REPORT

OF THE

ASTRONOMER ROYAL

TO THE

BOARD OF VISITORS

OF THE

ROYAL OBSERVATORY, GREENWICH.

Read at the Annual Visitation of the Royal Observatory, 1909 *June* 5.

GREENWICH OBSERVATIONS, 1908.

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Read at the Annual Visitation of the Royal Observatory, 1909 *June* 5.

The Report here presented refers to the year from 1908 May 11 to 1909 May 10, and exhibits the state of the Observatory on the last-named day.

I.—Buildings and Grounds, Movable Property, and Library:—

The new fireproof Storehouse was completed just before the last Visitation, and the inflammable and other stores, which were formerly in wooden sheds, have been removed to this building.

The canvas wind-screens which were fitted up in 1895 on the opposite ends of the shutter-opening of the 36-feet dome to protect the 28-inch telescope and the observer from the wind, have been renewed by arrangement with the Admiral Superintendent at Chatham Dockyard.

The vertical shutters on the south side of the Transit-Circle Room have been renewed.

The walls and floor of the developing room in the S.E. attic of the New Observatory building have been covered with sheet lead to protect them from the

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corrosive action of the chemicals used in the photographic work for the reproduction of the Astrographic Chart.

The principal movable instruments are thus distributed:—

At Greenwich—

Transits C, D, E, and the transit with axis view.

Altazimuth E.

Equatorials (6-inch).—Cooke No. 2, Simms No. 1, Hodgson, and Corbett. (The telescopes of the two last-named are mounted respectively on the Thompson and 28-inch Equatorials.)

Photoheliographs.—Nos. 1, 2, 3, and 5. (The object glass of No. 5 has been lent to Professor Turner since the Eclipse Expedition of 1898.)

Detached Telescopes (on tripod stands).—One 4-inch (Simms No. 1), two 4-inch (R.O. Nos. 1 and 2), one $3\frac{1}{2}$-inch (R.O. No. 3).

One Hilger Chronograph.

A single prism Spectroscope.

On loan—

Transit A, at the Cape Observatory. Transit B, at Malta temporarily for Longitude Observations.

Altazimuths.—A, at the Science Schools, South Kensington; B, at the Cape Observatory; D, to the Colonial Office for use of Major Watherston for Longitude Observations on the Gold Coast.

Equatorials.—Lee (6-inch), at the Hong Kong Observatory; Simms No. 2 (6-inch), lent to the Board of Education.

Photoheliographs.—No. 4, complete, at the Kodaikanal Observatory.

Detached Telescope.—4-inch (Simms No. 2) lent to the British Antarctic Expedition, 1907.

Clocks.—Dent No. 1916 and Dent No. 2013, at the Cape Observatory; Dent No. 2011, at the Kew Observatory; Dent No. 2010, at Devonport; Arnold 2, at the University Observatory, Oxford; and Graham 2, at Malta temporarily for Longitude Observations.

One Hilger Chronograph at Malta temporarily.

Lent to the Royal Observatory for observation of Solar Eclipse of 1905, and still left here:—

Coelostat, with 16-inch Mirror, by the Government Grant Committee.
Double Spectroscope, Quartz and Flint, by Major E. H. Hills, R.E.
Heliostat, with 12-inch Mirror, by Major E. H. Hills, R.E.

A 4-inch photographic lens of 18 inches focus has been kindly lent to the Royal Observatory by Mr. Franklin Adams for special use on Comets, &c.

Transit C was taken out to Malta for use in connection with the first part of the Longitude Observations and was brought back again. Transit B is now at Malta for the second part of the Observations, together with an Observing Hut, the Clock Graham 2 and one Hilger Chronograph.

The Photoheliograph No. 1 (except the heavier parts of the mounting) has been returned from the Cape Observatory, and the Photoheliograph No. 2 (without the mounting) will shortly be sent to the Cape in exchange, it being considered more convenient and expeditious to make an exchange of instruments, rather than to send No. 1 out to the Cape again, after adapting it to take photographs of the Sun on the 8-inch scale.

A collection of historical and modern astronomical and meteorological instruments, models, chronometers, photographs, and diagrams representative of the work of the Royal Observatory was sent to the Franco-British Exhibition on 1908, May 25. The exhibits were returned on November 11.

The annual examination of the Library has been made as usual, the books on the shelves being compared with the catalogue. Only one book (in the Magnetic and Meteorological Library) is missing, in addition to those previously reported. Of the books missing last year, three have since been returned.

II.—Astronomical Observations :—

Transit Circle.—The improved method of illuminating the field of view, which was applied last year, has been in regular use since. It was found, however, that owing to the spherical aberration of the short focus condensing lens the illumination of the field was not altogether satisfactory, and on September 17 a compound lens specially corrected by Mr. Simms was substituted for the simple lens as condenser. This has effected a marked improvement. From comparisons between the observations of two clock stars each night made with the old annular illumination and the observations with the new central illumination, it appears that the time of transit of stars observed with the annular illumination was $0^s{\cdot}060$ earlier than with the central illumination and simple condensing lens (28 nights from April 27 to September 16) and $0^s{\cdot}019$ earlier than with the compound condensing lens (31 nights from September 17 to December 31).

The Sun, Moon, planets, and fundamental stars have been regularly observed on the meridian as in previous years. The other stars observed are taken from a working catalogue of stars of 9·0 magnitude and brighter between the limits 24° to 32° of N. declination, serving as reference stars for the Oxford Astrographic Zones.

