Proceedings of Observatories.

Royal Observatory, Greenwich.
(Director, Sir William Christie, K.C.B., Astronomer-Royal.)

Transit Circle.—During the year 13,549 observations of transits and 12,309 of meridian zenith distances were obtained. These include about 8400 observations of stars within 26° of the pole, leaving about 5000 observations to be obtained this year to complete five observations of each star in the Catalogue. The Sun has been observed 163 times and the Moon 89 times. Reflection observations of stars have been obtained on 105 nights.

The re-reduction of Groombridge's observations is completed. The ledgers of the original observations are printed, and the Catalogue as far as 18th. Proper motions of the stars have been derived by comparison with modern Greenwich observations, and a comparison for check made with the Radcliffe (1845-0) Catalogue and the catalogues of the Astronomische Gesellschaft.

Mr. Cowell's analysis of the Greenwich lunar observations 1750-1901 is completed as far as the longitudes are concerned, and coefficients for 145 terms have been deduced from the observations as compared with revised theory. A comparison with the theoretical calculations of Professor Brown, Mr. Radau, and Dr. G. W. Hill shows an agreement to well within 0.010 for the large majority of these terms.

The Altazimuth.—With this instrument, used as a reversible transit circle, 1310 observations of right ascension and 1274 of north polar distance have been obtained. The instrument has been used in all four positions in the meridian for observation of the Sun, Moon, and planets and the fundamental stars contained in Newcomb's Catalogue. Since the beginning of 1905 observations of the crater Mösting A, as well as of the limbs of the Moon, have been obtained in the second and third quarters. The observations of transits will serve to connect the observations of the first and second limbs made before and after full respectively; and the observations of zenith distance will, in co-operation with the Cape Observatory, serve to determine the parallax of the Moon. A series of reflection and direct observations of zenith distance have been obtained in the four positions in the meridian.
meridian observations of the Moon have been obtained throughout the first and last quarters, when the Moon cannot be observed on the meridian or would be observed in a bright sky. The total number of extra-meridian observations obtained of the Moon is 63—35 near the beginning and 28 near the end of the lunation.

Reflex Zenith Tube.—During the year 817 double observations and 70 single were secured. Observations of the brighter stars have been made over as long periods as possible. γ Draconis has been observed 78 times, β Draconis 44 times, ν² Cygni 41 times, and θ Ursae Majoris 29 times.

Equatorials.—A hundred and nine observations of occultations of stars by the Moon have been made. These consist of observations by one or more observers of forty-six phenomena of disappearance or reappearance.

28-inch Refractor.—The weather has been even more unfavourable than in 1903 for the observation of close and difficult double-stars, as may be seen from the following statement of the year’s work:

<table>
<thead>
<tr>
<th>Month</th>
<th>No. of Nights</th>
<th>No. of Good Nights</th>
<th>No. of Stars Observed</th>
<th>Month</th>
<th>No. of Nights</th>
<th>No. of Good Nights</th>
<th>No. of Stars Observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>8</td>
<td>0</td>
<td>36</td>
<td>July</td>
<td>15</td>
<td>5</td>
<td>163</td>
</tr>
<tr>
<td>Feb.</td>
<td>10</td>
<td>1</td>
<td>54</td>
<td>Aug.</td>
<td>12</td>
<td>2</td>
<td>116</td>
</tr>
<tr>
<td>Mar.</td>
<td>11</td>
<td>2</td>
<td>80</td>
<td>Sept.</td>
<td>9</td>
<td>2</td>
<td>74</td>
</tr>
<tr>
<td>Apr.</td>
<td>10</td>
<td>4</td>
<td>120</td>
<td>Oct.</td>
<td>8</td>
<td>0</td>
<td>69</td>
</tr>
<tr>
<td>May</td>
<td>11</td>
<td>3</td>
<td>71</td>
<td>Nov.</td>
<td>7</td>
<td>1</td>
<td>73</td>
</tr>
<tr>
<td>June</td>
<td>10</td>
<td>5</td>
<td>107</td>
<td>Dec.</td>
<td>5</td>
<td>1</td>
<td>69</td>
</tr>
</tbody>
</table>

Totals for year 116 26 1032

An analysis of the observations gives:

76 stars of distance <0″.5
85 " " 0″.5-1″.0
127 " " 1″.0-2″.0
372 " " >2″.0

Amongst the stars observed are Sirius (once), Procyon (3 nights), κ Pegasi (7 nights), and δ Equulei (11 nights).

Thompson Equatorial.—With the 26-inch refractor 59 photographs of Neptune and satellite have been obtained on 28 nights, of which 41, belonging to the opposition 1903–4, have been measured. With the 30-inch reflector 178 photographs (generally four exposures on each) of 60 minor planets have been obtained. Comet α, 1904 (Brooks), was photographed on 58 nights, 76 photographs, each with several exposures, being obtained. Encke’s Comet was attempted on several nights, but owing to unfavourable weather only one successful photograph was obtained. A few photographs of nebulae were also taken.
Astrographic Equatorial.—During the year 200 photographs were taken on 86 nights. These include 103 successful chart plates more suitable for reproduction than those already obtained, 16 catalogue plates, 8 photographs of suspected variables, and 55 plates rejected mainly owing to photographic defects in the plates or to their not reaching the required standard in showing faint stars. During the year 108 plates have been measured, and the measurement has now been carried to within 3° of the pole. The number of plates left to be measured is 28. Vol. i. of the Astrographic Catalogue, containing the measures from Dec. 64°–72°, was published in the spring. The printing of Vol. ii. is being carried on continuously, Zones 72°, 73°, and 74° to 12h having passed through the press. The counting of the stars on the chart plates has been continued from Dec. 71° to Dec. 73°.

The publication of the Greenwich section of the Astrographic Chart by means of enlarged photographic prints was commenced at the beginning of May, the three Zones 65°, 66°, and 67° (232 plates) being taken in hand. Up to the middle of December the enlarged prints from 116 plates (12h to 24h) had been distributed to about fifty observatories and other institutions. It is expected that the publication for these three Zones will be completed in about twelve months from the time of commencement, after which the work will be continued with Zones 68°, 69°, and 70°.

Measures of Eros Photographs.—Besides Eros, ten or twelve reference stars taken from M. Loewy's list within 50' of the centre of each plate and distributed as symmetrically as possible with respect to the planet, and six comparison stars of about the same magnitude as Eros and within 25' of the centre, have been measured on each of the 198 plates taken with the astrographic equatorial. Eros and six comparison stars have been measured on each of the 152 plates taken with the Thompson Equatorial. Generally four exposures were measured on each plate in both the direct and reversed positions. The means of the separate measures and exposures have been taken and examined. Plate constants have been determined for about half the astrographic plates. A preliminary discussion of 27 photographs obtained on October 26 and October 27 has been made, and is published in the Monthly Notices, vol. lxiv. p. 626.

Photoheliograph.—Photographs of the Sun have been taken during the year 1904 on 230 days, and 541 of them have been selected for preservation. These were all taken with the Thompson Photoheliograph mounted upon the 26-inch photographic refractor. Upon three of these days photographs were also taken with the Dallmeyer Photoheliograph. Photographs have been received from India up to 1904 November 10; and there are now photographs available for the year ending on that date for 352 days out of 366. No photographs have been received from Mauritius since 1903 December 31, but the arrival of photographs for the first six months of 1904 is expected
shortly. The measurement of the Greenwich photographs had by the end of the year been carried as far as 1904 December 12, and of the Indian ones as far as 1904 October 11, and the reductions are in a very forward state. In the matter of printing, the complete proofs of the results for 1903 have been received from the printer.

The increase of solar activity during the year 1904 has been steady but not rapid, and there have been no groups of spots of all unusual dimensions.

Observations of Meteors.—The Perseid meteors were well observed on four nights, the number of meteors between August 10 and 14 being 473. A fair number of Leonids were observed on the morning of November 15, 342 meteors being seen during the night. A summary of the observations of Leonids is given in Monthly Notices, vol. lxv. p. 154.

Longitude Observations.—The printing of the determination of the longitude Greenwich-Waterville-Canso-Montreal is finished, and copy is being prepared for the printers of the determination Paris-Greenwich made in 1902. A short notice of this determination is given in Monthly Notices, vol. lxv. p. 219.

Mr. Crommelin and Mr. Bryant have been appointed assistants on the new establishment, and Mr. Davidson has been promoted to the higher grade of Established Computer.

