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ANNUAL REPORT* OF THE KODAIKANAL OBSERVATORY FOR THE YEAR 1951

General

The Golden Jubilee of the observatory was celebrated in September. The event was marked by the inauguration of the newly built Ionospheric Laboratory and of the newly installed "Bhavnagar Telescope" (a 20-inch Cassegrain Reflector constructed by Grubb which originally belonged to the now defunct Poona Observatory named after Maharajah Takhtasinghji of Bhavnagar). A souvenir pamphlet describing the activities of the observatory during the past 50 years was brought out on the occasion.

The 2nd meeting of the Standing Advisory Board for Astronomy was held soon after the Jubilee celebrations, when matters relating to the development plans of the Kodaikanal Observatory were discussed.

An expedition was organised to observe the total eclipse of the sun on February 25, 1952. The observations planned are the photography of the corona and photographic photometry of the flash spectrum and the coronal spectrum. Construction and testing of instruments for carrying out the above programme had to be completed at short notice. The party of four, led by Dr. A. K. Das, left Kodaikanal on December 27, 1951 for the eclipse camp at Ar Ratawi in Iraq.

International co-operation

Exchange of spectroheliograms and photoheliograms with foreign observatories was continued as in previous years. 207 calcium flocculus spectroheliograms obtained at Kodaikanal during the period October 1950—June 1951 were sent to the Solar Physics Observatory, Cambridge and 3 photoheliograms for certain specified days in 1950 were supplied to the Royal Greenwich Observatory. 60 H-alpha flocculus photographs and 70 K disc spectroheliograms relating to the year 1950 were obtained from Meudon Observatory, France; the Mt. Wilson Observatory, U.S.A., also sent 80 H-alpha flocculus and 91 K-prominence plates for the same year. Quarterly statements of solar flares observed at Kodaikanal were sent to Dr. L. d'Azambuja of Meudon Observatory and Mr. H. W. Newton of the Royal Greenwich Observatory.

Daily broadcasts of URSIGRAMMES through the All-India Met. Broadcasting Centre, New Delhi and the practice of issuing warnings for ionospheric and geomagnetic disturbances, whenever expected, were continued.

* 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.

Price : *Re.* 1/-/- *or* 1*sh*. 6*d*.

LISPOKodaikanal

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.
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 7-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 an 18-inch parabolic mirror of 10 ft. focal length and auxiliary reflecting devices.

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

The spectrograph can be fed by the 18-inch Foucault siderostat and 21-foot Cooke photovisual lens and an auxiliary reflecting mirror.

16. Hilger E315 Quartz spectrograph.
17. Standardising spectrograph.
18. Cambridge photoelectric microphotometer.
19. Harvard Visual Sky Photometer.
20. Large Lummer Interferometer (Quartz) by Hilger.
21. Two monchromators 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. Photoelectric non-recording Sky Photometer (designed and built in this observatory) for visual study of sky radiation.
24. Three Hilger comparators for measuring spectrograms.
25. Large induction coil capable of giving upto 16-inch sparks.
26. Large Dubois Electromagnet.
27. Four mean time clocks—
    (i) Kulberg M. 6326,
    (ii) Shelton,
    (iii) Arnold and Dent.
    (iv) W. Ottway and Co.
28. One sideral clock by T. Cooke & Sons, York.
29. Two chronometers—
    (i) Kulberg No. 6299.
    (ii) Frodsham No. 5476.
30. Two tape chronographs (one by Fuess and the other by Bregent).
31. Cooke Theodolite.

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

(b) *Magnetic instruments*

33. Kew Magnetometer No. 3.
34. Earth Inductor (No. 46, Wild pattern) by Schulze of Potsdam.
35. Horizontal Force Magnetograph (Watson type).
36. Vertical Force Magnetograph (Watson type).
37. Declination Magnetograph (Watson type).
38. Dip circle (Kew pattern).
39. La Cour, H, D and V Magnetographs.

(c) *Electronic instruments*

40. Multi-Frequency Automatic Ionosphere Recorder—C.R.P.L. Model C-3.
41. Dawe Universal Impedance Bridge—Model 314C.
42. Taylor Valve Tester.
43. Avo Wide range signal generator.
44. Cossor Double-beam Oscilloscope—Model 1035.
45. Marconi Valve Voltmeter.
46. Marconi Video Oscillator.
47. Marconi Signal Generating Type TF 801 A.
48. Megacycle Meter.
49. Dawe Pulse Generator Type 412 A.
50. Hallicrafter's Receiver type SX-62.
51. B.P.L. Resistance—tuned Oscillator Model LO63.—B.
52. Dawe Q-Meter type 622 C.