The number of observations with the Transit Circle from 1908 May 11 to 1909 May 10 is as follows :—

Transits	10,142
Determinations of Collimation error	287
Determinations of Level error	560
Circle observations	10,034
Determinations of nadir point (included in the number of circle observations)	557
Reflexion observations of stars (similarly included)	327

The transits are completely reduced (so as to exhibit Mean R.A. 1910·0) to 1909 April 15, and Apparent R.A. is formed to May 1.

The circle observations are completely reduced to 1909 April 15.

The investigation of personal equations is complete for 1908.

The R–D discordance has been investigated for 1908.

The corrections for variation of latitude for 1908 have not yet been received from Professor Albrecht.

The value of the colatitude determined from observations made in 1907 with Pulkowa refractions was 38° 31′ 21″·71.

The correction to the tabular obliquity of the ecliptic from solar observations in 1907 is − 0″·01. The discordances between the results of summer and winter solstices is +0″·20, indicating that the mean of the observed distances from the pole to the ecliptic is apparently too small by 0″·10. The apparent correction from observations of the sun to right ascensions of clock stars is − 0ˢ·028.

The apparent correction for discordance between the nadir observations and stars observed by reflexion in 1908 is − 0″·33. The values found since 1892 range from − 0″·20 to − 0″·41. Four-fifths of this quantity is applicable to observations of the nadir in forming the zenith point on days when no reflexion observations of stars are obtained, and since 1897 January 1 the value − 0″·25 has been adopted for this correction.

Observations of level and nadir have been made when practicable three or more times a day. The following are the mean values of the diurnal changes of level and nadir for 1908, and for the nine years 1897 to 1905, observations within three hours of noon, 6 p.m., midnight, and 6 a.m., respectively, being grouped together :—

	Diurnal Changes of Level.				Diurnal Changes of Nadir.			
	Noon.	6 p.m.	Midnight.	6 a.m.	Noon.	6 p.m.	Midnight.	6 a.m.
1908	+ 0″·14	0″·00	+ 0″·18	″ ...	+ 0″·10	0″·00	+ 0″·05	″ ...
1897–1905	+ 0·25	0·00	+ 0·21	+ 0·37	+ 0·14	0·00	+ 0·12	+ 0·11

The correction for R − D discordance found for 1908 is + 0″·065 + 0″·438 *sin* Z.D., the co-efficient of *sin* Z.D. being somewhat smaller than the adopted value (+ 0″·600).

The mean error of the Moon's tabular place (computed from Hansen's lunar tables with Newcomb's corrections) for 1907 is $-0^{s}\cdot387$ in R.A., and $-0''\cdot37$ in N.P.D., deduced from 96 observations. The corresponding mean errors in longitude and in E.N.P.D. from these observations are $-5''\cdot96$ and $+0''\cdot22$.

The mean error of the Moon's tabular place for 1908 is $-0^{s}\cdot417$ in R.A. deduced from 105 observations.

The Second Nine-Year Catalogue, Epoch 1900, which was terminated at the end of 1905, will shortly be ready for distribution, as the last sheets of the Introduction are now going through the press.

Altazimuth.—A compound lens was substituted on September 11 for the simple lens used as a condenser for the illumination of the field, as in the case of the transit-circle. Comparisons of observations of clock stars made with the old annular illumination and with the new central illumination before and after the change in the condensing lens indicate that there is no sensible difference in the results with this instrument depending on the mode of illumination of the field.

The instrument has been used as a reversible transit-circle in the meridian in four positions during the year, the positions being changed regularly every two months. Observations of the Sun, Moon, planets, and the fundamental stars, contained in the National Ephemerides and in Newcomb's Fundamental Catalogue, have been made throughout the year.

The instrument has been used regularly for extra-meridian observations of the Moon during the first and last quarters of the lunation.

The observations of the crater Mösting A, started in 1905, are being continued, whenever the object is observable. The observations of transits serve to connect the observations of the first and second limbs made before and after full moon respectively; and the observations of zenith distance will, in combination with similar observations now being made at the Cape Observatory, serve to determine the parallax of the Moon.

Mösting A has also been regularly observed with the transit-circle when practicable.

The following observations have been made with the altazimuth during the year :—

	No. of Observations.
Collimation, Level, and Azimuth - -	220, 397, and 124 respectively.
Nadir : Reflexion observations of stars -	384 and 99 ,,
R.A. and N.P.D. of Sun, planets, and stars (in meridian) - - - - - - -	1,362 and 1,168 ,,
R.A. and N.P.D. of Moon (in meridian) -	76 and 63 ,,
R.A. and N.P.D. of Mösting A - -	43 and 43 ,,
Azimuth and Zenith distance of stars (extra meridian) - - - - - -	181 ,,
Azimuth and Zenith distance of Sun and planets (extra meridian) - - - -	4 ,,
Azimuth and Zenith distance of Moon (extra meridian) - - - - -	36 ,,

The altazimuth observations are reduced to the end of 1908. Of the observations of 1909, the transits are reduced to March 30 and the meridian zenith distances to April 27.

The extra-meridian observations are completely reduced to March 27.

The R − D discordance has been investigated separately for each two months of the year during which the instrument remained in one position. The direct observations have also been compared in reversed positions of the instrument with the positions given in Newcomb's Fundamental Catalogue. Since 1907 it has been decided to employ the R − D correction deduced from the reflexion observations alone, instead of using the constant part of the correction as given by the comparison with Newcomb's places.