Royal Observatory, Cape of Good Hope.
(Director, Sir David Gill, K.C.B., H.M. Astronomer.)

By the death of Mr. Frank McClean the Observatory has lost a most sympathetic and generous patron, whose benefactions to the establishment are too well known to need mention here.

His genuine devotion to his work, coupled with his many acts of personal kindness, has endeared him to all with whom he came in contact during his stay at the Cape in 1897, and his loss is felt by every member of the staff as that of a true and warm-hearted friend.

A very large amount of labour has been devoted during the year to work connected with the installation and determination of constants of the new transit circle.

The investigation of the errors of division for every division line on the fixed circle (5' to 5') has been completed, and for the movable circle the error of each line marking the degrees. The observations were begun on 1903 September 28 and completed 1904 October 24: ten different observers took part in the work. The investigation involved 76,524 pointings for the fixed circle and 22,320 for the movable circle.

Four complete and independent series of investigations of pivot error were made during 1904: two clamp E and two
clamp W. All the series agree with each other and with the results obtained in 1903.

Investigation of the flexure and torsion of the axis, flexure of the tube and circles, constancy of the nadir under opposite conditions of motion from the zenith, have also been made, as well as a determination of the screw errors, screw value, and contact intervals of the Repsold travelling wire micrometer.

These operations were carried on day and night, to the practical exclusion of ordinary meridian observing with the new transit circle, because it is only by such investigations and their immediate discussion that instrumental defects can be discovered and remedied and a sound observing system with a sound instrument established.

The object-glasses of the long-focus lenses for adjusting the upper marks vertically over the underground marks have now all been received from Mr. Simms, and are in process of being mounted.

The observers have all passed through a course of training in observing by the Repsold method with the travelling wire—that is to say, in the original method proposed by Dr. Repsold in which no clockwork is employed to aid the observer. The apparatus for the automatic motion of the travelling wire at approximately the apparent rate of the star’s motion across the field is under construction by the Société Genevoise.

A large number of observations have also been made to test whether the travelling wire method is free from the personal error in right ascension depending on magnitude. The result goes to show that by the travelling wire this source of systematic error is almost, if not entirely, eliminated. The actual mean for the six observers makes a fainter star observed later than a bright star by $\pm 0.0026$ per magnitude, or about one-sixth part of the corresponding personality for the same observers when employing the usual method of chronograph observing. The mean result, however, scarcely exceeds its probable error, and it seems likely that with more experience of the method an almost complete elimination of personal error will result, not only in personality depending on magnitude, but also independent of the velocity and direction of motion of the star.

The new transit circle will be brought into regular catalogue observing work from the beginning of 1905.

Some experimental alterations were made on the new sidereal clock, after which its performance has been so far satisfactory—the variations of daily rate during its last period of trial not exceeding $\pm 0.03$. This, however, does not represent the accuracy of rate which should be attainable; indeed, the variations show a dependence on the difference between the temperatures at the top and bottom of the pendulum. The pressure of the air is maintained constant at 33 mm. within $\pm 0.1$ mm., and the temperature of the water that circulates about the inner iron case is also maintained constant within $\pm 0.1^\circ F$. But the
constant temperature selected for balancing the electric bridge that regulates the temperature (85° F.) has proved unnecessarily high—viz. 10° above that of the maximum temperature of the present room.

The result has been that the temperature of the air inside the iron clock-case, in consequence of radiation from the outer case (although the space between the water tubes and the outer case has a 2-inch-thick lining of felt) is always lower than that of the circulating water, and there are variable differences between the readings of the thermometers near the upper and lower ends of the pendulum which would account for errors of 0.02 or 0.03 in daily rate.

An outer chamber 8 feet square inclosing the clock case and having double wooden walls, 9 inches apart, the space between the walls being filled with sawdust, is now being constructed. The temperature of the air in this chamber will be automatically maintained at 74° F., and thus it is believed that a nearly perfect identity of temperature will be maintained throughout all parts of the inner clock-case.

Owing to an unfortunate accident which occurred during the absence of the regular observers the driving worm and sector of the Victoria telescope were damaged, and the moving portion of the instrument, including the polar axis and telescope tubes, had to be raised in order to remove the damaged sector. The sector, driving worm, and slow-motion gear have been sent to Sir Howard Grubb for alteration and repair.

The instrument was in consequence only in use till August 26, and was employed principally for the photography of star-spectra for determination of motions in the line of sight. Seventy-four star spectra were photographed during this period, of which thirty have been measured and radial velocities deduced for α Phoenicis, α Tauri, α Argus, α Canis Majoris, a Canis Minoris, β Geminorum, α Boötis, and α Centauri.

The progress of printing the Cape Catalogue of 8560 stars (Photographic Zone Standards) has been provokingly slow. The copy for press was sent off on 1902 August 6; only 112 pages of proof were received during the year.

The catalogue of 4360 stars, including 2798 selected zodiacal stars and all stars brighter than 8.1 magnitude which are not contained in Gould's General Catalogue (excepting those in the zone decl. -45° to -52°, most of which are included in the Cape Catalogue for 1900), is nearly completed in manuscript.

Part I. vol. xi. of the Cape Annals, containing a discussion of the Heliometer Triangulation of Southern Circumpolar Stars within 2° of the South Pole, has been distributed.

Part II. of the same volume, containing the results of a discussion of photographic plates covering the same region, has been passed through the press.

The work of the old transit circle has been confined to the few observations necessary to complete the catalogue of 2798

C C 2
selected zodiacal stars, and to a re-determination of the personal equation of the observers depending on magnitude, besides the necessary determinations of time. The total number of observations is therefore much less than usual.

Number of transits ... 3658 | Azimuth  ...  ...  81
Determinations of Z.D. 150  | Run  ...  ...  63
Collimation  ...  ...  59  | Nadir  ...  ...  62
Level  ...  ...  89  | Flexure  ...  ...  2

All observations are reduced to the end of December 1905.

With the new transit circle, in addition to a large amount of observations for practice in the "moving wire" method of observation, 1081 transits have been observed (twenty contacts each) for determination of personal equation depending on magnitude.

Only fifteen separate phenomena of occultations have been observed during the year—viz.:

Disappearances at the dark limb  ...  ...  ...  10
Reappearances  "  "  "  "  ...  ...  5

An announcement of the discovery of a new comet by M. Borrelly at Marseilles was received on December 31, and an observation was secured the same evening.

Heliometer.—Of the major planets, 145 oppositions on 19 nights have been observed with the heliometer during the year, and 841 observations in connection with the triangulations of the comparison stars in this and other oppositions.

The triangulations of the comparison stars for Mars, 1901, Mars, 1903, and Jupiter, 1903, are now completed.

Thirty-three observations have also been made connecting the distances of the stars employed as standards in Cookson’s observations of a Centauri in 1901 and 1902 with pairs of stars contained in the South Polar area.

The instrumental distances have been computed and checked for the following triangulations:—

Uranus, 1898, 1899, 1900; Saturn, 1898; Jupiter, 1898, 1899, 1900; Neptune, 1897–1904.

Those for Uranus, 1901–1904; Mars, 1901 and 1903, have been partially reduced.

Astrographic Equatorial.—With this instrument 548 plates have been taken during the year. Of these, 116 Chart plates with triple exposures of 20°, 236 Catalogue plates, 35 of Jupiter’s satellites, 28 miscellaneous plates for Mr. Franklin-Adams, and 15 adjustment plates are passed as satisfactory. There still remain to be taken 83 Chart plates with triple images, 151 Chart plates with single images, and 193 of the second series of Catalogue plates; 3 triple-image Chart plates and 24 Catalogue plates taken before 1904 have been rejected during 1904.

The grain of the Ilford Monarch plates was found to be too coarse for the most accurate measurement of images on the Catalogue plates, and on July 21 return was made to the Ilford Rapid plates.

During the year 1904, 183 Catalogue plates, containing 117,073 stars, have been measured in reversed positions of each plate—including 2157 standard stars, each of the latter being measured in reversed positions of the plate by both the measurers employed on each plate. Eleven plates measured in former years have since been rejected. The actual state of the work is as follows:

<table>
<thead>
<tr>
<th>No. of Plates Measured</th>
<th>No. of Plates Copied for Press</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before 1904</td>
<td>During 1904</td>
</tr>
<tr>
<td>577</td>
<td>183</td>
</tr>
<tr>
<td>Before 1904</td>
<td>During 1904</td>
</tr>
<tr>
<td>302</td>
<td>108</td>
</tr>
</tbody>
</table>

The total number of measured plates is now 760, containing over 440,000 stars.

