

Reports from Observatories

(These cover the year ending 1960 December 31, unless otherwise stated)

ROYAL GREENWICH OBSERVATORY

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ROYAL OBSERVATORY, CAPE OF GOOD HOPE

(*Director, Professor R. H. Stoy, C.B.E., H.M. Astronomer*)

The Lords Commissioners of the Admiralty have approved an administrative merger between the observatories at Herstmonceux and at the Cape. Joint programmes embracing observations in both hemispheres are planned, and staff are already being exchanged between the two establishments. The present report covers both observatories and is for the period 1960 April 1–1961 March 31.

PHOTOMETRY

The Cape staff have made 9322 photoelectric observations of which 2210 were with the Victoria Telescope, 2549 with the Astrographic Telescope and 4431 with the 18-inch reflector. The observing programme for the Victoria Telescope consists mainly of stars on the current radial velocity programmes at the Cape, stars with known radial velocity, large proper motion stars, parallax stars, etc. The Astrographic Telescope has been used for obtaining $(U-B)_C$ colours for bright stars between declinations -4° and -64° . The 18-inch reflector, which has an aluminized mirror, has been used for obtaining observations as closely as possible on the (U, B, V) -system of all stars brighter than visual magnitude 5.0 (HR) between declinations $+6^\circ$ and -90° . The principal aim is to establish a strong and uniform (U, B, V) -system over the southern sky. This programme is very nearly finished.

Dr Cousins has devoted considerable time to the reduction of all the available material for E-region stars, and bright southern stars, to one homogeneous system which, as far as the blue and yellow observations are concerned, should be the same as the (B, V) -system in the north. Much time has also been spent in reducing all of the Cape photoelectric observations to this same system and compiling a general catalogue of stellar magnitudes and colours. Reliable results from other observatories are also being included.

Dr Eggen obtained some 5 000 three-colour photoelectric observations with the 74-inch Radcliffe reflector and the 24-inch refractor and 18-inch reflector at the Cape. In addition to standard stars the observed objects included the following:

(a) Four galactic red variables, five in ω Cen, four in 47 Tuc and one in M80. The three-colour light curves of these red variables are discussed in *Royal Observatory Bulletin* No. 29.

(b) 35 stars in the region of ω Cen in the magnitude range $V_E = 9.3$ to 17.2. By applying blanketing corrections to the observed colours the modulus of the cluster is found to be $13^m.2$.

(c) 20 members of 47 Tuc. The cluster members show an ultra-violet excess near $0^m.2$ when compared with the members of the Hyades cluster.

(d) 40 stars between $V_E = 9.9$ and 18.1 in the vicinity of NGC 6397. Applying blanketing corrections to the observed colours and fitting the main sequence of the cluster to that of the Hyades gives a modulus, corrected for absorption, of $11^m.2$.

(e) 30 eclipsing systems selected for short period (less than $1^d.5$) and showing continuous light variation with nearly equal light minima. The period-colour relation for these systems is discussed in *Royal Observatory Bulletin* No. 31.

(f) 11 stars between $V_E = 15.0$ and 17.3 in the Greenwich LMC Field No. 1 to serve as additional standards for the photographic photometry in that area.

(g) 26 stars in the galactic cluster NGC 6383. The colour-magnitude diagram for the cluster is almost identical with that of the very young cluster NGC 2264.

(h) 29 stars in NGC 6405. The K5 supergiant BM Sco belongs to the cluster. After correcting for a reddening of $0^m.13$ and fitting the main sequence of the cluster to that of the Hyades a value of $M_V = -3^m.3$ is derived for the supergiant.

(i) 300 known or suspected subdwarf and high-velocity stars. These include the southern "trigonometric" subdwarfs and the new high-velocity stars found by Deeming from spectra taken with the 74-inch reflector.

Three-colour photographic photometry of the globular cluster NGC 6397 has been completed from plates taken with the 74-inch reflector diaphragmed to 44 inches. All of the stars in the cluster brighter than visual magnitude 15.0 have been measured and in addition sample surveys of the fainter stars in selected regions have been made. Wherever possible cluster members have been distinguished from field stars by an appeal to the two-colour diagram.

Periods and blue light-curves for 40 cepheids in Greenwich Field No. 1 of the LMC have now been obtained. The slope of the period-luminosity

relationship for these stars is considerably greater than that obtained by Arp for some cepheids in the SMC.

The area of the Large Magellanic Cloud has been photographed with both the photographic and photovisual astrometric lenses and a series of plates with the Victoria 24-inch and 18-inch refractors covering the same area has been commenced. These plates will be used in compiling a photometric atlas of the Cloud.

Photographic and photovisual magnitudes have been completed for the 16 600 stars in the zones between -64° and -80° .