The observations of the Moon both in and out of the meridian seem very satisfactory, as shown by the agreement between the two instruments—transit-circle and altazimuth.

The values for the mean error in R.A. of the Moon's Tabular Place from the altazimuth observations in 1908 are—

Moon's limb in meridian - -	− 0^s·40
Mösting A in meridian - -	− 0^s·43
Moon's limb, extra-meridian - -	− 0^s·39

The following table shows the number of days on which observations of the Moon were obtained with the transit-circle and altazimuth, respectively, in the year ending 1909 May 10:—

Time of Moon's Meridian Passage.	Transit Circle.		Altazimuth.		
			Meridian.		Extra Meridian.
	Limb.	Mösting A.	Limb.	Mösting A.	Limb.
h. h.					
1–2 G.M.T. - -	0		0		0
2–3 - - -	0		0		4
3–4 - - -	6		0		6
4–5 - - -	7		1		6
5–6 - - -	3		0		5
6–9 - - -	16	13	14	9	2
9–12 - - -	24	18	23	15	0
12–15 - - -	29	17	20	10	0
15–18 - - -	18	10	16	9	3
18–19 - - -	2		1		3
19–20 - - -	7		1		3
20–21 - - -	0		0		2
21–22 - - -	0		0		2
22–23 - - -	0		0		0

The total number of observations of the Moon is 113 with the transit-circle and 112 with the altazimuth, viz.:—76 in the meridian and 36 extra-meridian.

Taking both instruments, observations of the Moon have been obtained on 139 days during the year.

It is proposed to form a Ten-Year Catalogue of the stars observed with the altazimuth in the meridian in the years 1899 to 1908, reduced to the equinox 1900·0. The catalogue will contain about 1,500 stars of the following classes:—

(1) Stars in Newcomb's Catalogue of Fundamental Stars.

(2) Stars used for Heliometer observations of the major planets at the Cape.

(3) Reference stars for Eros, 1900–01.

(4) Moon culminators and other selected stars.

Reflex Zenith Tube.—During the year, 1,040 double observations and 17 single observations have been obtained, the number of different stars observed being 88.

The enlarged scheme of observation introduced in 1906 November has been in operation throughout the year. The following table shows the number of observations obtained in each month in each group of stars since 1906 May. In this table the principal groups denoted by A and B are each divided into two halves (A_1, A_2, B_1, B_2); *a* and *b* are the subsidiary groups introduced to strengthen the connection between the principal groups. It will be seen that the overlap of the groups is sufficient to obtain a good connection between them.

Group.	A_1.			A_2.			*a*.			B_1.			B_2.			*b*.		
Limits of R.A.	$4^h\ 59^m$–$7^h\ 6^m$			$7^h\ 6^m$–$9^h\ 26^m$			$12^h\ 19^m$–$14^h\ 22^m$.			$17^h\ 28^m$–$19^h\ 31^m$.			$19^h\ 31^m$–$22^h\ 34^m$.			$0^h\ 12^m$–$1^h\ 44^m$.		
	1906 7.	1907–8.	1908–9.	1906–7.	1907–8.	1908–9.	1906–7.	1907–8.	1908–9.	1906–7.	1907–8.	1908–9.	1906–7.	1907–8.	1908–9.	1906–7.	1907–8.	1908–9.
May	—	—	—	—	—	—	—	24	29	40	67	75	—	—	—	—	—	—
June	—	—	—	—	—	—	—	19	5	85	65	57	—	1	—	—	—	—
July	—	—	—	—	—	—	—	—	1	143	158	88	3	10	13	—	—	—
August	—	—	—	—	—	—	—	—	—	88	87	67	104	90	96	—	—	—
September	—	5	—	—	—	—	—	—	—	67	141	41	124	266	101	—	2	6
October	—	33	15	—	1	—	—	—	—	9	25	22	84	92	42	—	21	12
November	17	19	18	27	2	—	—	—	—	10	7	4	9	13	7	—	5	10
December	46	10	8	45	4	4	—	—	—	9	10	1	15	9	2	4	11	—
January	25	25	25	30	9	25	16	50	19	7	14	1	3	4	2	1	5	2
February	24	30	18	47	69	38	27	57	19	8	6	1	—	—	—	—	—	—
March	31	—	1	84	37	11	76	22	9	15	8	—	—	—	—	—	—	—
April	—	—	—	5	2	12	36	42	39	40	15	48	—	—	—	—	—	—

Group B_1 contains the bright stars, β and γ Draconis and ι^2 Cygni, which are observed throughout the year.

As the arrangement for modifying the illumination of the field by tilting an annular reflector was not satisfactory, a rheostat has been introduced recently for this purpose, and the form of the reflector has been modified, as it was found that part of the pencil of rays for a star at some distance from the centre of the field, such as β Draconis, was cut off by the annular reflector.

Clocks and Chronographs.—The clock Graham 2 was taken from the Thompson Dome and sent to Messrs. E. Dent & Co. for repair previous to being used in the determination of the longitude of Malta. It was sent to Malta on February 5. Arnold 1 was set up in the Dome to replace Graham 2.

Equatorials.—During the year ending 1909 May 10, nine disappearances and two reappearances of stars occulted by the Moon have been observed by one or more observers. Five of the stars of which the disappearance was observed were below the limit of magnitude adopted by the Nautical Almanac, which is 7·0. The number of observations is fewer than usual owing to interference from cloud on many occasions.