Telegraphic signals were exchanged with Major O'Shee, R.A., of the Anglo-Portuguese Boundary Commission, on April 22, 26, and 28. The observations were reduced at the Cape, and the resulting longitude of the observing pillar at Tete—viz. 2° 14' 21'' 03—has been communicated to the Colonial Office.

Major Watherston, R.E., C.M.G., arrived at the Observatory on November 22, and during his stay until December 14 practised observing with the 14-inch altazimuth, and, as a first step in the determination of the longitude of Accra, on the West Coast of Africa, made with Mr. Pett a very satisfactory determination of his personal equation in time determination and in sending and receiving submarine mirror signals.

The records of the seismograph have been regularly forwarded to Professor Milne, Secretary to the Seismological Committee of the British Association.

The meteorological observations made during 1903 have been communicated to the Cape Meteorological Commission.

H.M. Astronomer was absent on leave from March 26 to October 25. During his visit to England he attended the Congress of the International Association of Scientific Academies as a delegate of the Royal Society, and was also much occupied with preliminary arrangements in connexion with the approaching visit of the British Association to South Africa in August 1905.

Geodetic Survey of South Africa.
(Report from Sir David Gill.)

The work of the Geodetic Survey in the Transvaal and Orange River Colony has been energetically pushed on under Colonel Morris.

The whole of the reconnaissance of the principal chains of triangulation, about 2200 miles in length, has been completed,
with the exception of 360 miles, which have been discarded as not absolutely necessary.

The beaconing of all points, 125 in number, of the primary chains has been completed, leaving only 47 points of a secondary chain from Ottoshoop to Kimberley to be beaconed. The base lines at Kroonstad and Houts River (some thirty miles north of Pietersburg) have been measured.

The angles of the whole chain from Newcastle in Natal through Belfast to Ottoshoop (435 miles in length, containing 38 points, including four base terminals) have been measured.

The angles of another chain from Pretoria southwards through Basutoland to Cala in the Cape Colony have reached the neighbourhood of Lindley in the Orange River Colony; the work done covers 160 miles of chain, containing 16 points, including two base terminals.

Levelling operations from M. S. L. at Lorenzo Marques have been carried along the railway to Melalane (86 miles); the levelling of the remainder of this line (107 miles) to Machadodorp has been left for execution next winter. From Machadodorp the chain of levelling has been carried a further 136 miles—that is, within twenty miles of Pretoria. The total amount of levelling done is thus 222 miles during five months of 1904.

Observations for astronomical latitude and azimuth have been made at Belfast (S. terminal of base), Ottoshoop (N. terminal of base), and Observatory Hill (Johannesburg); and observations for astronomical latitude only at

N. terminal of base
Langekloof, Points on the Belfast base extension.
Mare's Kop
Inkwelo
Salt Lake

In the north of Natal.

The whole of the above astronomical observations, with the exception of the latitudes of the two points in Natal, have been reduced; the horizontal and vertical angles of the chain Newcastle-Belfast and Belfast-Ottoshoop have also been reduced and the geographical co-ordinates computed.

The results of the base measurements made, like those mentioned in last report, with nickel-steel wires are most satisfactory. The lengths of the wires were determined before and after the measurement of each section by comparison with a 480-foot ground base, the length of which was similarly measured with the bars of the geodetic base apparatus before and after the measurement of each section of the base.

The results were:

For the Kroonstad base

<table>
<thead>
<tr>
<th>Sections</th>
<th>Meters</th>
<th>Meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>19787.341±0.004</td>
<td></td>
</tr>
</tbody>
</table>

"", " Houts River base

<table>
<thead>
<tr>
<th>Sections</th>
<th>Meters</th>
<th>Meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>33961.340</td>
<td>0.005</td>
</tr>
</tbody>
</table>

These probable errors of the total length of the base are derived from the differences of the three independent measures of each section, and include therefore all the effects of the accidental errors of measurement with the Jäderin wires as well as the accidental errors of the different measurements of the standard base, but not the systematic errors due to the determination of the absolute length of the steel bars of the geodetic base apparatus.

The accuracy attainable with the Jäderin method and the employment of *invår* wires is thus all that can be desired.

Up to the present time the computations include the closure of fifty-seven triangles. The errors range as follows:—

<table>
<thead>
<tr>
<th></th>
<th>c'0</th>
<th>o'5</th>
<th>l'o</th>
<th>l'5</th>
<th>2'0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newcastle-Belfast</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neighbourhood of Belfast</td>
<td>10</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Belfast to Ottoshoop</td>
<td>13</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td></td>
<td>31</td>
<td>13</td>
<td>8</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

The probable error of the levelling operations appears to be about 1 inch per 100 miles.

The difference between the length of the side (Salt Lake-Inkwelo) in the north of Natal, as found on the one hand from the Natal base and on the other from the Belfast base, is 1'46 foot in 30'7 miles, or about 1 : 100,000; an agreement which appears to indicate that these two independent systems of triangulation—the one depending on short base lines measured with the steel bars and the other on long base lines measured with nickel steel wires—are in substantial agreement.

As mentioned in last report, progress with the arc of meridian, north of the Zambesi, had been very much hindered by grass fires, and any but astronomical observations for latitude at Msambansou and for latitude and azimuth at Kawira had been impossible. Dr. Rubin was in consequence instructed to demarcate the Portuguese boundary running due south from the Zambesi near Zumbo, and to fix the point where the 15th parallel of latitude crosses the river Loangwa. This work, together with that of reconnaissance and beaconing, occupied Dr. Rubin and his party till April 1904, since which time the points Tondongwe, Inyangan, and Msambansou have been occupied for the measurement of horizontal and vertical angles and astronomical latitude determined at Kapsuka. No report of work after June 30 has yet been received from Dr. Rubin.
Royal Observatory, Edinburgh.
(Director, Dr. Copeland, Astronomer Royal for Scotland.)

The meridian observations made during 1904 have been restricted for the most part to the same programme as for several years past—viz. the zodiacal stars and heliometer comparison stars of Sir David Gill's lists and the clock-star list of the Berliner Jahrbuch. The total number of observations, all of which have been made by Mr. G. Clark, is somewhat less than the average of several years past; a result which is to be attributed to the long-continued periods of cloudy weather experienced in the latter half of the year. During the past four months only 18 or 20 nights could be classed as good observing nights, and on several of these observations were possible only for an hour or so. In the same period about 50 per cent. of the nights were completely overcast. Of the observations secured, 305 were of clock-stars, 714 of zodiacal stars, 71 of azimuth-stars, and 21 of the planets Juno, Neptune, Saturn, and Jupiter, making a total of 1111. All of these observations, with the exception of a few of the clock-stars, included measures of right ascension and declination. The instrumental errors, whenever possible, were determined both at the beginning and the end of each night's work, with satisfactory results as to the stability of the instrument. Reductions of the recent meridian observations have been carried on steadily during the year, and there is reason to hope that all the observations made up to the end of 1904 may be completely reduced to apparent place during the next few months.

The new reductions of the observations of stars made by the late Professor Henderson and Mr. Wallace at the Calton Hill Observatory during the years 1834–45, having been completed last year, have again been carefully examined and revised, and the MS., including introduction, annual results, and catalogue, finally prepared for the press. The work is now in the hands of the printer. At the request of Professor Boss a considerable number of positions of stars have been sent to him for utilisation in his investigation of standard right ascensions and declinations. As in last year, Dr. Halm has again had the able assistance in this work of Mr. Blackett, who has acted as temporary computer.

The spectroscopic observations of the rotation of the Sun have been continued throughout the year, and the greater part of the observations have been reduced. A preliminary paper on the results of 1901–3 was communicated to the Royal Society of Edinburgh and printed in their Transactions. Dr. Halm has also read before the same Society papers on Seeliger's theory of temporary stars, on the structure of the line and band series in spectra, and on the diurnal change of terrestrial magnetism,
which will appear in future numbers of the *Transactions and Proceedings* of the Society.

The 24-inch reflecting telescope has recently been equipped with a photographic plate carrier, designed by Mr. Heath and constructed by Mr. J. B. McPherson, engineer to the Observatory. It is provided with two slow-motion screws for moving the plate and guiding eyepiece in two directions at right angles to one another.