Before his departure for the Lick Observatory Dr Kinman finished his photometric study of 22 southern RR-Lyrae stars. Light curves in three colours were obtained with the Victoria and 18-inch telescopes.

Mr de Kock continued his programme of visual observations with the 6-inch telescope at the Cape and obtained 5 416 observations of 174 long-period variables and 3 flare stars.

SPECTROSCOPY

As in previous years, approximately one-third of the time with the 74-inch Radcliffe reflector was purchased by the Admiralty. Weather conditions were rather below average, however, and only 59 per cent of the time assigned could actually be used for observing. Nevertheless, 1 073 Cassegrain spectra were obtained for the radial-velocity programmes.

Radial velocities, spectral types and photoelectric magnitudes of 120 A-type stars in the south galactic polar cap have been prepared for publication by Dr Wayman. This material indicates an intrinsic dispersion of about 9 km/sec in the component of the space motion perpendicular to the galactic plane and there is no evidence of any increase of this dispersion with distance from the plane up to about 40 parsecs.

The spectra of 315 southern stars of types Fo to M and visual magnitudes (HD) between 8.5 and 8.6 have been completely measured for radial velocity by Dr Wayman.

The current programme of the one-prism spectrograph on the 36-inch reflector (Herstmonceux) is the radial velocities of 460 B9-A5 stars brighter than visual magnitude 6.35. The observations have been completed in the region from 6^h to 21^h and 1 200 spectra were obtained of which some 200 have been measured.

Approximately 100 plates of Hyades cluster members and miscellaneous late-type stars, obtained by the Astronomer Royal with the Cassegrain spectrograph of the Mount Wilson 60-inch reflector, have been measured for radial velocity.

Photoelectric measurements and spectral types of 56 double or multiple stars have been discussed by Dr Wayman. Several interesting systems

have been found but none are in conflict with current theories of stellar evolution.

Dr Evans has completed a discussion of spectroscopic binaries found in the current Cape radial velocity programme.

STELLAR DYNAMICS AND KINEMATICS

Theoretical models representing the density distribution of stars in globular clusters have been investigated by the Astronomer Royal. These models involved the numerical solution of Poisson's equation for the isothermal gas sphere and its truncations which have been carried out by Mr Dickens with the aid of the HEC 1201 electronic computer of the Nautical Almanac Office. Projected densities for some models were computed and compared with photoelectric observations of galactic globular clusters made by Kron and Mayall at the Lick Observatory. The dynamics of a rotating cluster were also investigated by the Astronomer Royal and Mr Dickens and a first-order solution obtained. Several models were constructed using the electronic computer to examine the density distribution.

Dr Eggen has compiled a catalogue of the B-type stars brighter than visual magnitude 5. Both "post-1900" (N30) and "pre-1900" (GC) proper motions are available for all of these stars; the post-1900 motions for the southern objects were greatly improved by including the new Cape meridian catalogue for 1950 with a mean epoch near 1955. Using the moduli determined from a calibration of the MK-luminosity classifications, the space motions of these bright B-stars have been computed on the HEC 1201 computer of the Nautical Almanac Office using a programme written by Mr Murray.

Dr Eggen has also computed post-1900 proper motions for all of the stars in the GC for which radial velocities are available and which appear in at least two positional catalogues with mean epochs later than 1925. A catalogue has been formed of some 4 000 stars for which the uncertainty in the space motion due to the proper motion alone is less than 5 km/sec; the "best" luminosity, as judged by available spectroscopic and trigonometric evidence, is used as the distance indicator in applying this criterion. A similar catalogue for the much small number of extreme subdwarfs, as judged by the ultra-violet excess, is also being prepared.

Relative proper motions have been derived at the Cape for 35 stars in NGC 2477, 22 southern RR Lyrae variables, 17 stars in Melotte 227 and 31 southern cepheid variables. In most cases the modern places were photographic and derived either from existing Cape material or from plates taken especially for the purpose.

During the year 59 modern-epoch plates were obtained with the Cape Astrographic Telescope for the Gröningen Carte du Ciel Programme and proper motions on an "absolute" system derived for 30 variable stars.

A total of 408 plates were secured on 74 nights with the Herstmonceux Astrographic. About seventy-five per cent of these were repetitions of Oxford Zone catalogue plates, most of the remainder being exposed on fields in the Greenwich and Oxford Zones containing either red variables in the Gröningen list or suspected subdwarfs. Priority is given at Herstmonceux to the proper motions of known and suspected subdwarfs in the Oxford and Greenwich astrographic zones.

Second-epoch plates of M67 were obtained at Herstmonceux to match a long-exposure direct plate of the cluster secured in 1899. An attempt will be made to set up a useful proper-motion criterion of cluster membership.

A total of 1682 parallax plates were exposed on 143 nights with the 26-inch refractor at Herstmonceux.