The 28-inch Refractor.—Observations of double stars have been made from a working catalogue containing all known double stars showing relative motion, the G. W. Hough stars not previously observed at Greenwich, and a number of pairs from Hussey's and Aitken's Catalogues under 2″ separation.

The measures consist of—

68	pairs	under	0″·5 separation.
109	„	between 0″·5	and 1″·0 separation.
176	„	„ 1″·0	„ 2″·0 „
286	„	over 2″·0	separation.

κ Pegasi was observed on 9 nights, δ Equulei on 16 nights, 70 Ophiuchi on 21 nights, and Procyon on one night.

Equatorial and polar diameters of Jupiter have been measured with the bifilar micrometer, and also with the double-image micrometer on the same nights. The 28-inch is well adapted for this, as the breech end is arranged for either direct

or diagonal view by means of a plane mirror which can be readily inserted or withdrawn. The bi-filar was mounted for direct view, and the double-image micrometer for diagonal view with the plane mirror. The following table shows the number of measures:—

—	Bi-filar Micrometer.	Double-image Micrometer.
Equatorial diameter - - - - -	120	62
Polar diameter - - - - - -	120	61

Measures of Jupiter's diameter were also made by Mr. Bowyer before sunset to ascertain the effect of irradiation.

The new outer dusky ring of Saturn was examined on 13 nights in October and November. The results were communicated to the Royal Astronomical Society (M.N. LXIX., No. 1); measures of the diameters of the planet and rings were made on 10 nights.

Thompson Equatorial. — The 30-inch mirror was dismounted in July for re-silvering. Advantage was taken of this opportunity to replace the lignum vitæ blocks which had been used since 1906 November to hold the mirror rigidly in its cell by 12 adjustable cast-iron blocks, shaped to fit the steel supporting band round the edge of the mirror, the pressure being applied by screws passing through the cell, so that the strain may be adjusted as required. The result is very satisfactory, the mirror being held quite firmly without distortion. The mirror was again re-silvered in December, in order to have it in the best condition possible for the observation of Jupiter's eighth satellite and the search for Halley's comet. To facilitate the guiding, a position micrometer was made and fitted to the guiding telescope of the 30-inch reflector, by means of which the motion of any object may be readily compensated whilst guiding on a star. Whilst Comet *c* 1908 was under observation some trouble had been caused on damp nights through the absorption of moisture by the photographic plate (which is quite exposed at the mouth of the tube), with a consequent diminution in its sensitiveness. An electric heater was devised by Mr. Davidson which could be put into the plate holder at the back of the plate. It has been successful in keeping the plate dry, and there is no apparent falling off in definition. In December a new central illumination was fitted to the guiding telescope of the 30-inch reflector, similar to that applied to the transit-circle and altazimuth.

With the 26-inch Refractor in connection with the observations of Saturn's and Jupiter's distant satellites, six photographs of Saturn on five nights, and eight photographs of Jupiter on seven nights, have been taken for determination of their positions with reference to the stars used in the reductions of the observations of the satellites.

With the 30-inch Reflector, the following photographs have been taken:—

23	photographs	of	Saturn	and	Satellite IX.	on 15 nights.
20	„		Jupiter	„	VI. „ 16	„
8	„		„	„	VII. „ 8	„
15	„		„	„	VIII. „ 15	„
57	„	22 minor planets.				
32	„	Comet *c* 1908 on 30 nights.				

In addition to the above, all of which were taken for place, 139 photographs were taken on 37 nights of Comet *c* 1908 for the purpose of studying the rapid changes which took place in the tail of the comet. Supplementing these, 23 photographs on 20 nights were taken with a portrait lens lent by Mr. Bowyer, mounted on the Astrographic Equatorial, to record the extension of the tail.

Besides these, 20 long exposures were given on 18 nights in an unsuccessful search for Halley's comet, and a few miscellaneous plates were taken chiefly for instrumental adjustments.

During the year the following photographs have been measured and the results published in the *Monthly Notices R.A.S.*:—

Jupiter, Satellite VI. 1907–8	38	photographs.
„ „ VII. 1907–8	21	„
„ „ VIII. 1907–8	13	„
Saturn, Satellite IX. 1908	23	„
Neptune and Satellite 1907–8	26	„
Comet *c* 1908 (for position)	32	„
38 minor planets, 1907	109	„

Preliminary remarks on the photographs of Comet *c* 1908, with special reference to the movements shown in the coma and tail, were published last November. The measurement and reduction of the photographs of minor planets taken in 1908, and of Jupiter's Sixth, Seventh, and Eighth Satellites taken during the last opposition, are proceeding.

The first photograph of Jupiter's Eighth Satellite obtained at this opposition was taken on 1909 January 16, its position agreeing fairly closely with the orbit computed by Mr. Cowell and Mr. Crommelin. Mr. Cowell has corrected the orbit to fit the observations of the oppositions of 1908 and 1909, and the ephemeris has been carried forward to cover the opposition of 1910.

Astrographic Equatorial.—Work with this instrument is still mainly confined to replacing Chart plates which, though satisfactory in other respects, are, owing to slight photographic defects, unsuitable for reproduction of enlarged copies, and to taking subsidiary photographs of reference stars for the determination of the position of the faint satellites of Jupiter and Saturn on photographs taken with the 30-inch Reflector.

