

Proceedings of Observatories

ROYAL GREENWICH OBSERVATORY

(Director, Dr R. v. d. R. Woolley, O.B.E., F.R.S., Astronomer Royal)

(Report for 15 months ending 1960 March 31)

COOKE TRANSIT CIRCLE

Observations of members of the solar system number:

Sun	131	Mars	6	Neptune	42
Moon	21	Jupiter	49	Ceres	34
Mercury	48	Saturn	47	Pallas	25
Venus	77	Uranus	36	Vesta	20

The total number of transits observed is 33 365, the majority being of AGK₃ Reference Stars and stars in FK₃ and FK₃ (Supp.). Stars in Blaauw's list of stars needing observation for use in galactic research and stars in this and other observatories' P.Z.T. lists are also under observation. The number of transits in 1959 alone, namely 28 516, is by far the largest for any one year at this observatory. It is the result of (1) the exceptional observing weather, (2) covering the whole of the hours of darkness with a change of observers at 01.00 (civil time), and (3) the outstanding zeal of the observers. The average annual number of transits observed with the Airy T.C. over its long career is 7 225; the nearest approach to last year's figure was the 16 423 secured in 1913.

PHOTOGRAPHIC ZENITH TUBE

The instrument has been converted from pen-chronograph recording to direct card-punching (EPIC), and the greater part of its circuitry has been redesigned and rebuilt. An entire night's operating instructions could now be fed in in advance and the instrument left to carry them out at the appropriate times, but this procedure has not yet been adopted.

The number of stars observed was 3 011, on 271 plates. The latitude and time results have been sent regularly to the Bureau de l'Heure in Paris and the office of the International Latitude Service in Turin. The latitude results have been incorporated in the Service Internationale Rapide (S.I.R.) which publishes co-ordinates of the pole with the minimum delay, for the correction of time observations made at all observatories which maintain time services. They are also required in the reduction of the declinations observed with the Cooke Transit Circle. The

time results are used in the establishment of the Observatory Time Service.

The closing error in latitude of $0''.5$ found in previous years is confirmed by the observations made in 1959.

ASTROLABE

The Danjon impersonal astrolabe O.P.L. No. 9 was installed during the second half of 1959, after being converted from pen-chronograph to photographic registration; it is being used on an experimental programme, and 1591 observations have been made since September 1. The computations are being programmed for the electronic computer and no definitive results are yet available.

MIRROR TRANSIT CIRCLE

An axis and mirror, suitable for an eight-inch "Mirror Transit Circle", have been designed and made, and the stability of the assembly has been tested by auto-collimation through the hollow pivot. Any real "fidget" of the mirror in the axis must be small compared with the observational error, since the two together are several times smaller than the best that can be done, in an equal time, in determining collimation on the Cooke T.C. The axis is also satisfactorily stiff; deflections of the mirror's normal from its mean "near-great" circle, due to the combined effects of pivot-errors and axis-flexure, stay within $\pm 0''.078$, and the flexure and pivots can both still be improved.

TIME SERVICE

Observations with the Photographic Zenith Tube, corrected for the effects of polar variation and annual fluctuation, have been used in conjunction with quartz crystal clocks to establish a uniform time system (U.T.2). The line link for the direct comparison of standards at the Observatory and at the National Physical Laboratory and the Post Office Radio Branch Laboratories continued to operate throughout the year. The National Physical Laboratory also provided information relating to the caesium standard. During 1959 it appears that the U.T.2 time system has suffered no significant secular change with respect to the caesium standard. The reception and measurement of radio time signals has continued and the corrections to these signals relative to U.T.2 have been published in the Royal Greenwich Observatory Bulletins. An investigation is being conducted into the possibility of producing an atomic time scale by the cumulative summation of the caesium frequency measures.

Agreement has been reached between the Royal Greenwich Observatory, the National Physical Laboratory, and the Post Office for the co-ordination of the radio time signals emitted by Rugby GBR and its associated short-wave transmitters, and the MSF standard frequency transmissions. The GBR signal will in future originate at Rugby, as MSF already does, and the Royal Observatory will monitor it as before and will decide when it should be "jumped", to correct for the rate of the controlling crystal and keep the signal close to U.T.2. The land-line to Rugby will thus become superfluous.

