ANNUAL REPORT* OF THE KODAIKANAL OBSERVATORY FOR THE YEAR 1955.

General.—On May 12 news was received of the death of Dr. Thomas Royds, who was Assistant Director of the Kodaikanal Observatory from 1911 to 1922 and Director from 1922 to 1937; as a mark of respect to his memory the observatory was closed for the rest of the day.

Dr. A. K. Das attended the 9th General Assembly of the International Astronomical Union held at Dublin from the 29th August to the 5th September and the symposium on Radio Astronomy organised by the International Astronomical Union at Manchester before the Dublin meeting. He spent three weeks in the U. S. S. R. visiting important astronomical centres as a guest of the U. S. S. R. Academy of Sciences, and attended the conference on the Physics of the Sun, Stars and Nebulae at the Crimean Astrophysical Observatory between the 19th and 22nd September. He also visited some astronomical and other institutions in Budapest and Prague as a guest of the Academies of Sciences of Hungary and Czechoslovakia.

Dr. Das visited the Sonhat-Amarkantak area in Vindhya Pradesh in connection with the selection of a suitable site for the Central Stellar Observatory.

Three Russian scientists visited this observatory in January 1955. Other foreign visitors during the year were 5 Japanese astronomers and a French astronomer from the Paris-Meudon Observatories who came to this observatory after their eclipse expeditions to Ceylon.

Final orders were placed with M/s. Sir Howard Grubb Parsons & Co., Newcastle-Upon-Tyne for the projected large Solar Telescope. Steps were taken for placing final orders with M/s. Optique et Precision de Levallois, Paris, for the principal optical components of a Lyot Monochromatic Heliograph.

The fourth meeting of the Standing Advisory Board for Astronomy and Astrophysics in India was held at New Delhi in February 1955, when details concerning the equipment and the objectives of the proposed Central Stellar Observatory were discussed.

Eclipse observations.—An expedition from this observatory consisting of 7 members was organised for making optical, geomagnetic, ionospheric and radio-astronomical observations during the total solar eclipse of 1955 June 20. A camp was set up at Hingurakgoda in Ceylon near the central line of totality. The programme of observations consisted of:

(1) *Optical:*

(a) Photographing the flash spectrum using a three-prism spectrograph of 6 feet focal length in conjunction with a coelostat and a parabolic reflector.

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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 ~~detaits~~ details in the Administration Report of the India Meteorological Department.

(b) Photographing the spectrum of the inner corona with a low-dispersion spectrograph in conjunction with an 8″ objective of 9½ feet focal length and a Foucault Siderostat.

(c) Direct photography of the corona in red light using a camera of 10″ focal length provided with an arrangement for measuring the polarisation at great distances from the sun's limb.

(d) Direct photography of the corona in blue-violet light using a camera of 48″ focal length with arrangement for measuring polarisation in the corona.

(e) A photographic polarimeter using an object-glass of 24″ focal length for determining the polarisation of the corona in green light at various distances from the sun's limb.

All the above instruments had devices for photographic photometry.

(2) *Geomagnetic :*

(a) Registration of the horizontal and vertical components of the earth's magnetic field using Eschenhagen variometers and an Askania H-Field balance as also absolute measurement of H and V with a set of QHM and BMZ instruments.

(3) *Ionospheric :*

Continuous medium-wave signal strength recordings to examine the influence of the eclipse on transmission conditions.

(4) *Radio-Astronomical :*

Registration of solar radio-noise emission at 200 Mc/s.

An intensive programme of solar, geomagnetic and ionospheric observations was also carried out at Kodaikanal for several days including the day of the eclipse. Unfortunately, owing to cloudy weather, optical observations were impossible at Hingurakgoda, but the geomagnetic, ionospheric and radio-astronomical observations were successfully made.

During the partial eclipse of 1955 December 14 special geomagnetic and ionospheric observations were made at Kodaikanal and a close watch was also kept on the variations of solar activity on that day.