Altogether, 109 photographs have been taken on 50 nights. Thirteen of these have been rejected, two because the exposure was unfinished owing to cloud, or because they did not reach the standard in showing faint stars; eleven for photographic defects and miscellaneous causes.

The remaining 96 plates are made up as follows:—

Chart Plates (exposure 40^m)	61
Fields for Jupiter	6
,, Saturn	3
,, minor planets	22
Venus	2
Comet *c* 1908	1
Plate for adjustment of telescope	1

In September a portrait lens with camera and a Dallmeyer rapid rectilinear lens and camera were mounted on the telescope, with which the photographs of Comet *c* 1908, mentioned on another page, were taken. In November the Dallmeyer lens was replaced by a 4-inch lens of 18 inches focal length, kindly lent by Mr. Franklin Adams, with which some photographs have been taken for trial.

The computing work of the Astrographic branch during the year has consisted in converting the rectangular co-ordinates of selected stars between declination 80° and the Pole, given in Volume II. of the Greenwich Astrographic Catalogue into Right Ascension and Declination. This has been done for 3,650 stars of Carrington's Catalogue, whose declination for 1900·0 lies between 81° and the Pole, and for some other stars, making about 3,700 in all. This has involved the computation of about 9,000 separate star-places. A discussion of some of these results to derive information about systematic and probable errors was communicated as part of the Report to the Astrographic Conference held at Paris in April. The computation of Right Ascensions and Declinations of all the stars, 887 in all, in Zone 80° of the Astrographic Catalogue, which occur in the Bonn Durchmusterung is proceeding, and is complete as far as the formation of observed standard co-ordinates by application of the plate constants.

The reproduction of enlarged prints of the Chart plates has been carried on throughout the year. Sets of prints have been made during the year for the Zones 75°, 76°, 77°, and 78° from 4^h to 12^h, completing these Zones, and for the whole of the Zones 79°, 80°, 81°, and 82°. The total number of prints made during the year is about 12,000, reproducing on double scale 202 plates. Altogether reproductions have been made of 1,024 plates since the work was begun in 1904, leaving 125 plates to complete the total of 1,149 plates which make up the Greenwich Section. It is confidently expected that this work will be completed by the end of the year.

Mr. Cowell and Mr. Crommelin have finished their calculations on Halley's Comet, at any rate until the comet has re-appeared. The date for the perihelion passage of Halley's Comet that was given in the last Report (1910, April 8) depended in part on Rosenberger's calculations for the revolution 1759–1835. Since then the perturbations for that revolution have been computed anew by Pontécoulant's method, and the Jupiter perturbations for the first quadrant of the revolution, 1835–1910, have been re-computed, using a mean motion for the comet that agrees more nearly with its actual motion than that employed in the earlier calculations, and thus correcting in part for the second-order terms. The effect of these changes is to change the date of the next perihelion passage from 1910 April 8 to April 13.

The motion of the comet from 1759 to 1910 has since then been re-investigated by a new and entirely independent method, using mechanical quadratures for the comet's rectangular co-ordinates, instead of supposing it to move in a perturbed ellipse. The whole of the planetary action is included in this method, instead of the first-order terms only, as in Pontécoulant's method. The resulting date for the next perihelion passage is 1910 April 16, or only three days later than that found by Pontécoulant's method. The discordance is so small as to give rise to the hope that there are no important numerical errors in either investigation.

A search ephemeris was constructed, and a search was made with the 30-inch reflector, but without success. A search ephemeris has been published for the coming autumn and for next year in the Journal of the British Astronomical Association, based upon the date 1910 April, 16·5 G.M.T., for perihelion passage.

The identifications of Halley's Comet in the past have been carried back to B.C. 240. There are no trustworthy records previous to this date.

A set of drawings showing the coronal streamers (on a small scale), and details of the prominences from photographs taken in the Eclipses of 1898, 1900, 1901, and 1905, by parties from the Royal Observatory, has been made by Mr. Wesley, supplementing the series of drawings of the corona for these eclipses mentioned in previous Reports.

III.—Heliographic Observations:—

In the year ending 1909 May 10, photographs of the Sun were taken in all upon 207 days, the Thompson photoheliograph being in regular use for this work throughout the year, except for a few days in 1908 July, when new adjusting screws and blocks were being fitted to the 30-inch mirror, which is carried by the same equatorial. During this interval the Dallmeyer photoheliograph, which has throughout remained on its own mounting on the South Terrace of the New Building, was used; and a few times a supplemental photograph has been taken with the Dallmeyer on days when the Thompson has also been used. In all, the Thompson photoheliograph was used alone on 192 days, the Dallmeyer alone on 10 days, and both instruments were used on 5 days.

Of the photographs taken, 417 have been selected for preservation, besides 30 with double images of the Sun for the determination of zero of position angles. Supplementary photographs have been received from Kodaikánal Observatory, India, up to 1909 February 4; from Dehra Dûn, India, through the Solar Physics Committee, up to 1909 March 3; and from Mauritius up to 1908 February 17.

The Greenwich series of photographs, supplemented by the photographs from the two Indian observatories, was complete for the year 1908, with the exception of two days, 1908 August 19 and September 15, which are, at present, unrepresented. The record for 1909 is complete up to March 3, the date of the last photograph received from Dehra Dûn, which came to hand on April 21.