In addition, agreement has been reached between the British and U.S. agencies concerned, to co-ordinate the VLF transmissions from Rugby GBR and Summit NBA in time and frequency.

All domes and pavilions throughout the Observatory now have access to both solar and sidereal seconds-pulses, and to solar and sidereal 50-cycle and 1000-cycle A.C., controlled directly from the Time Department.

13-INCH ASTROGRAPHIC REFRACTOR

(a) *With Moon-Camera.*—The Moon-Camera has been in regular use during those parts of each month which are suitable. Sixty-five pairs of plates have been selected for measurement, out of 76 nights, during the 15 months. In addition, 60 pairs have been received from Perth, of which about 20 per cent have had to be rejected as unsuitable, or as damaged in transit. Punched cards giving the measurements of 51 pairs from Herstmonceux and Perth have been sent to the U.S. Naval Observatory for reduction.

(b) *In astrometric work.*—During the dark of the Moon, and also near Full Moon, the Moon-Camera has been removed and the ordinary breech-end replaced. Second-epoch proper-motion plates have been or are being secured for (a) the associations of B-stars in Lacerta and Perseus, (b) those red variables in Plaut's Groningen list which appear on Greenwich or Oxford astrographic plates, (c) certain suspected sub-dwarfs in the Greenwich and Oxford zones, (d) (eventually) the whole of the Oxford zone. (For the Lacerta field, however, the borrowed first-epoch plates were found unsatisfactory, and the work was transferred to the 26-inch.) 485 plates were secured in these programmes, on 123 nights in the 15 months. Measurement is proceeding, and the reductions are now being performed on the Hollerith 1201 electronic computer. This makes several techniques possible which would previously have been too burdensome, such as trial reductions undertaken to select the most suitable comparison stars on the basis of size of their residuals.

26-INCH REFRACTOR

Regular parallax work is proceeding. Key plates for all but 20 of the 330 fields have been taken, and the first programme plates were secured in May. During the latter part of the period the midnight hours were used for second-epoch proper-motion plates on the B-associations in Lacerta and Perseus. Adequate first-epoch places have been obtained from the AGK2, and the analysis has been completed for the Lacerta field; it does not support the idea that this association is expanding. In all, 1761 plates were taken on 140 nights in the 15 months, the weather being exceptionally favourable for this instrument also.

28-INCH REFRACTOR

The telescope was used throughout the year for double-star measurement exclusively. 1147 complete measures were secured of 249 pairs (1014 measures in 1959 alone). The best year in the period 1919-39 was 1936, when 692 measures were made of 238 pairs. The distribution in angular separation is as follows:

sepn.	$d < 0''.5$	$0''.5 < d < 1''.0$	$1''.0 < d < 2''.0$	$2''.0 < d$
no.	200	376	436	135

The working catalogue of 440 double stars selected in 1958 December has been extended by a further 100 pairs. These are chiefly neglected pairs and stars whose motion is obscure. Catalogue members which do not show appreciable motion in a decade are taken off the list as soon as they have been satisfactorily measured.

It has long been known that while the instrument's resolving power equals its theoretical value, it is surprisingly difficult to measure close pairs below the eighth magnitude. During the year the objective was tested by Hartmann's method, and was found to be slightly over-corrected. Hartmann's constant was satisfactorily small (0.3), but a detailed calculation of the diffraction image then showed that the central intensity was only 60 per cent of that of the theoretical Airy disk. Ray tracing indicated that the over-correction could be removed by a slight further separation of the lenses, and an additional 0.28 inch was adopted after further trials. The spherical aberration then virtually vanished except for a small zone of slightly longer focal length near the centre of the lens, and Hartmann's constant over thirteen zones was found to be 0.05 compared to 0.16 for the Yerkes 40-inch, the best large object glass for which information was available. The resulting distortion of the colour curve was estimated as moving the peak 100 Å towards the blue. Dr Linfoot and Dr Steavenson of the Cambridge Observatories gave valuable advice on this work.

