·53
Whole year (weighted mean) . .	1·15	1·17	2·32	4·63	3·75	8·38

Compared with the previous year's values, prominence activity as represented by areas shows a decrease of 16 percent, while the numbers indicate an increase of 23 percent.

The distribution of areas in 5° ranges of latitude shows maximum activity in the zones 10°–15°N, 25°–30°N and 35°–40°S. A comparison with the distribution in 1951 reveals that in the north, in addition to the peak of activity at 25°–30° persisting since last year, another low latitude maximum has developed at 10°–15° and in the south the zone of maximum activity has shifted by 15° towards the equator. As in the previous year, practically no activity was observed in the high latitudes beyond 55° in both the hemispheres. The east-west distribution of prominences showed that areas were in excess on the west limb while the numbers were evenly distributed on either side.

Doppler shifts of the H-alpha line in prominences were observed on 5 occasions with the prominence spectroscope. Of these, 3 were in the northern hemisphere and 2 in the south. As regards their east-west distribution, 3 were seen on the east limb and 2 on the west.

The heights of 24 prominences in H-aplha, D_3 and Hβ lines were measured with the prominence spectroscope. These were compared with the corresponding heights in the K line as obtained from the spectroheliograms. The average heights were 66″·9 in K, 63″·2 in H-alpha, 59″·4 in D_3 and 57″·5 in Hβ.

There were 9 occasions during the year when sudden disappearances of hydrogen absorption markings on the disc or of prominences on the limb were observed.

Particulars of Doppler displacements of the H-alpha line in prominences and dark markings observed with the spectrohelioscope are tabulated below :

	Displacements towards			Total
	Red	Violet	Bothways	
Prominences	2	..	18	20
Dark markings	7	3	19	29

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

1952	Area (in millionths of sun's visible hemisphere) uncorrected for foreshortening.			Number.		
	North	South	Total	North	South	Total
January-June . .	1227·2	861·7	2088·9	11·20	7·75	18·95
July-December .	915·6	620·5	1536·1	10·89	7·55	18·44
Whole year (weighted mean).	1082·7	747·9	1830·6	11·06	7·66	18·72

Compared with the previous year's value, the mean daily area of the H-alpha absorption markings for the whole year shows a decrease of 35 percent and the number a decrease of 27 percent, the values for 1951 being 2815 and 25·76 respectively.

The distribution of areas in 5° ranges of latitude shows peaks of activity in the zones 10°–15°N, 0°–5°S and 35°–40°S. A comparison with previous year's distribution shows that, except for the peak at 35°–40°S, the chief centres of activity in both the hemispheres have again shifted towards the equator. As in the case of prominences at the limb, practically no activity of the markings was observed in the high latitudes $\pm$55°–90°. The east-west distribution of the absorption markings shows that both the areas and the numbers are in excess in the western hemisphere.

Eclipse Expedition :—An Indian eclipse expedition consisting of four members led by Dr. A. K. Das went to Iraq to observe the total solar eclipse of February 25 and set up camp at Artawi (latitude 30° 33′ 28″N longitude 47° 05′ 52″E) in the desert west of Basrah. Unfortunately the observational programme was frustrated by bad weather at the time of the eclipse.

Bhavnagar Telescope :—Preliminary adjustments of the 'Bhavnagar' telescope were carried out during the year in order to put the telescope into commission.

Geomagnetic observations :—As in previous years, continuous photographic records of horizontal, vertical and declination elements of the earth's magnetic field were made with Watson and LaCour magnetographs. A photoelectric recording H-magnetograph by Messrs. Askania Werke, Berlin, was under installation.

Absolute measurements of H and D were made once a week with Kew Magnetometer No. 3 and observations of inclination with an Earth Inductor on five days in the week.

During the year 25 magnetic storms of range $>150\gamma$ were recorded at Kodaikanal as compared with 24 in 1951. Of these, 6 were of the sudden commencement type. No storms were recorded with ranges in H exceeding 400γ.