The photographic record at present in hand, for the year 1908, is made up from the following sources:—

Greenwich	171	days.
Dehra Dûn	172	„
Kodaikánal	10	„
Mauritius	11	„
Unrepresented	2	„
Total	366	„

The measurement of these photographs is complete to the end of 1908, except for the 11 photographs from Mauritius, received 1909 May 6, in substitution for photographs from Dehra Dûn of the same dates, and for 16 photographs from Dehra Dûn, which it is hoped to replace by others from Kodaikánal. The photographs taken at Greenwich in 1909 have been measured up to April 15, and those taken at Dehra Dûn up to February 23.

As noted in last year's Report, the printing of the Heliographic Results had to be suspended in consequence of the discovery of a serious error in the orientation of the spider-lines of the Dehra Dûn photoheliograph. Photographs in substitution for the Dehra Dûn photographs which had thus to be discarded have been obtained from either Mauritius or Kodaikánal for 145 out of the 155 days required, and have been measured and reduced. The printing of the Heliographic Results for 1906 has, therefore, been resumed; the new copy for press of the daily results is in the printer's hands for the entire year, proof sheets have been received and returned for revise up to 1906 June 2, and have

been passed for press up to 1906 April 1. For 10 days of the year the Dehra Dûn photographs still supply the only record; and for these days the areas only of the spots and faculæ have been deduced from the photographs; the positions have been left undetermined.

The re-measurement for the year 1907 and for 1908 up to February 20, when the Dehra Dûn photoheliograph was again replaced correctly in position, has not yet been commenced, but photographs for 110 of the days required have now been received from Mauritius through the Solar Physics Committee, and it is hoped that all or nearly all of the 68 days still remaining to complete the series will be supplied from Kodaikánal.

The Government of Mauritius have informed Mr. T. F. Claxton, Director of the Royal Alfred Observatory, Mauritius, that in consequence of the financial condition of the Colony they are no longer able to continue their support to the work of daily photographing the Sun. Mr. Claxton, therefore, finds himself reluctantly obliged to discontinue this series which has been carried on so long, forming, in fact, the most nearly continuous record of the Sun's surface ever secured at any one observatory, and which has, from 1884 to the present time, so usefully supplemented the series taken at Greenwich and Dehra Dûn.

Mr. S. S. Hough, H.M. Astronomer at the Cape, has, however, undertaken, with the sanction of the Admiralty, to include the daily photographic record of the Sun's surface in the programme of the Royal Observatory, Cape of Good Hope, and so provide against any interruption in the combined series of photographs which might otherwise have arisen from the cessation of heliographic work in Mauritius It is hoped that the series from Greenwich and the Cape may prove nearly complete, and may require only occasionally to be supplemented from other sources.

The numeration of the spot-groups from a preliminary examination of the solar photographs, and the publication, month by month, in *The Observatory* of the lists of the spot-groups thus numbered, with their descriptions and rough estimations of their areas and mean heliographic longitudes and latitudes, have been continued during the year, the last list published being that of the groups of 1909 January, appearing in *The Observatory* for 1909 May. This numeration of the spot-groups has been officially communicated, month by month, to the Director of the Kodaikánal Observatory.

The solar activity as shown in the numbers and areas of sun-spots during the year 1908 has declined a little below the level attained in 1907, but has been only slightly inferior to that of 1906. No marked and long continued diminution of activity has yet set in. The tendency so marked in 1907, for long processions of groups to form following each other at short intervals along a parallel of solar latitude, has been less apparent, and certain meridians have become practically quiescent. But there have been a number of fine groups observed during the year, particularly in the months of 1908 August and September, when four groups were visible to the naked eye; and the groups of faculæ have been about as numerous, if not quite as extensive, as in any year of the present maximum, so that there is no sign as yet of the near approach of the next minimum.

Owing to a breakdown in health, Mr. Maunder was absent on sick leave from 1908 October 8 to 1909 March 18.

IV.—Magnetic Observations:—

The variations of magnetic declination, horizontal force and vertical force, and of earth currents have been registered photographically, and accompanying eye observations of absolute declination, horizontal force and dip, have been made as in former years.

The regular determinations of magnetic declination, horizontal force and dip, have been made with the new declinometer, the Gibson deflexion instrument, and the Airy dip circle mounted in the Magnetic Pavilion.

The magnetic reductions for 1908 are completed to the following stages:—

The eye observations of the declination and horizontal and vertical force magnets are completely reduced, and the hourly ordinates of the photographic registers are read off and tabulated. The temperature of the magnet basement at every hour has been read from the Richard thermograph sheets, and the daily and hourly means have been taken. The declination, dip, and deflexion observations made in the Magnetic Pavilion are completely reduced.

The principal results for the magnetic elements for 1908 are as follows:—

Mean declination - - -	15° 53′·5 West.
Mean horizontal force - - -	4·0184 (in British units). 1·8528 (in metric units).
Mean dip (with 3-inch needles) -	66° 56′ 17″.

These results depend on observations in the Magnetic Pavilion, and are free from any disturbing effect of iron in the Observatory buildings.

A marked difference was noted between the results of dip observations with the two 3-inch needles, D_1 and D_2, which appeared to have become much greater since D_2 was fitted with a new pivot in 1907 March. In 1909 February, Mr. Bryant rotated the spindle of D_2 through an angle sufficient to cause a fresh portion of the axis to rest on the knife edges, and also adjusted both needles for symmetry. There is reason to believe that the discordance has been greatly reduced.