The derivation of proper motions for stars previously observed for parallax with the Victoria Telescope at the Cape has continued and 333 plates were measured for this purpose.

A number of long-exposure plates of the Large Magellanic Cloud were taken with the Cape Astrograph to duplicate plates taken some 40 to 60 years ago. These will provide material from which the proper motions of a large number of stars down to magnitude 14 may be obtained and non-members of the Cloud identified. Eleven such plate pairs are now at Herstmonceux for measurement.

SOLAR SYSTEM

The programme of photographing ten selected minor planets at ten-day intervals has been continued at the Cape and 85 plates were obtained with the old Astrometric lens.

No plates have been taken with the dual-rate Lunar Camera at the Cape since 1959 December 31. During the year, 104 of the 136 plates received from Tokyo were measured at the Cape and the results forwarded to the U.S. Naval Observatory. The programme at Herstmonceux was discontinued on 1961 January 11. In addition to 104 pairs of plates secured at Herstmonceux, 87 pairs received from Perth have been measured.

The following observations were made at Herstmonceux with the Cooke Transit Circle:

Sun	69	Mars	23	Neptune	18
Moon	10	Jupiter	20	Ceres	4
Mercury	19	Saturn	20	Pallas	12
Venus	55	Uranus	10	Vesta	10

The Sun was photographed at Herstmonceux in white light with the 4-inch photoheliograph on 286 days and in $H\alpha$ with the Lyot birefringent filter on 249 days. Two photographs in white light were obtained at the Cape on 335 days and the Lyot $H\alpha$ Heliograph was run on 282 days for a total of 1690 hours.

Twenty-four sunspot groups exceeding 500 millionths of the visible hemisphere in area have been observed against 39 for the previous year. The largest group crossed the Sun's disk between November 6 and 18 in latitude 26° north, its maximum area being 1775 millionths.

Only 11 solar flares were observed at Herstmonceux. The films from the Lyot Heliograph at the Cape were examined at the Dunsink Observatory and 676 flares detected.

Mr Yallop is studying the effect of the "solar wind" on coronal line widths. It appears that the kinetic temperature is unlikely to exceed the electron temperature by more than a few times 10^5 degrees and part of the observed line width must probably be attributed to macroscopic motions.

POSITIONAL ASTRONOMY

The copy for press of the second Cape catalogue for 1950.0 was completed except for the proper motions. These are being recomputed for most of the stars by combining the new catalogue places with the data given in the G.C.

While the cameras on the zenith distance circle at the Cape were being modified a short programme of right ascensions was carried out with the reversible transit circle. The objects of this programme were the training of new observers, investigating the systematic discordances between the observed and tabular places of FK3 stars that had been noted in the previous catalogue, and studying the stability of the instrument adjustments. The programme was begun on 1960 April 27 and terminated on 1961 February 21 during which time 3834 transits were observed. The preliminary reductions have been completed.

Observing for the third Cape catalogue for 1950.0 began on 1961 February 21 and 1037 observations were made before March 31. This catalogue contains all FK3, FK3S and FKSZ stars south of the equator together with a selection of FK3 stars between the equator and $+30^\circ$. This programme will run concurrently with observations for the faint star catalogue which is to be observed on a cooperative basis by a number of southern observatories and which is an extension of the AGK3R project now nearing completion in the northern hemisphere.

Copy for press has been written out for the -64° to -68° and -68° to -72° zones of the Cape Photographic Catalogue for 1950.0. The

proper motions have been completed for the first of these zones and nearly completed for the second. The final 1950.0 positions and precessions have been completed for the -72° to -76° zone and the proper motions derived for the first 18 hours of right ascension. By March 31 nearly half of the remaining 70 astrometric plates of this zone had been measured.

The current programme with the Cooke transit circle at Herstmonceux includes the AGK3 reference stars, all stars in the FK3 and FK3S from the pole to -30° , stars on various P.Z.T. lists, and a few objects selected for astrophysical interest. The number of observations on this programme totals 17410 for the year.

During the year 172 plates have been obtained with the P.Z.T. at Herstmonceux.

The Danjon astrolabe at Herstmonceux was used to observe 130 two-hour groups during the year with an average of 26 stars each. The HEC 1201 computer of the Nautical Almanac Office has been used for reduction of the observations.

The North Polar Distances obtained with the Airy transit circle at Greenwich in the years 1851 to 1940 are being analysed. Corrections have been applied to the annual places of frequently observed stars to put them on one consistent system of reductions throughout this period. Corrections have been computed with the HEC 1201 computer for the FK3 proper motions in declination of 50 circumpolar stars separately at upper and lower culmination; similar computations have been made for over 100 non-FK3 stars. The probable errors are comparable with those of the FK3. The programme is being modified to include additional stars before a detailed discussion is undertaken.