(d) *Other instruments*

53. Small dividing engine by the Cambridge Scientific Instrument Co., Ltd.
54. Milne-Shaw Seismograph E-W component only.
55. A complete set of meteorological instruments.
56. Kolhörster Cosmic Ray Recorder.
57. Microscopes—2 Nos.
58. 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 for solar observations as compared with the previous year. Photographic observations were possible on 298 days while visual observations could be made on 311 days. The average definition of the sun's image estimated on a scale in which 1 is the worst and 5 the best was however 2.76, as compared with 2.95 in the previous year. There were 26 days on which the definition was 4 or more and 76 days on which it was 2 or less.

Routine observations

The normal observational programmes of work with the photoheliograph, the prominence spectroscope, the spectrohelioscope and the spectroheliographs were carried out uninterrupted. Direct photographs of the sun on a scale of 8 inches to the sun's diameter were obtained on 298 days as against 281 in 1950. Spectroheliograms of the disc in the H-alpha and the K lines were obtained on 292 and 285 days respectively and prominence photographs in the K line on 276 days.

Sunspot activity

Sunspot activity during the year showed further decrease as compared with the previous year. The number of new sunspot groups observed during the different months of the year, their distribution in the two hemispheres and the mean daily numbers are given in the following table :—

Month		Jan.	Feb.	Mar.	Apr.	May.	Jun.	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Number of new spot groups	N.	8	7	11	5	10	5	8	13	13	12	13	7	112
	Equator					1		1						
	S.	9	11	8	10	9	4	10	6	8	4	6	15	100
Total ..		17	18	19	15	20	9	19	19	21	16	19	22	214
Mean daily Number :		3·6	4·3	3·7	4·2	5·7	4·0	3·8	3·7	5·1	3·1	4·1	2·7	4·00
Mean relative sunspot numbers.*		60·8	63·9	50·2	74·6	83·9	64·7	54·0	42·8	75·5	43·1	52·7	39·5	58·8

* These are based on visual observations on a solar image of 8 inches in diameter projected by a refractor of 2¾ inches aperture. The sunspot numbers are calculated from the wellknown formula $r=k\ (10g+f)$. The constant k has been taken as unity.

Although the total number of *new* spotgroups observed during the year is practically the same as in the last year, the mean daily number shows a decrease of about 17 per cent as compared with the last year's value. There were no spot-free days out of the total number of days of observation as against 3 spot-free days in 1950. The yearly mean latitude of all the spotgroups for both the hemispheres was 10°.6 as compared with the last year's value of 12°.9. The mean latitude for the spotgroups in the northern hemisphere was 11°.1 and that for the southern hemisphere spots 10°.1.

The largest sunspot group of the year appeared in May. The region in which this spotgroup appeared was markedly active from January to June. The spotgroup was comparable in appearance as well as in area to the large spotgroup of March 1947. Its total area on May 16, the day of its central meridian passage, was 3,965 millionths of the sun's visible hemisphere (corrected for foreshortening).

Prominences

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

1951	Area (in sq. minutes)			Number		
	North	South	Total	North	South	Total
January—June ..	1·40	0·99	2·39	3·44	3·35	6·79
July—December	1·58	1·58	3·16	3·60	3·28	6·88
Whole year (weighted mean)	1·48	1·27	2·75	3·52	3·32	6·84

Compared with previous year's values, there has been a slight increase in the areas of 7 per cent while the numbers show a decrease of 15 per cent. The increase in areas is due to greater prominence activity in the second half of the year.

The distribution of areas in 5° ranges of latitude shows maximum activity in the zones 25°—30°N and 20°—25°S. A comparison with the distribution of areas in 1950 indicates that the peaks of activity in the low latitudes have remained stationary while the high latitude secondary maxima seen last year have subsided.

10 metallic prominences were observed with the prominence spectroscope. Of these, 9 were seen in the northern hemisphere; 3 were observed on the east limb.

Doppler displacements of the H-alpha line over prominences were noticed on 24 occasions with the prominence spectroscope. In 6 cases the shifts were towards red, in 3 cases towards violet and on the rest of the occasions in both directions. Particulars of a few prominences which showed larger Doppler shifts are given below :—

Date	Co-ordinates of prominences	Doppler shifts observed
March 3 (0310 hrs UT)	10°N—W limb	3·5A to red and 1·5 to 2 A to violet.
June 15 (0305 hrs. UT)	34½°N—W limb	4A to violet.
Aug. 30 (0320 hrs. UT)	5°N—E limb	2A—to red and 2·5A to violet.
Oct. 24 (0245 hrs. UT)	31°N—E limb	2A to red at top 2A to red at bottom. (Eruptive prominence.)

There were 16 occasions during the year when sudden disappearances of hydrogen absorption markings on the disc or of prominences on the limb were observed.