In 1908 there were two days of great magnetic disturbance, and there were six of lesser disturbance. Traces of the photographic curves for these eight days selected in concert with M. Moureaux, will be published in the annual volume. The calculation of diurnal inequalities from five typical quiet days in each month, selected in concert with Dr. Chree, has been continued. The list of "quiet" or "normal" days is also communicated to Paris, Lisbon, Bombay, and Mauritius, and for publication by the International Committee on Terrestrial Magnetism in their "quiet day" circular. To the same International Committee quarterly reports are sent classifying the days in three divisions according to their magnetic character.

V.—Meteorological Observations:—

The meteorological instruments are all in good order. A new thermometer screen on the same principle as that on the roof of the Magnet House, designed for free circulation of air, has been set up in the Magnetic Pavilion enclosure for comparison of thermometer readings with those in the rotatory open stand and in the Stevenson screen.

The registration of atmospheric pressure, temperature of the air and of evaporation, pressure and velocity of the wind, rainfall, sunshine, and atmospheric electricity has been continuously maintained. Cloud observations in connection with the international balloon ascents have been made with a Fineman nephoscope.

The meteorological reductions are in the following state:—The observations of barometer, thermometers, anemometers, rain-gauges, and sunshine recorder (corrected, where necessary, for instrumental error) are reduced up to the present time. On the photographic sheets all time-scales are laid down, and the hourly ordinates are read out and completely reduced to the end of 1909 April, except for the electrometer, which is complete to the end of 1908. The table of principal changes of the wind for 1908 is not yet completed.

The mean temperature for the year 1908 was 49°·8, or 0°·2 above the average for the 65 years 1841–1905.

During the twelve months ending 1909 April 30 the highest temperature in the shade (recorded on the open stand in the Magnetic Pavilion enclosure) was 84°·0 on July 3. On the same day the highest temperature in the Stevenson screen in the Magnetic Pavilion enclosure was 82°·2, and in that in the Observatory Grounds 83°·4.

The lowest temperature of the air recorded in the year was 12°·1 on December 30. During the winter there were 54 days on which the temperature fell below 32°·0, being two less than the average number.

The mean horizontal movement of the air in the year ending 1909 April 30 was 266 miles, which is 16 miles below the average of the preceding 41 years. The greatest recorded daily movement was 776 miles on February 3, and the least 36 miles on January 28. The greatest recorded pressure of the wind was 16·2 lbs. on the square foot on September 9, and the greatest hourly velocity 43 miles on November 23 and February 3.

During the year 1908, Osler's anemometer showed an excess of 21 revolutions of the vane in the positive direction N., E., S., W., N., excluding the turnings which are evidently accidental.

The number of hours of bright sunshine recorded during the 12 months ending 1909 April 30, by the Campbell-Stokes instrument, was 1,752 out of 4,456 hours during which the Sun was above the horizon, so that the mean proportion of sunshine for the year was 0·393, constant sunshine being represented by 1. As contributing to this exceptionally high proportion, it may be mentioned that in three of the months, October, November, and April, the amount registered was the highest for those months, reaching in April a percentage of 60 for the first time in any month, and in three other months, June, January, and February, the amount registered was the second highest for those months.

The rainfall for the year ending 1909 April 30 was 22·60 inches, being 1·52 inches less than the average of the 65 years 1841–1905. The number of rainy days (0·005 inches or over) was 155.

It has not been found practicable to complete the summary of 40 years' records of the Robinson anemometer. Much of the work is ready for press, but unforeseen delay has arisen in connection with the hourly inequality tables projected, owing to the imperfect way in which the earlier observations were entered. It may be found necessary to restrict the hourly inequality tables to 32 years instead of 40.

Progress has been made with the daily rainfall investigation, and it has been decided to commence the series with 1861, to avoid the difficulties mentioned in the last Report, and to complete the 50 years, which postpones the end of the period to 1910 December 31.

VI.—Printing and Distribution of Greenwich Publications :—

The copies of the volume of Greenwich Observations for 1906 were distributed in September 1908.

The printing of the volume of Greenwich Observations for 1907 is finished, with the exception of the Introduction and the Photoheliographic Results. The Introduction is now being printed and will be completed shortly, but, as explained in last year's Report, the preparation of the Photoheliographic Results has been unavoidably delayed. The Results for 1906, however, are being printed, and will be included in the Greenwich Volume for 1907.

The printing of the 1908 Observations has not yet commenced, but the Rates of Chronometers and Watches for 1908–9 have been printed and distributed.

The printing of the Greenwich Second Nine-Year Catalogue (1897–1905) is finished, with the exception of the Introduction, which is in the press.

Precession Tables have been printed for use in connection with the preparation of the Third Ten-Year Catalogue (1910·0), and will form an appendix to the Volume for 1908.

VII.—Chronometers, Time Signals, and Miscellaneous :—

The number of Government marine chronometers and watches now at the Observatory is 407, viz., 242 box chronometers, 27 pocket chronometers, 81 chronometer watches, and 57 hack watches. In addition to these there are, at the Observatory, 9 hack watches and 2 high-class stop watches on trial for purchase, and also 25 box chronometers belonging to the Indian Government.

In the year ending 1909 May 10, the average daily number of chronometers and watches being rated was 520, the total number received was 1,565, the total number issued was 1,548, and the number sent for repair 678. These include 36 box chronometers and 2 pocket chronometers for the Indian Government.