Dr Atkinson has continued experimental work in the design and development of a mirror transit.

DOUBLE STARS

Nearly 600 observations were obtained on 127 nights with the 28-inch refractor at Herstmonceux; 81 observations of pairs with separation less than $0''.5$ and 287 of pairs of separation less than $1''.0$.

The measures made with the 28-inch since its removal to Herstmonceux were collected and discussed for publication: 1600 observations made from 1957 November 1 to 1960 November 16 are included.

TIME SERVICE

By agreement between the Royal Greenwich Observatory, the National Physical Laboratory and the Post Office, arrangements have been

made for the unifying of the MSF standard frequency transmissions and the radio time signals emitted by GBR and its associated H.F. transmitters, with effect from 1960 April 1. Under the new arrangements the measurement and control of the radiated frequencies is the responsibility of the Director, National Physical Laboratory, and the measurement and control of the time signals is the responsibility of the Astronomer Royal. This unification has eliminated the need for land-lines between the Observatory and the transmitter; all measurement and checking is carried out by means of the radio link.

A further agreement between the United Kingdom authorities and the organizations concerned in the United States has extended the coordination on an international basis. Astronomical observations made with the Photographic Zenith Tubes at Washington and Richmond, Virginia are combined with those made at Herstmonceux for the determination of time and rate. From 1961 January 1 the time signals from GBR, MSF, NBA, WWV and WWVH have been synchronized. Other observatories, including those in Switzerland, Canada and South Africa, have announced their intention to participate in the coordination plan. Each observatory will, as hitherto, publish independent corrections based on its own observations alone.

The U.T.2 time system of the Observatory is established by plotting the P.Z.T. observations, incorporating the corrections adopted by the Bureau International de l'Heure, in groups of weight 50 on several quartz clocks and fitting a smooth curve to the plotted points. The clocks employed have been selected from those available at Herstmonceux, at Dollis Hill (Post Office Laboratories) and at Teddington (N.P.L.). The frequency of the N.P.L. clock Q13 is measured in terms of the caesium resonance and, since Q13 operates beat counters at Herstmonceux, the calibration may be transferred to other clocks. The scale of atomic time, referred to in last year's report, has been continued. Throughout 1959 and 1960 this atomic scale, CsI (EB), has been in agreement with the independent atomic scale, A1, of the U.S. Naval Observatory to within 2 milliseconds. Comparisons during this period between CsI (EB) and U.T.2 have shown no significant secular change.

NAUTICAL ALMANAC OFFICE

The routine calculations and proof reading in the preparation and printing of the publications for which the Nautical Almanac Office is responsible have been continued. The volumes issued during the year were as follows:

Astronomical Ephemeris 1961—published in April

Astronomical Ephemeris 1962—published in March

Astronomical Ephemeris 1965—first part distributed in March

Nautical Almanac 1961—published in April

Star Almanac 1961—published in May

Air Almanac 1961—parts I and II published in October and March.

Some special work of navigation interest has also been undertaken. A new form of "Sight Reduction Tables for Surface Navigation" was developed; specimen tables, together with the corresponding plotting sheets and plotter, were produced for trial by the Royal Navy. A new edition, for equinox 1965.0, of volume 1 of A.P. 3270 ("Sight Reduction Tables for Air Navigation") is being prepared in cooperation with U.S. Naval Observatory and U.S. Hydrographic Office. New graphs for sunrise, sunset and twilight were prepared, accepted by the R.A.F., U.S.A.F., and R.C.A.F. and introduced into the "Air Almanac".

The Nautical Almanac Office programme for lunar occultations has continued unchanged. Predictions for 1963 have been completed. The occultations observed in 1958 and 1959 have been reduced and those for 1958 analysed. Dr Watts of the U.S. Naval Observatory has supplied limb corrections for the 1958 observations and an analysis of the observations including these corrections is almost complete. Predictions of occultations of radio sources for 1961 have been distributed.

Sextant observations by the Nautical Almanac staff of the upper and lower limbs of the Sun have been intensively made throughout the year, at varying altitudes and in varying conditions with the object of determining the effect of irradiation on such sights.

PUBLICATIONS

Following the administrative merging of the Royal Observatory, Cape, with the Royal Greenwich Observatory, the publications of the two observatories are being combined. From No. 21 the *Royal Greenwich Observatory Bulletins* have been retitled *Royal Observatory Bulletins* without changing the system of numeration or of pagination. In the future most of the work done at the Cape and at Herstmonceux will be published in these bulletins or in the *Royal Observatory Annals*.

VACATION STUDENTS AND HERSTMONCEUX CONFERENCE

Twenty-eight students attended the two six-week courses held at Herstmonceux from June 27 to August 5 and from August 8 to September 16.

Thirty-seven astronomers attended the Herstmonceux Conference on 1960 April 11 and 12.