ASTRONOMER ROYAL'S DEPARTMENT

Dr Eggen spent some months, Dr Wayman all the year, and Mr Alexander eleven months, in South Africa. Dr Eggen made photo-electric observations on the Magellanic Clouds: Dr Wayman continued his spectroscopic work at the Radcliffe Observatory, and Mr Alexander took photographic plates on selected areas in the Magellanic Clouds at the Cape and at Pretoria. The Astronomer Royal, helped by Miss Mather, measured a large number of plates, taken by Dr Sandage at Pretoria and by Mr Alexander at the Cape, with the Iris Diaphragm photometer at Herstmonceux: the original null-indicator of this has been replaced by a cathode-ray display-tube, and this has produced a marked gain in accuracy and decrease in fatigue. Some results were communicated to the Society, but a large amount of measuring still remains to be done. The Astronomer Royal visited Mount Wilson Observatory from September to November and secured a large number of spectra with the 100-inch and 60-inch telescopes. This programme was mainly directed at the radial velocities of stars in the Hyades. Dr Hunter spent six months in the United States, mainly at Mount Wilson, and secured a number of second-epoch proper-motion plates in the Hyades.

YAPP 36-INCH REFLECTOR

Regular observing with the one-prism spectrograph (120 Å/mm at $H\gamma$) has continued and some 1400 spectra were obtained. During October the iron arc comparison source was replaced by a hollow-cathode discharge in argon with copper electrodes, giving a more favourable distribution of unblended lines at low dispersion and a more predictable intensity. At the same time, an integrating photoelectric exposure-meter, constructed by the Observatory's Electronics Department and Workshop, was added to the spectrograph and has given excellent results. The collimation of both comparison and Moon spectra has been checked by taking out-of-focus exposures, and uniform illumination of the slit has been checked by measuring spectra of the Moon and demonstrating the absence of systematic errors in excess of 1 km/sec.

A considerable amount of material has been collected on the velocities of A stars in Oort's galactic polar zone and on the luminosity classification of Ko stars in the HD catalogue. During the summer, an intensive study was made of the spectroscopic binary HD 134646. Four spectra of Nova Herculis 1960 were obtained between March 22 and April 1; they show a velocity of expansion of 1300 km/sec from hydrogen lines $H\beta$ to $H9$, and suggest the star was by then about 3.3 magnitudes down from maximum. In addition to the work with this telescope, some 200 of

Dr Wayman's Pretoria spectrograms were measured at Herstmonceux. The measurement of plates of stars within 20 pc taken by the Astronomer Royal on the Mount Wilson 60-inch and 100-inch telescopes in 1957-58 has also been completed.

The new Cassegrain grating spectrograph designed for the Yapp is now being manufactured.

30-INCH REFLECTOR

The Cassegrain mirror has been re-figured and re-mounted, and tests show an appreciable improvement in the images. Some preliminary work has been undertaken to explore the practicability of constructing a vertical north coude spectrograph in and below the dome.

SOLAR DEPARTMENT

Photographs of the Sun in white light were obtained with the 4-inch photoheliograph on 350 days. Negatives in duplicate have been received from the Royal Observatory, Cape of Good Hope, up to December 31. Two days, April 30 and May 20, were unrepresented in the Herstmonceux-Cape-Kodaikanal series.

The measurement and reduction of the combined series has been carried up to 1958 June 30; the Photoheliographic Results for 1956 have been published in Royal Greenwich Observatory Bulletin No. 14, and copy for press for 1957 is in course of preparation.

Photographs in $H\alpha$ light were taken with the Lyot-Levallois birefringent filter on 35 mm film on 290 days and representative negatives of disk and limb features supplied fortnightly to the Fraunhofer Institut for the compilation of daily maps of the Sun.

Owing to the extension of the I.G.Y. into the International Geophysical Co-operation period (which ended on December 31), a daily flare patrol from 1400 hours to 1600 hours U.T. was carried out from March 22 to September 21; the overall coverage obtained was about 40 per cent. Information on flares, surges and prominences was sent to the appropriate World Data Centres. Forty-one solar flares were observed with the filter and spectrohelioscope and 118 sudden enhancements of atmospherics (S.E.A.s) recorded on 26.5 Mc/s. The occurrence of these is down about 30 per cent from 1958. Current information has been distributed as in the past, by immediate message and by monthly circular, to individuals and institutions.

The 16-inch coelostat for the solar cellar was completed and installed during the year and a much improved slow-motion motor fitted to the Newbegin refractor.