Scientific co-operation.—Exchange of spectroheliograms with foreign observatories was continued. 263 K-disc spectroheliograms for the period 1954 October—1955 September were sent to the Cambridge University Observatories. For the period January 1954—June 1955, 84 H-alpha disc and 77 K-disc spectroheliograms were received from the Meudon Observatory, France, and 119 H-alpha disc and 133 K-prominence spectroheliograms from Mt. Wilson Observatory, U.S.A.

In connection with the publication of daily maps of the sun under international co-operation sponsored by the Fraunhofer Institute, Germany, copies of daily spectroheliograms (disc in H-alpha and K and limb in K) on 35 mm. film were supplied in fortnightly batches to Prof. Dr. Kiepenheuer with effect from the 1st April, 1955.

Three photoheliograms together with the relevant zero plates for certain specified dates in 1954-55 were supplied to the Astronomer Royal, Royal Greenwich Observatory, to fill the gaps in the combined Greenwich-Cape-Kodaikanal series.

Quarterly statements relating to solar flares were sent as in the previous years to the Meudon and the Greenwich Observatories.

As in the previous years, the C. R. P. L., National Bureau of Standards, U. S. A. was supplied with the monthly median values of F2 layer critical frequency and the maximum usable frequency factor for 3000km. transmission. Monthly median values of all other ionospheric parameters were supplied to them and to the Radio Research Station, Slough, England, in quarterly statements. Quarterly statements of magnetic storms recorded at Kodaikanal were sent to Dr. John A. Simpson of the Institute of Nuclear Studies, University of Chicago, Illinois, U. S. A. The practice of broadcasting URSIGRAMMES relating to solar and geomagnetic activity was continued.

Details regarding the intensive programme of observations relating to solar physics, geomagnetism, atmospheric ozone, ionosphere and cosmic rays in which this observatory agreed to participate during the I. G. Y. were drawn up.

Periodical lists of solar flares were communicated to a number of scientific workers in India and abroad. Information relating to the Central Meridian passage of prominent sunspot groups and forecasts of expected magnetic and ionospheric disturbances were also supplied to certain interested institutions in India.

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 barrell 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 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's 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 ~~and~~ 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 ~~Foucault~~ mirror of 10 ft. focal length or an 8-inch lens of 10 ft. focal length. parabolic

(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) Harvard 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) Kullberg 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 412A.

(57) Hallicrafters Receiver—Type SX-62.

(58) B.P.L. Resistance—Tu~~r~~ned Oscillator—Model LO63.

(59) Dawe Q-Meter—Type 622 C.

(60) Eddystone Receiver—Type 504.

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

(62) Browing 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.)

(d) *Workshop Machinery*

(70) 6″ Cooke Lathe.

(71) 5″ Wilfin Lathe.

(72) 5″ Jessop Lathe.

(73) 'Victoria' Model U2 Milling Machine.

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

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

(76) 'Cruickshank' Combined Grinding & Buffi~~i~~ng Machine.

(77) 'Adcock & Shipley' Slitting Machine.

(78) Canedy 'Otto' Drilling Machine.

(79) 'Davla' Saw Bench.

(80) Smith's Hearth.

(81) Adcock & Shipley Optical Centring Lathe.

(e) *Other Instruments*

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

(83) Milne-Shaw Seismograph (E-W component).

(84) A complete set of meteorological instruments.

(85) Kolhörster Cosmic Ray Recorder.

(86) Microscope—2 Nos.

(87) Aldis Epidiascope.

Weather conditions.—Weather conditions continued to be less favourable for solar observations than usual. Photoheliograms were made on 289 days and visual observations of the sun were also possible on 289 days as compared to 299 and 289 days respectively in 1954. H-alpha disc, K-disc and K-Prominence spectroheliograms were taken on 275, 264 and 258 days as compared to 278, 264 and 251 days respectively in the previous year. Observations with the spectrohelioscope were made on 281 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—same as in the last year. There were 40 days on which the definition was 4 or better.