A large eruptive prominence was observed on October 24, on the east limb at mean latitude 31°N. On the first calcium prominence spectroheliogram of the day taken at 0243 U.T., the prominence was seen already in a very advanced stage of eruption. It was detached from the limb and had risen to a height of 720 seconds of arc from the surface of the sun. On the next—and the last—plate taken at (0249 UT), the prominence had risen still higher and the height of the topmost part was 780″ (nearly 360,000 miles). No further photographic observations were possible during the day due to bad sky conditions. Visual observations made with the spectrohelioscope showed no trace of the prominence at 0340 U.T. The prominence was first noticed on 19th October and showed rapid changes in shape on succeeding days.

The heights of 94 prominences were measured with the prominence spectroscope in H-alpha, D and H β lines. These were compared with the corresponding heights in the K line as obtained from calcium spectroheliograms of prominences. The mean heights were 63.9″ in K, 57.2″ in H-alpha, 54.1″ in D_3 and 51.6″ in H β

Particulars of Doppler displacements of the H-alpha line over prominences and dark markings observed with the spectrohelioscope are given below :—

	Displacement towards			Total
	Red	Violet	Both ways	
Prominences	8	10	40	58
Dark Markings	3	8	26	37

The mean daily area of H-alpha absorption markings for the year (without applying foreshortening correction) was 2,815 millionths of the sun's visible hemisphere representing a decrease of 13 per cent as compared with the value for the previous year. The distribution in latitude shows peaks of activity at 25°—30°N, 15°—20°N and 10°—15°S indicating an equatorial drift of the zones of maximum activity.

Geomagnetic observations

As in the previous years continuous photographic records of the horizontal, vertical and declination elements of the earth's magnetic field were made with Watson Magnetographs. The instrumental equipment of the Magnetic Observatory was supplemented by the addition of a complete set of La Cour Variometers during the year and regular recording with these instruments was begun from June 16. 1951. The results of magnetic observations made at Kodaikanal Observatory from January 1950 are being published in the half-yearly bulletins of this observatory, which hitherto contained only solar data.

Absolute measurements of 'H' and 'D' were made once a week with Kew Magnetometer No. 3 and observations of inclination with the Earth Inductor on 5 days in the week.

During the year, 24 magnetic storms of range > 150γ in H were recorded at Kodaikanal as compared with 27 in 1950. Of these, 18 magnetic storms were of the sudden commencement type. Two storms which commenced respectively at 0650 U.T. on April 18, 1951 and at 1,152 U.T. on October 28, 1951 had ranges greater than 400γ

Seismology

The Milne-Shaw seismograph (E-W component) recorded 156 earthquakes during the year. Of these, 4 were severe and 25 moderate.

Time-service

The standard clocks of this observatory were rated by comparison with Greenwich time signals.

Library

87 books and 1.277 periodicals were added to the library during the year. The newly built additional room for library was utilised for accommodating and rearranging the books and periodicals.

Research work and publications

The reasearch problems taken up during the pervious year were continued.

To study the variations in the equivalent widths of the H and K lines over the umbra and penumbra of sunspots as compared with the undisturbed photosphere, a number of spectrograms were taken and were being analysed, A Kolhorster Cosmic Ray Recorder was installed for continuous recording of the cosmic ray intensity. One of the objects of the measurement of cosmic ray intensity is to study the relation between solar flares and sudden increases in cosmic ray intensity.

A 220 m/c. "Radio Telescope" was under construction in connection with the study of solar noise.

Study of solar-geomagnetic relationships and statistical analysis of observations of prominences and hydrogen absorption markings made at Kodaikanal from 1905 to 1950 were taken up.

The following were either published or sent for publication during the year :—

(1) "Intensity Variations in Sunspots"—Nature.

(2) "Kodaikanal Observatory 1900-1950"—Indian Journal of Meteorology & Geophysics.

(3) Synopsis of solar and geomagnetic observations made at Kodaikanal during the 4th quarter of 1950, 1st, 2nd and 3rd quarter of 1951—Indian Journal of Meteorology & Geophysics.

(4) "A note on the observations of sunspots made at Kodaikanal from 1903 to 1950"—Kodaikanal Observatory Bulletin No. CXXXIII.

(5) "Geomagnetic field variations at Kodaikanal"—Nature.

(6) "Recurrence Feature of some of the great magnetic storms recorded at Kodaikanal (1949-51)"—Indian Journal of Meteorology & Geophysics.

(7) "Changes of Atmospheric Electric Potential Gradient at Poona (India) during disturbed weather from an analysis of Poona electrograms (1936-40)"—Indian Journal of Meteorology & Geophysics.

Kodaikanal Observatory Bulletins embodying the results of prominence observations for the 2nd half of 1949 and those of prominences and geomagnetic observations for the 1st half of 1950 were sent to the press for printing. Printed copies of the Annual Reports of the Kodaikanal Observatory for the years 1949 and 1950 were received from the press. Two research scholars holding scholarships awarded by the Government of India were working in the observatory during the year.

KODAIKANAL;

March 1952.

A. K. DAS,

Director,

Kodaikanal Observatory.

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