Several attempts were made by Mr. Clark to observe Encke's Comet, and comets 1904 d and 1904 e, with the 15-inch equatorial, but unfortunately without success, clouds or bright moonlight having on every occasion interfered with the observations.

Seismographical observations are made continuously and reported to the Seismological Committee of the British Association.

The Observatory supplies Greenwich mean time to Edinburgh and Dundee daily.

Meteorological observations are made continuously.

**Cambridge Observatory (Director, Sir R. S. Ball).**

*Reduction of Photographs of Eros.*—The reduction of a series of photographs of *Eros*, taken at nine observatories during the period 1900 November 7–15, was completed in June 1904, and a summary of the results communicated to the Society by Mr. Hinks (*Monthly Notices*, vol. lxiv. p. 701). The value of the solar parallax deduced from 295 exposures was $8".797 \pm 0".0047$. There is evidence of an oscillation in the place of the planet with a semi-amplitude of $0".03$ and a period of $2^h \ 38^m$, half the complete period of variation of light.

Since July good progress has been made with an investigation of systematic differences between the published results of different observatories and in the formation of a standard system of comparison stars for the whole extent of the observations.

Twenty-three exposures to complete the Cambridge contribution of 112 exposures to the above-mentioned investigation were measured in January by Mr. Hinks, who has had the help in computation of Miss Bell and Miss Malden.

*Meridian Circle.*—The alterations and additions to the meridian circle mentioned in the last report were completed by Messrs. Troughton & Simms in April. During the summer the instrument was completely adjusted and reduced to a condition of steadiness, and the observation of Sir David Gill's Zodiacal Star Catalogue was resumed on September 15, since which date about 700 observations have been made by Mr. Hartley.

The observations for the second list of heliometer comparison stars have been sent to Sir David Gill.
Sheepshanks Equatorial.—Good progress has been made with the observation of the objects in the stellar parallax working list prepared in 1903. During the year 177 successful plates have been taken by Mr. Russell and 32 by Mr. Hinks; the number of exposures on each plate is usually four. Mr. Russell has measured 107 plates, and the reductions are well advanced.

Floating Zenith Telescope.—Mr. Cookson has returned to Cambridge from the Royal Observatory, Cape of Good Hope. He has removed his floating photographic zenith telescope from the small dome on the main building and installed it in a new building designed to avoid the effects of temperature changes and of wind. The instrument has been adjusted, and is now at work on a determination of the aberration constant by Küstner’s method, and of the variation of latitude.

Self-recording Meteorological Instruments.—The Dines self-recording barograph mentioned in the last report was installed in the spring, and has been constantly compared with the standard barometer.

The Bendorf electrograph, with radium radiator, has been at work, with a few interruptions, since June.

The Callendar sunshine-receiver lent by Dr. W. E. Wilson has been mounted equatorially with a new form of driving mechanism, but is not yet working.

The Newall Telescope, Cambridge Observatory.  
(Mr. H. F. Newall.)

The Newall Telescope was used for observations on sixty nights in the course of the year 1904; six possible observing nights were not utilised in November and December, the driving of the telescope having become defective.

Spectroscopic studies of the stars have been carried on as in recent years, principally in the determination of velocity in the line of sight. One hundred and twenty-six photographs of stellar spectra have been obtained by Mr. Bellamy relating to twenty-six stars, fifty-eight photographs relating to ten stars chosen as “velocity-reference-stars” observed in co-operation with other observatories. This work has been carried out with the four-prism spectroscope adjusted for Hγ.

In the autumn one of the four prisms was removed, and in its place a prism of larger angle was inserted; the instrument was adjusted for λλ 4900–5890, and photographs have been obtained of the green part of the spectrum of several of the brighter stars for special investigations. This work had hardly been begun before it was interrupted by faulty driving of the telescope. After ten years of remarkably efficient work it seemed that the clockwork had become defective; this, however, was not the case, but it took a long time to trace the trouble to its real cause—namely, the loosening of a nut on the spindle of one of the anti-
Friction rollers at the bottom of the polar axis of the telescope. The photographic work was not resumed till 1905 January 12. Now that every part of the mechanism has been so thoroughly overhauled, measurements are to be made and recorded of the power required to move the telescope, of the power transmitted by the clockwork, and so forth, for comparison with measurements when any future defect calls for rectification.

Provision is being made for making solar spectroscopic observations, and specially for testing the atmospheric conditions for such work at Cambridge with the large instrument. The interest in the results of this investigation has been enormously enhanced by the munificent bequest of £5000 made by the late Mr. Frank McClean, F.R.S., with the view of extending and improving the instrumental equipment of the Observatory. The preliminary work thus assumes a new aspect when it is begun with the immediate prospect of its being developed in the direction that experience may show to be desirable; and though it is our great loss that we have not now the benefit of his expert advice, it is a peculiar pleasure to have the work connected with the memory of Frank McClean—a benefactor who has shown in so many ways his desire to advance astrophysical science.

Dunsink Observatory.

(Director, Prof. C. J. Joly, Royal Astronomer of Ireland.)

The chief work during the past year consists in the reduction of the observations of the stars of Sir David Gill's zodiacal list which were made with the Pistor and Martin's meridian circle. All the stars observed have been reduced to 1900. The precessions and secular variations for the stars observed in 1900 have been computed, and the work of preparing the results for their final form is proceeding.

The opportunity afforded by the cessation of systematic observation with the meridian circle was utilised in having the instrument overhauled. The mirrors for the illumination were resilvered and traces of fungus were removed from the object-glass. A new reticle was also fitted. Two series of observations were made in order to determine the personal equation due to the magnitude of stars in transit. By means of a suitable series of screens the stars were observed over half the wires at full magnitude, and over the remaining half at about the eighth magnitude. The first series gave a fairly marked personal equation. As the star images during this series of observations were not particularly good, a new series was carried out after the object-glass had been readjusted. The personal equation deduced from the new set of observations was practically nil.

The errors of each degree division of each circle of the meridian instrument were also determined.

Three hundred and forty-seven stars were observed with the
meridian circle during the year. Of these, 165 were observed for clock-error and 182 for the personal equation determinations.

A number of photographs of nebulae and star clusters were taken with the Roberts equatorial. This is a reflector with a 15-inch mirror and a guiding telescope. A good deal of trouble has always been experienced with this instrument owing to the instability of the mirror in its cell. Frequently plates are spoiled owing to sudden displacements of the images, especially during long exposures. Some modifications were made in the cell during the past year, and the performance of the instrument is undoubtedly improved. There is, however, still at times a perceptible shift of the mirror.

Some measures of double stars were made with the South equatorial with the object of testing the suitability of the instrument for systematic work in this department. The imperfections of the driving-clock interfere seriously with the accuracy of the results. This instrument has, as usual, been employed on the first Saturday of each month in showing objects of interest to visitors.

The time service to Dublin has been continued, and it has been considerably improved by corrections for the temperature and for the barometric pressure deduced from a new set of tables compiled from observations of the clock-rate.

Durham Observatory. (Director, Prof. R. A. Sampson.)

The Almucantar has been used on fifty-two nights during the year, making in all 759 transits. Attention has been directed chiefly to experiment in the quantity of mercury used, screening from temperature variations, and other such matters; these experiments are still being carried on.

The discussion of the elements of Jupiter's satellites has proceeded, so that the elements of I. and II. are believed to be now very nearly in a final state; those of III. still require revision.

Glasgow Observatory. (Director, Dr. Becker.)

The determination of absolute positions of four stars in the immediate vicinity of the pole was continued with the transit circle. Eight years of observations are now available, and it is proposed to extend them over a whole period of the node of the lunar orbit. In the last three months the weather conditions were even worse than in former years; with the exception of two nights the sky was either not clear for a sufficiently long time or heavy mist made faint stars invisible.

The spectroscopic work was mostly of an experimental character. Worth mentioning are our attempts to photograph
the red and yellow region of the spectrum of Jupiter. The photographs confirm the existence of one dark band near $C$, while they contain no trace of those visually observed in the yellow.

A new sidereal clock by Riesler was installed in December.


The time service and meteorological observations have been carried on as in former years.

Liverpool Observatory. (Director, Mr. W. E. Plummer.)