Sunspot activity.—Sunspot activity was on the increase during the year, the increase being pronounced during the second half. There were only 56 spot-free days out of a total of 289 days of observation compared to 243 such days in 1954. The yearly mean latitude of all the observed spot-groups in the northern and southern hemispheres was 25°·1 and 25°·5 respectively as against 24°·8 and 20°·2 for the previous year. Details of sunspot observations are given in the following table :—

——		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
No. of new spot-groups.	N	3	7	0	4	3	1	5	8	6	11	14	6	68
	S	4	2	1	1	1	2	3	3	6	6	7	7	43
Total . .		7	9	1	5	4	3	8	11	12	17	21	13	111
Mean daily No. of spot-groups.		1·52	1·64	0·35	0·79	1·50	1·10	1·58	2·13	2·78	2·60	5·10	3·90	2·08
Kodaikanal daily relative sunspot No.*		22·0	21·6	4·7	11·5	23·2	22·1	21·9	37·3	35·3	38·2	78·8	60·1	31·4

Solar Flares.—5 solar flares were observed during the year, all of intensity 1.

*The relative sunspot numbers published in the previous Annual Reports were based on the visual observation of a solar image of 8 inch diameter projected on a screen by a refractor of $2\frac{3}{4}''$ aperture. From January 1955 the relative sunspot numbers are those computed from photoheliograms on a scale of 8″ to the solar diameter obtained with a 6″ refractor. The constant K in the formula for relative sunspot numbers is taken as 1.

PROMINENCES.

Prominences.—With the advance of the new sunspot cycle there has been in 1955 a very great increase in all forms of prominence activity compared to 1954. The mean daily areas and numbers of calcium prominences at the limb as derived from photographs taken at Kodaikanal are given below :—

1955	Area in Sq. minutes					Numbers				
	North	South	East	West	Total	North	South	East	West	Total
January to June	2·21	1·14	1·59	1·76	3·35	4·24	3·28	3·71	3·81	7·52
July to December	2·47	1·96	2·01	2·42	4·43	4·60	3·77	4·09	4·28	8·37
Whole year (weighted mean)	2·32	1·51	1·78	2·05	3·38	4·40	3·50	3·88	4·02	7·90

Compared with the previous year prominence activity as represented by areas shows an increase of 154% while the numbers show an increase of 47%.

The distribution of areas in five-degree ranges of latitute shows maximum activity in the zones 45°—50° in the northern hemisphere and 40°— 45° in the southern hemisphere with a secondary maximum between 10° and 15°. The zone of maximum activity in the northern hemisphere has advanced nearly 10 degrees towards the pole and the peak in the southern hemisphere has moved five degrees nearer the pole from their positions in 1954. Greater activity than in the previous year is observed beyond latitude 50° in both the hemispheres. The western preponderance in prominence areas and numbers noticed last year continues.

Only one metallic prominence was observed during the year.

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	58	43	52	49	6	..	95	101
Dark markings	8	1	5	4	1	1	7	9

The heights of 19 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
74″·7	72″·4	60″·9	54″·3

Four instances of sudden disappearance of absorption markings and 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. The areas and numbers in this table have been derived from the values computed for each five-degree zone for the four quadrants NE, NW, SE and SW of the disc.

1955	Area in millionths of the sun's visible hemisphere (uncorrected for foreshortening)					Number				
	North	South	East	West	Total	North	South	East	West	Total
January to June	902·4	376·5	686·3	592·6	1278·9	6·20	2·62	4·66	4·16	8·82
July to December	1623·4	830·5	1108·0	1354·9	2453·9	10·01	4·90	6·78	8·13	14·91
Whole year (weighted mean)	1234·4	585·5	880·6	939·3	1819·9	7·95	3·67	5·63	5·99	11·62

Compared with the previous year there has been an abnormal increase in activity in both areas and numbers, the increase in areas being about 231% and the increase in numbers 117%.