Ionospheric observations :—Regular ionospheric observations were begun at Kodaikanal in January 1952 using type C-3 Ionosphere Recorder developed by the Bureau of Standards, Washington, the observations being restricted to daylight hours for the time being.

Radio Astronomy :—Continuous recording of solar noise flux was commenced using a 100 Mc/s radio-telescope.

Cosmic ray observations :—Continuous photographic recording of cosmic ray intensity was made throughout the year using a Kolhörster apparatus.

Seismology :—The Milne-Shaw Seismograph (E-W component) recorded 213 earthquakes during the year. Of these 4 were severe and 11 moderate.

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

Time-service :—The standard clocks of this observatory were rated by comparison with Greenwich time signals.

Library :—81 books and 1143 priodicals were added to the library during the year. The library now has some 1000 books and 10000 periodicals relating to astronomy, astrophysics, physics, mathematics and allied subjects.

Workshop :—The machine shop of the observatory was equipped with a milling machine, a shaping machine, a back sawing machine, a slitting machine and a new lathe.

Research work and publications :—Under the Research Training Scheme sponsored by the Ministry of Education (Government of India), two junior scholars and one senior scholar were working in this observatory during the year.

The following are the more important problems in solar physics which were under investigation during the year :—

(*a*) Experimental study of centre-to-limb variation in the intensity of continuous spectrum over the solar disc throughout the photographic region of the spectrum,

(*b*) Study of the Balmer discontinuity in the solar spectrum,

(*c*) Determination of the temperature of the sun at the pole and the equator,

(*d*) Study of radiation flux across sunspots, and

(*e*) Study of solar noise at 100 Mc/s with a specially constructed receiver and recorder.

In geophysics, certain aspects of the variations in the earth's magnetic field as revealed by the Kodaikanal magnetograms, such as the study of the diurnal variation of the horizontal force at Kodaikanal by harmonic analysis, sudden commencements in geomagnetic field variations at Kodaikanal, lunar magnetic and ionospheric variations at Kodaikanal etc. were under investigation. Analysis of the cosmic ray records to study the periodic and non-periodic variations in cosmic ray intensity was in progress. Certain interesting features brought out by ionospheric observations such as the disappearance of ionospheric echoes at Kodaikanal in the pre-dawn period and their reappearance from greater virtual heights at about ground sunrise etc. were studied. The study of fbEs and Fmin and of their relationship with solar and geomagnetic phenomena was taken up.

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

(1) " Prominence Activity and the Sunspot Cycle ", *Nature.*

(2) " Distribution of Radiation flux across Sunspots ", *Zeitschrift Für Astrophysik.*

(3) A short article on ' Kodaikanal Observatory ', *Nature.*

(4) A note on " The Indian Eclipse Expedition to Iraq ", *Indian Jl. of Met. and Geophysics.*

(5) A short note on the meeting of the 8th General Assembly of the International Astronomical Union held at Rome in September 1952, *Indian Jl. of Met. and Geophysics.*

(6) " A New Early Morning Ionospheric Phenomenon ", *Nature.*

(7) " Solar Noise Burst of 1952 April 11 and associated ionospheric and geomagnetic disturbances ", *Indian Jl. of Met. and Geophysics.*

(8) " Spectrophotometric Study of Sunspots ", *Proc. Indian Acad. of Sci.*

(9) Kodaikanal Observatory Bulletin for the 1st half of 1951 giving summary of the results of prominence and magnetic observations.

(10) Synopsis of solar and geomagnetic observations made at Kodaikanal during the 4th quarter of 1951 and 1st, 2nd and 3rd quarters of 1952 and synopsis of ionospheric observations made at Kodaikanal during the 3rd quarter of 1952, *Indian Jl. of Met. and Geophysics.*

The Annual Report of Kodaikanal Observatory for the year 1951 was sent to the press for printing.

A. K. DAS,

KODAIKANAL ; *Director,*

March 1953. *Kodaikanal Observatory.*

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