In the last Annual Report it was mentioned that it was proposed to measure some photographs made at other observatories, but that difficulty had been found in the lack of the necessary measuring apparatus. By the kindness of Professor H. H. Turner this deficiency has been supplied by the loan of a measuring machine. A plate of the Hercules cluster taken at the Yerkes Observatory has been measured in the past few months. The number of objects whose positions have been recorded is 2131. In the densest part of the cluster one star has been observed on an average in an area of ten square seconds. The constants of the plate have been determined, and other inquiries connected with the distribution of the stars in the cluster are now being prosecuted.

A good deal of attention has been devoted to comets, as in previous years. Many of the observations have been reduced, and these will be presented to the Society in due course. Double stars have also been observed occasionally.

The Observatory has to report no alteration in its staff or permanent equipment. The meteorological and seismological observations are continuously maintained. In connection with the routine work may be mentioned the distribution of time signals, the testing and rating of chronometers, the examination of sextants and other apparatus, for which the Mersey Docks and Harbour Board is prepared to grant certificates of test. Lectures in connection with the University of Liverpool are regularly given in the Observatory.

Radcliffe Observatory, Oxford.
(Director, Dr. Rambaut, Radcliffe Observer.)

During the past year very little routine work has been done with the transit circle. Occasional observations have been made for the determination of time and instrumental errors. The working parts of the instrument have been carefully tested. The condition of the micrometer screws of the microscopes and
eyepiece was examined in the manner described in the Radcliffe Observations, 1886, p. xi, with the satisfactory result that no sensible effect of wear could be detected. A re-determination of the horizontal flexure corroborated very closely the value for this quantity obtained in 1902 which had been used in the reductions. But the principal work in connexion with the transit circle was the examination of the errors of the pivots.

In previous reports references have been made to this subject, but hitherto all attempts to determine these minute errors have been unsatisfactory. This year a novel and highly sensitive method of testing the pivots has been adopted, and the errors have been measured with a remarkable degree of precision. The method employed and the results obtained are described in a paper communicated to the Society and published in the Monthly Notices, vol. lxv. 1, p. 56. This paper contains a table (p. 77) giving the corrections necessary to the Radcliffe Catalogue for 1890 to free them from this source of error.

The printing of the catalogue referred to in recent reports has had to be postponed for lack of funds, and accordingly other more pressing work has been allowed to interfere with the actual preparation of the copy for press. But the material is now complete, and it is hoped that the copy will soon be in the printer’s hands.

The Barclay 10-inch equatorial has been used chiefly for observations of new or variable stars and comets. Observations of the brightness of Nova Persei, Nova Auriga, and Nova Geminorum were made on January 15, and of Mr. Stanley Williams’s new or variable star (159, 1904) on October 7, 8, 11, 13, 18, December 3, 5, 7, 8, 12, and 16 (see Monthly Notices, vol. lxv. 2). On March 22 the occultations by the Moon of three stars in Taurus were observed, and on April 18 and 23 Brooks’s Comet 1904 a was examined and its position approximately determined.

The preliminary work of getting the new equatorial into thorough working order, which was in progress at the date of last report, continued to occupy a great deal of time during the earlier months of the year. Several unexpected difficulties arose. Amongst others the illumination of the field of the guiding telescope and of the bifilar micrometer gave a good deal of trouble; but after a number of experiments a very satisfactory illumination was in both cases at length obtained. During the course of the long and tedious trials of the various parts of the instrument many plates were taken, some of which no doubt are of very little permanent value; but several photographs (e.g. those of the Pleiades, M vi. 33 and 34 [Persei], Praesepe [Cancer], M 38 [Auriga]), Mr. Stanley Williams’s Nova and other groups) have been preserved, and may, it is hoped, prove of use when an opportunity of measuring them presents itself.

During the summer a programme of stellar parallax work, according to the method proposed by Professor Kapteyn (Bulletin de la Carte du Ciel, tome i. p. 262), was arranged in
consultation with him. This work might have commenced at
the beginning of September, but unfortunately the necessity of
waiting for a special plateholder caused so much delay that it
was found impossible to make a beginning until the middle of
October, after which the state of the weather interfered very
much with operations. Thirty-one photographs, each containing
three separate exposures, have been made in connexion with
this work, of which twenty-one have been carefully stored away
undeveloped in tin boxes to be exposed again during the spring
months, and finally once more in the following autumn, so as to
obtain, in close juxtaposition on the plate, images of the stars
at each of three successive maxima of parallax, in accordance
with Professor Kapteyn's scheme.

Early in June a machine of a novel pattern for measuring
photographs was supplied by Sir Howard Grubb. This in-
strument is constructed to measure plates of any size up to
12 in. × 12 in. So far the work done with it has been confined
to measures for testing the micrometer screws and examining
the division errors of the scales. Until quite recently a diffi-
culty has been experienced in getting a sufficiently accurate
scale for subdividing the réseau intervals; but it is expected that
before long a scale satisfactory in every respect may be obtained.
The errors of the screws are found to be exceedingly small.

Meteorological and earth-temperature observations have been
carried on as heretofore.

University Observatory, Oxford.
(Director, Prof. H. H. Turner.)

The portion of the Astrographic Catalogue assigned to this
observatory was completed in February last in MS. The first
plates were exposed in 1892 January, and the work has gone on
continuously until 1904 February 17, when the reductions of
the last plate were completed. During the twelve years which have
elapsed since the commencement of the work much has been
learnt from experience, and some of the earlier plates could be
improved. But the work can be reported complete, leaving
revisions and additions to be made as opportunity offers. It is
hoped that funds for printing the work will soon be provided by
the Government and the University jointly; but the negotia-
tions, in which the Royal Society has rendered kind and im-
portant assistance, are still proceeding.

Attention has now been directed more particularly to the
Eros plates, many of which have been measured. Those falling
within the period 1900 November 7–15, for which Mr. Hinks of
Cambridge undertook a general discussion, were measured with
attention to his suggestions, and the results sent to him for incor-

The stereo-comparator presented to this observatory by
Mr. C. L. Brook, F.R.A.S., was set up in January last, and a number of plates have been compared during the year, but without finding anything worthy of special notice as yet. This, perhaps, is only what might have been expected.


The Director visited the United States during the summer in connexion with the St. Louis Congress of Arts and Sciences, and gratefully acknowledges the cordial reception he met with at a number of observatories.

In recording the conclusion of the heavy piece of work on the Astrographic Catalogue the labours of three persons call for special recognition. Mr. F. A. Bellamy has taken practically all the plates and superintended the whole work throughout with unfailing devotion and care. It is pleasant to be able to mention that the University has conferred upon him the honorary degree of M.A. in acknowledgment of these special services. Mr. B. Gray and Mr. E. A. Gray have done the lion's share of the measures and reductions with an accuracy and neatness which could scarcely be improved. It is sad to chronicle their departure from the Observatory as the natural sequel to the completion of the work.

Temple Observatory, Rugby. (Director, Mr. G. M. Seabroke.)

The use of this observatory by members of the school has been increasing, and some of the boys are sufficiently advanced as to be allowed to go there alone at all times. Transit and double-star observations and photography of the Moon have constituted the chief work.

Solar Physics Observatory, South Kensington. (Director, Sir Norman Lockyer, K.C.B.)

Observations of Sun-spot Spectra.—The Sun was seen on 241 days during 1904, and spot spectrum observations were made on 114 days, 181 spots being observed in the region F—D. The records continue to show that the chief lines affected are due to vanadium, titanium, and the "unknown" light-sources.

Daily photographs (glass negatives) of the Sun's disc are received from Dehra Dun (India) and Mauritius, the gaps in the Indian record being filled up, as far as possible, by negatives from Mauritius. The negatives are forwarded to Greenwich for
reduction as they are required. A positive on paper accompanies each negative, and these are mounted on cartridge paper and then bound up into half-yearly volumes, the Mauritius prints being primarily used to fill the Indian gaps. The printing from Canon Selwyn's excellent Ely negatives is now complete, and affords a fairly continuous record of the changes on the solar disc from 1863 February 9 to 1874 February 25. The total number of prints thus obtained is 1655, of which 1481 have been mounted in a similar manner to the Indian prints.

The Spectro-heliograph.—A hundred and twenty-seven days were fine enough to warrant attempts being made to obtain monochromatic photographs of the Sun. Owing to its unfavourable location the instrument can only be used between April and November, and during that period 477 "K-light" negatives of the disc and 95 of the limb and disc combined were obtained. A number of these have been enlarged to 8-inch glass positives, and experimental measures are being carried out for the purpose of finding the most satisfactory method of determining the positions and areas of the calcium vapour clouds shown thereon.