The distribution of areas in latitude shows a pronounced peak of activity between latitudes 45° and 50° in both the north and the south hemispheres with a secondary maximum between latitudes 30° and 35° in the southern hemisphere. Here again both areas and numbers show a western excess.

Radio Astronomy.—Recording of Solar Noise at 100 Mc/s. was temporarily discontinued because of instrumental defects. An equipment for recording radio-radiations from the sun at 200 Mc/s. was built for observations during the 1955 June 20 eclipse. Construction of a 10 cm. receiver for radio-astronomical work at this observatory was completed by Dr. J. L. Pawsey, Asst. Chief, Division of Radio Physics, C.S.I.R.O., Australia.

Geomagnetic Observations.—Continuous photographic recording of H, Z and D with Watson and La Cour magnetographs and ink-recording of Horizontal Force with an Askania Field Balance were continued. Measurements of H and D were made weekly with QHM Nos. 254, 255 and 256. Vertical force was determined weekly with a BMZ. Absolute measurements of H and D with the Kew Magnetometer were restricted to once a month and of vertical force with an earth-inductor to once a week.

During the year 12 magnetic storms with ranges in H between 110γ and 285γ were recorded. Of these 4 were of the sudden commencement type.

Ionospheric observations.—Vertical incidence h/f ionospheric observations, which were previously confined to daylight hours, were extended to twenty-four hours from September 1, 1955.

Commencing with the data for September 1955, hourly values of all ionospheric parameters together with magnetic storm, sunspot number, and solar flare data were supplied to the Secretary, Radio Research Committee, Council of Scientific & Industrial Research, New Delhi, for publication in the Radio Research Committee Bulletins.

Cosmic Ray.—Recording of cosmic ray intensity with the Kolhörster apparatus continued to be under suspension due to shortage of staff.

Seismology.—The Milne-Shaw seismograph (E-W component) recorded 109 earthquakes.

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

Library.—66 books and 1,669 periodicals were added to the library.

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

The following problems in astrophysics and geophysics were investigated or were under investigation during the year :—

1. A study of the red-shift of solar spectrum lines and its relation to the Theory of Relativity.
2. The distribution of Calcium flocculi on the sun's disc.
3. Measurements of intensities of selected Fraunhofer lines in the solar spectrum, especially their variation from the centre of the disc to the extreme limb.
4. Variation of continuous absorption in the near ultraviolet solar spectrum.
5. Study of ionospheric and geomagnetic effects during the total eclipse of the sun of 1955 June 20 at Hingurakoda and Kodaikanal
6. Study of Magnetic Disturbance Field at Kodaikanal.
7. Study of the vertical movements in the F-region of the ionosphere over Kodaikanal.

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

1. The Magnetic Disturbance Field at Kodaikanal—*Indian Journal of Meteorology and Geophysics.*
2. Solar Tides in the F2 region over Kodaikanal—*Indian Journal of Meteorology and Geophysics.*
3. Effect of Solar Eclipse of 1955 June 20 on the lower Ionospheric Layers—*Kodaikanal Observatory Bulletin.*
4. Ionosphere F2 layer behaviour during the eclipse 1955 June 20—*Kodaikanal Observatory Bulletin.*

5. A study of the geomagnetic variations during the total solar eclipse of 1955 June 20—*Kodaikanal Observatory Bulletin.*
6. Day-to-day variation of cosmic ray intensity at Kodaikanal—to be published by the National Institute of Sciences of India.
7. Quarterly Synopses of results of solar, geomagnetic and ionospheric observations—*Indian Journal of Meteorology and Geophysics.*
8. Annual Report of the Kodaikanal Observatory for 1954.
9. Reports to the Royal Astronomical Society on :

   (i) The work of the Kodaikanal Observatory for the year 1954.

   (ii) The prominence activity for the year 1954.

A. K. DAS,

KODAIKANAL,
April, 1956.

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