A new 12-inch photo-visual Cooke objective, of 18 feet focal length, has been in use since April 9 for focussing the solar image on the primary slit, and this has produced a marked improvement in shortening the times of exposure. A brief description of this instrument and an account of the results so far obtained are in hand and will be submitted to the Society at an early date.

Stellar Spectra.—The instruments principally used in photographing stellar spectra were the 6-inch Henry prismatic camera, with one 45° objective prism; the 2-inch calcite-quartz prismatic camera; the 9-inch prismatic reflector, with one 72° objective prism; and the 36-inch reflector. Fifty-two spectra have been photographed with the first-named instrument, forty-two in the ordinary region and ten taken during focussing trials preparatory to photographing the green, F—D, region in the spectra of the brighter stars. The calcite camera has been chiefly used for photographing spectra of pairs of stars situated on the same levels, but on opposite sides, of the temperature curve based on the chemical classification, the purpose being to test the equality of temperature of such pairs. Altogether, twenty-nine negatives, including twenty-five different pairs of stars, were obtained, and besides these a number of trial exposures were made to determine the colour curves and ranges of various makes of dry plates. The spectra of fifteen of the fainter stars have been photographed with the 9-inch prismatic reflector. The pressure of other work and the delay in readjusting the rails, which are out of level owing to the subsidence of the concrete foundations on which they rest, have prevented any extensive employment of the 36-inch reflector; but the field of best definition has been determined, and the Hammersley 3-prism spectroscope, which is used in conjunction with this
instrument, has been cleaned, adjusted, and remounted in preparation for the photographing of the spectra of various nebulae and red stars which is now in progress.

Meteors.—No organised attempt was made to observe the Perseid and Leonid showers of 1904, but observations made during the intervals between routine work led the observers on duty to the conclusion that the former shower afforded a fairly rich display. Thirteen plates exposed in ordinary cameras by one of the observers on August 11 and 12 showed no trace of a meteor trail.

Laboratory Work.—A number of arc spectra of elements have been photographed in the region $\lambda 4800 - \lambda 5900$ with the 21-foot Rowland grating, using the third order. The 3-inch Cooke spectroscope has been used to obtain the arc spectra of various substances, including several mineralogical specimens submitted for analysis by the Geological Survey. Researches on the dissociation of gas from minerals under varying electrical conditions have been commenced and are still in progress.

Correlation of Solar and Meteorological Phenomena.—The time of the computing staff has been largely employed in continuing the reduction and plotting of published meteorological data on uniform lines for comparison with similar reductions of the solar records. The resulting tables and curves emphasise the close relationship between these two classes of phenomena, and form a valuable and ready source of reference for present and future works.

Publications.—Papers dealing with sun-spot variations, stellar temperatures, atmospheric pressure, magnetic storms and aurorae, the spectra of sun-spots and stars, enhanced lines and the spectrum of silicon have been communicated to the Royal Society during the past twelve months, some of them subsequently appearing as appendices to the Monthly Notices. Numerous papers dealing further with these subjects are in course of preparation.

Stonyhurst College Observatory. (Director, Rev. W. Sidgreves.)

The 4-inch prismatic camera has been removed from the equatorial telescope and mounted on the polar axis of the "Cross" 7-inch reflector, of which mention was made in last year's report. The driving-clock, which was built for a greater polar axis, has been successfully geared to the smaller one, and runs the same very smoothly. The results at present are meagre but promising. The continuous night-cloudiness has frustrated the hope of obtaining an ample and succinct series of spectrographs of the binary or possibly multiple system of $\beta$ Aurigae; but the lines are measurably double on some of the plates, and sharp singles on others. Another projected series of $\gamma$ Cassiopeiae

has suffered in the same way; there have been too many days between successive exposures, and many of the photographs are of inferior value owing to unfavourable atmospheric conditions.

The solar surface has been observed on 215 days, recorded by 213 drawings of spots and faculae and two blank sheets.

Spectrographs of the larger spots have been taken with the grating spectrograph in the green and violet regions; and a considerable number of experiments have been made on the photography of the red end of the spectrum.

*Mr. Edward Crossley's Observatory, Bermerside, Halifax.*

The work of the Observatory has been resumed as in past years—viz. the observation of double stars, the phenomena of *Jupiter's* satellites, and the usual meteorological observations at 9 A.M. and 3 P.M.

*Wolsingham Observatory. (Rev. T. E. Espin.)*

The work of measuring the double stars of Herschel, and other stars which have been mostly neglected, between N. 30° and 40°, has been carried on; between thirty and forty new pairs have been detected as well. Most of these have been measured, though some of them are too difficult for the 17½-inch. The majority of the measures have been made since August, ill health preventing night work in the earlier part of the year.

*Sir William Huggins's Observatory, Upper Tulse Hill.*

The photography of the spectra of stars and other celestial bodies, which has been in progress for many years, is being continued.

Experimental work in the laboratory has included, in addition to the photography of terrestrial spectra, further experiments of the radiation of radium.

*Rousdon Observatory, Lyme Regis, Devon.*

*(Late Sir C. E. Peek's; C. Grover, Observer in Charge.)*

The building and instruments are maintained in good working order. The year has been decidedly favourable to astronomical work, and observations have been made on 141 nights. The 6½-inch Merz-equatorial has been used in the observation of long-period variable stars, and 489 magnitude determinations
have been made. Argelander's method has been followed, as during the previous nineteen years. At each observation the light of the variable is estimated relatively to five comparison stars in the same field of view, the mean result being assumed to be the magnitude on the date of observation. About twenty-five long-period variables are under regular observation; and as most of these are circumpolar in this latitude, their light-changes are continuously recorded.

The occultation of Aldebaran by the Moon on February 24 was well observed: the star was clear and well defined, and disappeared instantaneously at 5h 53m 30s G.M.T. Aldebaran was again occulted in the early morning of July 9 and in bright sunshine, but the star was beautifully defined and disappeared instantaneously at 17h 28m 28s.

The following occultations of stars were observed 1904 March 22. The disappearances at the dark limb were all instantaneous:—

<table>
<thead>
<tr>
<th>Star</th>
<th>Magnitude</th>
<th>Date</th>
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<tbody>
<tr>
<td>Taurus</td>
<td>5.3</td>
<td>10 1</td>
</tr>
<tr>
<td>Tauri</td>
<td>3.9</td>
<td>10 2</td>
</tr>
<tr>
<td>D.M. +15° 633</td>
<td>6.5</td>
<td>10 4</td>
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Encke's Comet was observed on seven nights between November 24 and December 18. On November 24 it was large and diffuse, with but slight central condensation. By December 10 it had considerably diminished in size, but was brighter with more central condensation, and on December 18 it was very faint owing to moonlight. On November 28 it was in the same field of view with the cluster 15 M Pegasus, and the contrast between the large, faint, and diffuse comet and the small and bright star cluster was most interesting.

Starfield Observatory, Crowborough Beacon.

(Late Dr. Isaac Roberts's; W. S. Franks, Observer in Charge.)

Subjoined is a list of the nebulae and clusters photographed with the 20-inch reflector of the above observatory during the year 1904 up to the date of Dr. Roberts's death on July 17. Since that time the photographic work has been practically suspended, and it is not possible at present to say whether it will be renewed or not. The meteorological observations have been regularly kept up, so that there should be no break in their continuity. In the following list it has been deemed expedient to omit the co-ordinates of the objects in order to economise valuable space; they can be easily enough identified by reference to the well-known catalogues of Dr. Dreyer. They are placed, of course, in order of R.A.
Feb. 1905.  
**Eighty-fifth Annual General Meeting.**

**List of Photographs taken in 1904.**

<table>
<thead>
<tr>
<th>Neb.</th>
<th>Expos. m</th>
<th>Expos. m</th>
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<tbody>
<tr>
<td>H V 16 Andromæ</td>
<td>90</td>
<td>H V 26 Leonis Minoris</td>
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<tr>
<td>H I 159 Cassiopeæ</td>
<td>90</td>
<td>H V 23 Ursæ Majoris</td>
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<tr>
<td>VII 42 Cassiopeæ</td>
<td>60</td>
<td>H I 79 Ursæ Majoris</td>
</tr>
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<td>H I 108 Piscium</td>
<td>90</td>
<td>H II 81 Leonis</td>
</tr>
<tr>
<td>M 103 Cassiopeæ</td>
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<td>H II 50 Leonis</td>
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<td>VI 31 Cassiopeæ</td>
<td>60</td>
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<td>H II 160 Leonis</td>
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<tr>
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<td>Groombridge 1830 Ursæ Majoris</td>
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<td>M 34 Persei</td>
<td>60</td>
<td>H II 162 Virginis</td>
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<tr>
<td>N.G.C. 1770 Arietis</td>
<td>90</td>
<td>H II 132 Virginis</td>
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<td>IV 17 Eridani</td>
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<td>H I 95 Comæ</td>
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<td>H II 749 Canum Venat.</td>
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<td>N.G.C. 1499 Persei</td>
<td>2b 30</td>
<td>H I 83 Comæ</td>
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<td>VII 60 Persei</td>
<td>60</td>
<td>H I 124–5 Virginis</td>
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<td>VII 61 Persei</td>
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<td>H II 95 Virginis</td>
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<td>H I 158 Eridani</td>
<td>54</td>
<td>M 94 Canum Venat (2)</td>
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<td>H II 289 Leporis</td>
<td>90</td>
<td>H I 162 Virginis</td>
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<td>M 38 Aurigæ</td>
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<td>M 37 Aurigæ</td>
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<td>h 373 Monocerotis</td>
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<td>IV 20 Monocerotis</td>
<td>90</td>
<td>M 14 Ophiuchi</td>
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<td>VI 2 Geminorum</td>
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<td>h 1989 Herculis</td>
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<td>H VII 30 Sagittarii</td>
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<tr>
<td>VI 1 Geminorum</td>
<td>60</td>
<td>M 16 Cluye</td>
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<tr>
<td>M 46 Argæ</td>
<td>90</td>
<td>H VI 23 Sagittarii</td>
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<tr>
<td>47 Argæ</td>
<td>60</td>
<td>M 57 Lyne</td>
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<td>VI 37 Argæ</td>
<td>50</td>
<td>H VIII 13 Aquilæ</td>
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<tr>
<td>H II 908 Ursæ Majoris</td>
<td>90</td>
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</table>

[Mrs. Roberts wishes it to be known that all the photographs will be carefully preserved by her at Château Rosa Bonheur, By Thomery, Seine-et-Marne, France, and will be available for reference.]

* Stopped by clouds.
Mr. Saundervs Observatory, Crowthorne, Berks.

Four of the Paris negatives of the Moon have now been completely measured, the results prepared for publication and communicated to the Society. In all, 2302 measures have been made of 1433 points. Of these, 38 points have been measured on all four plates, and from these it has been deduced that the radius of the Moon directed towards the Earth is about half a mile longer than the polar radius. Not much reliance is placed upon the absolute value obtained, but the result of the investigation shows that with further measures a satisfactory result may be expected, and that the elongation is small.

It is purposed to measure next two of Mr. Ritchey's negatives taken with the Yerkes 40-inch. In a preliminary examination of one of these a small unrecorded crater was noticed on the floor of Ptolemaeus, a formation which has been kept under close examination with the telescope for some years. Its existence has since been verified, but it is, even under favourable conditions, a difficult object in a 7-inch refractor, and its detection on the photograph affords another proof of the great advances Mr. Ritchey has made.

The telescope has been used chiefly for minute study of special regions on the Moon.

The photographic measures have all been made by Mr. J. A. Hardcastle. Considerable help in the reductions has been received from Mr. B. G. C. Gray, and Mr. J. C. W. Herschel has made an index map of the points measured.

Daramona Observatory, Street, Westmeath. (Dr. W. E. Wilson.)

The weather during the past year has been the worst yet recorded for observational work.

A quartz train spectroscope was obtained with the object of photographing the ultra-violet spectrum of sun-spots, but it could not be used.

The differential bolometer for recording continuously the intensity of solar radiation has been sent to Cambridge Observatory, and it is hoped will give in time a valuable record.

Hong Kong Observatory. (Director, Dr. W. Doberck.)

(Report for the years 1902, 1903, and 1904.)

Weather forecasts and storm warnings and the other meteorological work is continued, and means have been taken of twenty years' hourly readings and eye observations. Absolute magnetic observations have been made at regular intervals during each year.

The time service is continued, but the time of the meridian eight hours east of Greenwich has been adopted. In 1902 the number of transits observed was 2842, in 1903 1667, and in 1904 1144. The observations of transits of southern stars were finished in July 1904, and a catalogue of over 2000 southern stars is in the press. It depends upon about 16,000 transits. The probable error of a right ascension determined from eight transits reduced to the equator is \( \pm 0.01 \). Stars of the sixth magnitude and brighter stars were screened so as to appear of about magnitude 6.5 or 7, which is about the magnitude of the greatest number of stars observed. The light-equation, if any, is therefore very small. The magnitudes were carefully estimated as often as possible, and a table of corrections was constructed for reducing the recorded magnitudes to the S.M.P. The probable error of an observed magnitude is \( 0.2 \) on the S.M.P. scale. As many of them were observed eight times in the course of the six years, the results are just as accurate as those determined photometrically. Possibly magnitudes directly estimated are even better than those obtained by aid of photometers, but the latter are required for settling a fixed scale.

About 500 micrometrical measurements of double stars, mostly southern pairs, were made at Hong Kong, and nearly double that number at the University Observatory, Copenhagen, where the Director spent about a year during his leave of absence from Hong Kong.

The recalculation of the orbits of double stars has been continued and new orbits of Castor, ζ Sagittarii, η Boötis, β 416, φ Ursae Majoris, 99 Herculis = A.C. 15, and Sirius have been published in the *Astronomische Nachrichten*, where also papers on the distribution of double stars and on the accuracy of the Markree observations of double stars have been printed. In the former paper the preponderance of binaries in certain hours of right ascension has been pointed out; in the latter the systematic errors are proved to depend upon the definition and steadiness of the images.

The fourth edition of *The Law of Storms in the Eastern Seas* has been printed. Twenty annual volumes have been issued; and as they now contain investigations of typhoons, climate, &c., as complete as can be carried out with the instrumental outfit at this observatory, it is intended to discontinue this series.

*Kodaikánal and Madras Observatories.*

*(Director, Prof. C. Michie Smith.)*

The year was, on the whole, a very favourable one for observations, and at Kodaikánal there were only twenty-two days on which no solar observations were possible. Photographs of the Sun were taken with the Dallmeyer photoheliograph on 264 days, and could have been taken on more had it not been
for a want of suitable plates early in the year. Sun-spots were observed visually on 344 days, and sketches were made of important details. In all, 236 new groups were observed during the year. The smallest number of new groups appearing in any one month was eleven in February and, the largest, twenty-nine in December. The mean daily number of groups visible varied from 2.8 to 5.0 in December.

Sun-spot spectra were observed on 227 days, and attention was given, not only to widened lines, but also to the behaviour of hydrogen and helium lines in and near spots.

Prominences were observed on 251 days, but on twenty-one of these it was not possible to complete the work before clouds came up. All prominences are sketched and the heights of the more important ones are measured. Rapidly changing prominences are followed for some time and repeated sketches are made. The spectra of a number of eruptive prominences have also been studied.

The spectroheliograph, made for the Observatory by the Cambridge Scientific Instrument Company, was received in August, and was brought into regular use in October as soon as the buildings for it were sufficiently advanced to permit of the sliding roof covering the siderostat being moved. Since then it has been employed on every fine day except during a great part of November, when the director was absent from Kodaikanal. The instrument is a very fine one, and promises to give excellent results.

Meteorological observations and earthquake records with the Milne horizontal pendulum have been continued as in former years.

A European assistant has been sanctioned for the Observatory, but has not yet joined the staff.

Astronomical work at Madras was, as for some years past, practically confined to the observations necessary for the efficient maintenance of the time service.

Melbourne Observatory. (Director, Mr. P. Baracchi.)

Meridian Work.—The following observations were made with the 8-inch transit circle:

<table>
<thead>
<tr>
<th></th>
<th>Observations</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in R.A.</td>
<td>in N.P.D.</td>
</tr>
<tr>
<td>Clock stars</td>
<td>578</td>
<td>—</td>
</tr>
<tr>
<td>Azimuth stars</td>
<td>337</td>
<td>71</td>
</tr>
<tr>
<td>List stars</td>
<td>1432</td>
<td>1442</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>2350</td>
<td>1516</td>
</tr>
</tbody>
</table>

The list stars were selected from the Melbourne Astrophotographic Catalogue plates, to serve as standard stars for the
reduction of those plates. The total number of these standard stars now completely observed three times or more is 4912.

Astrophotographic Work.—The following table shows the number of regions photographed:

<table>
<thead>
<tr>
<th>Chart plates with triple exposure of 30° each</th>
<th>Passed as Satisfactory</th>
<th>Rejected</th>
<th>Total Number passed as Satisfactory</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
<td>...</td>
<td>110</td>
<td>4</td>
</tr>
<tr>
<td>Catalogue plates, second series</td>
<td></td>
<td>56</td>
<td>3</td>
</tr>
<tr>
<td>Test plates on South Polar Regions</td>
<td></td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Test plates on Oxford Type Charts</td>
<td></td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Plates for trails, adjustment of focus, centre, &amp;c.</td>
<td>...</td>
<td>...</td>
<td>27</td>
</tr>
</tbody>
</table>

The photographic record of the variation of the magnetic elements, of meteorological elements, and earth tremors has been continued throughout the year without interruption.

The usual routine work in connection with the various services required by the public, as—

- Time service,
- Weather service,
- Registration of tides,
- Rating chronometers,
- Testing of instruments,
- Verification of standard weights and measures &c.—

have been carried out as in former years.

Sydney Observatory.
(Mr. H. A. Lenihan, Acting Government Astronomer.)

In January the Public Service Board separated the work of the departments of the Observatory, the meteorological branch of the work, heretofore carried on under the direction of Mr. Russell in conjunction with the astronomical work, was put under the charge of the first meteorological assistant, Mr. H. A. Hunt, and the astronomical portion under Mr. H. A. Lenihan, who had the full control of the two departments under his guidance. This arrangement will terminate on 1905 February 28, when Mr. Russell will retire from the service.

Early in the year Professor Otto Klotz, the Government Astronomer of Ottawa, Canada, visited Sydney in connexion with the latitude and longitude of the stations of the Pacific Cable route to Australia and New Zealand, and determined the difference of longitude between Sydney and Southport (Queensland), and the differences between Wellington and the terminal station at Doubtless Bay (New Zealand), Sydney having pre-
viously determined the longitude of Wellington. Professor Klots also took observations at Sydney for personal equation.

Later in the year Dr. O. Hecker, of the International Geodetic Association, visited this Observatory. His mission was to determine the gravity of the Earth at various stations throughout the world: this he expects to complete by the end of March next. He also took magnetic observations for inclination and declination; but as the electric disturbance of the city interfered with the observations, a stone pillar was removed from the Observatory to Red Hill Branch, and there cemented into position. On this pier he made a successful series of observations with the most approved modern instruments. At the end of June Dr. Hecker left for San Francisco to continue his work. Sydney was the second place he had visited, results having previously been determined at Melbourne.

Two sets of time signals with Washington (U.S.A.) have been received, with very satisfactory results—viz. on 1904 January 1 and September 8, through the Pacific Cable.

Repairs to the floor and building at Red Hill Branch have been carried out, and new triangular wires have been placed in position, 7 seconds of arc apart, in the finder of the photographic telescope, so that three equidistant pictures can be taken.

Transit Work.—Mr. W. E. Raymond, who has this work in hand, was incapacitated by illness for some months, and although the assistance of a special officer, Mr. C. J. Merfield, was placed at the disposal of the Observatory, this circumstance interfered with the results obtained. During the early part of the year rain and cloud, and in the latter portion hot and dusty weather, rendered the seeing of stars of ninth and tenth magnitudes very difficult, and on many evenings the work had to be abandoned.

The equatorial has been in use during the year, but not on any special work. When permanent arrangements are made for the Director to succeed Mr. Russell, the equatorial will be put into constant use.

In November a small house was erected over the magnetic pier at Red Hill Branch, and the magnetic work has been started. The results compare very well with the last position determined at the Sydney Observatory—viz. 9 deg. 34 min. 78 sec. E.

Details of the Work.—

Number of R.A. observations of stars ... 2248
" N.P.D. " ... 1839
" R.A. " of Sun ... 469

making a total of 2717 R.A. observations.

The 9 A.M. collimations, 300; level, 300; nadir, 300. The 9 P.M. level, 127; nadir, 127; azimuth determinations, 172.

The reductions of previous years' astronomical observations are in a very forward state, and it is hoped that sanction will be
given during the present year for printing the accumulated results now in manuscript.

The visitors' list for the year has been increased; no fewer than 1167 were shown over the Observatory, of whom 542 attended during the evenings, and on sixty occasions Mr. Lenahan gave lantern lectures and demonstrated with the equatorial. These visits took up a considerable time from the usual duties of the Observatory.

Mr. J. W. Short, astronomical photographer, gives the following results of his year's work with the Astrographic Telescope at Red Hill Branch:

Eighty-seven chart plates, each 1½ hour's exposure; 115 plates exposed. The preparation of a number of star lantern slides ordered by the late Minister for distribution; magnetic work which was commenced at the end of the year and other duties occupied much available time. To these and other causes the small number of plates taken is due.

Meteorology.—The number of weather charts issued was 22,100. Forecasts have been telegraphed daily to 63 stations in N.S. Wales; 4112 charts of daily rainfall and 588 monthly charts with percentages of rainfall over the State.

Climatology.—Fifty-six new stations have been established, making in all 1903, of which 1863 send monthly returns; and 40, annual returns.

Mr. W. C. Graham reports that 977 volumes have been distributed—a number considerably below that of last year, owing to delay at the Government Printing Office in completing the annual publication; 1200 volumes have been received during the year.

It is again the Director's pleasing duty to record his appreciation of the work of each officer of the staff of the Sydney Observatory, who by their industry helped in bringing the year's work to a successful issue.


This work is being done at the Melbourne Observatory by a special Bureau, maintained at the joint expense of the Governments of New South Wales and Victoria, as stated in previous reports.

The measurements during the whole of the year 1904 were made with the two measuring machines made by the Repsolds' on the plan of Sir David Gill, which have continued to give full satisfaction.

Mr. Russell's new measuring machine, described by him in Monthly Notices, vol. lxiii. page 39, has been on trial for a con-
siderable time, but was not required for systematic use during the year. The plates were measured in two positions, direct and reverse, and the measures passed as satisfactory if they agreed within 0.6.

The plates measured are:

- 90 Sydney plates, containing 44,958 stars.
- 64 Melbourne plates, containing 39,924 stars.

The total numbers of plates now fully measured are:

- 314 Sydney plates, containing 176,019 stars.
- 576 Melbourne plates, containing 187,267 stars.

There were unavoidable delays and interruptions in the work during the year owing to changes in the staff and the training of new observers.

_Lovedale Observatory, South Africa._ *(Dr. Alex. W. Roberts.)*

The work of this Observatory during 1904 has been, as in previous years, the observation of variable stars south of $-30^\circ$.

The number of stars under regular examination is 102, and the number of observations made 3500.

The variation of stars of the close binary type is estimated by the Cooke prismatic telescope. This instrument yields measures freed from position error.

Variable stars of both the short-period and long-period class are kept under observation with either the 1-inch or the 3.4-inch telescope.

During the year a system of standard stars from 2.0 mag. to 10.0 mag. has been determined by the method of sequences and limiting apertures. It is proposed during 1905 to extend this system down to 11.0 mag.

The magnitudes of the comparison stars surrounding three variable stars of the close binary type—*V Puppis, X Carinae, R R Centauri*—have been determined by means of the Oxford wedge photometer.

_Mr. Tebbutt's Observatory, the Peninsula, Windsor, N.S. Wales._

In consequence of the observer's advanced years, active work has been discontinued at this Observatory. The only observations made during the year 1904 are the following comparisons with the filar micrometer on the 8-inch equatorial:

<table>
<thead>
<tr>
<th>Objects Observed</th>
<th>Nights of Observation</th>
<th>Number of Comparisons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uranus</td>
<td>8</td>
<td>95</td>
</tr>
<tr>
<td>Ceres</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Hebe</td>
<td>13</td>
<td>155</td>
</tr>
</tbody>
</table>

Rough observations of Encke's Comet were obtained on November 30 and December 1, but it was too faint and diffused for good work.

In addition to the astronomical work, the usual meteorological observations were made during the year.