For the annual trial of chronometers, which lasted 29 weeks with a range of temperature from 41° to 104°, 48 chronometers were sent in. During the trial 15 were rejected because the difference between one week's rate and the next exceeded 1.2 seconds. Of the remaining 33 chronometers, 9 were purchased for the Navy and 4 for the Indian Government.

The performance of the chronometers generally came up to the standard attained previous to last year, when there was such a serious falling off both in numbers sent in and in performance.

For the annual trial of chronometer watches, lasting 16 weeks and including trials in the oven and in positions, 157 watches were entered, of which 66 were classified, and of these 51 were purchased for the Navy. Among the watches classified were 13 with centre-seconds dials; of these 10 were purchased. There were 28 "Karrusel" or "Tourbillon" watches classified, of which 20 were purchased. The performance of the watches this year shows an improvement on that of last year.

A trial of pocket chronometers took place concurrently with the trial of chronometer watches, and under the same conditions as regards duration of trial, temperatures, and positions. Of the 11 pocket chronometers sent in, 2 were purchased for the Navy.

The next trial of box chronometers will commence on June 19, and of pocket chronometers and chronometer watches on July 31.

The Greenwich time-ball was not raised on one day (April 30), owing to the violence of the wind. On two days, March 19 and April 16, in consequence of the clips not being set, the ball was not held in position for dropping at 13^h. On each occasion the ball was raised at 14^h and dropped correctly. On June 11 the train of the Mean Solar clock stopped for 2^s just before 13^h, and the ball was dropped 2^s late. The 13^h signal was also 2^s late on this day.

On the morning of January 7 it was found on working up transits of stars obtained after a week of cloudy weather, that the adopted error of the Sidereal Standard clock found by carrying on its rate from December 31, and checked by comparisons with the other Observatory clocks, and also with 19 of the best chronometers in the Annual Trial, was erroneous to the amount of fully 2 seconds. The time signals for the period January 1 to 6 are therefore to some extent erroneous, and consequently in taking percentages and averages for the errors of the Devonport, Portsmouth, Portland, and Westminster clocks, the signals from January 1 to 7 have been omitted, as being affected with the uncertain error of the Greenwich clock.

The automatic drop of the Deal time-ball failed on 5 days owing to interruptions of the telegraphic communications. On 2 days the ball was not raised owing to the violence of the wind. On 2 days the current was too weak to drop the ball. On 1 day, June 29, a false current dropped the ball 12^s too soon.

The return signal from Devonport failed on 59 days (of which 11 were Sundays), and could not be observed on 28 days (of which 22 were Sundays) owing to interruptions by telegraph signals. The apparent error of the clock signal (after daily correction of the clock by aid of a time signal from Greenwich, on the plan described in the Report for 1885) did not exceed $0^s{\cdot}2$ on 85 per cent. of the 272 days of observation, and did not exceed $0^s{\cdot}5$ on 97 per cent. On 8 occasions it exceeded $0^s{\cdot}5$, but never exceeded $1^s{\cdot}0$. The average error for the year was $\pm 0^s{\cdot}13$.

The return signal from Portsmouth failed on 40 days (of which 22 were Sundays), and could not be observed on 33 days (of which 24 were Sundays) owing to interruption by telegraph signals. The apparent error of the clock (corrected in the same manner as the Devonport clock) did not exceed $0^s{\cdot}2$ on 75 per cent. of the 286 days of observation, did not exceed $0^s{\cdot}5$ on 97 per cent., was between $0^s{\cdot}5$ and $1^s{\cdot}0$ on 4 days, and exceeded $1^s{\cdot}0$ on 4 days. The average error for the year was $\pm 0^s{\cdot}20$.

The return signal from Portland failed on 57 days (of which 30 were Sundays), and could not be observed on 26 days (of which 22 were Sundays), owing to interruptions by telegraph signals. The apparent error of the clock (corrected in the same manner as the Devonport clock) did not exceed $0^s{\cdot}2$ on 89 per cent. of the 277 days of observation, did not exceed $0^s{\cdot}5$ on 97 per cent., exceeded $0^s{\cdot}5$ on 9 days, on one of which it was over $1^s{\cdot}0$. The average error for the year was $\pm 0^s{\cdot}14$.

The automatic signals from the Westminster clock have been received regularly since the last report. On 1 day the signal failed, and on 8 days it was interrupted by telegraph signals. Its apparent error was not greater than $0^s \cdot 5$ on 49 per cent. of the days of observation, not greater than $1^s \cdot 0$ on 76 per cent., not greater than $2^s \cdot 0$ on 96 per cent., not greater than $3^s \cdot 0$ on 99 per cent., and never exceeded $4^s \cdot 0$.

A telegraphic determination of the longitude of Malta was undertaken in the spring; the observations had not been quite completed at the date of this Report. The electrical arrangements were generally similar to those used in the determination of the longitude of Ascension last year, and the signals were transmitted directly between Porthcurnow and Malta without a relay. The Eastern Telegraph Company again kindly gave the free use of a cable for the exchanges of signals. At Malta the pier and observing hut were erected on the roof of the Eastern Telegraph Company's offices at St. George's Bay.

The observations were made by Mr. Eddington and Mr. Harold Christie; they were divided into two parts, the observers with their instruments being interchanged in the interval. The observations of the first part were made from February 20 to March 8. The second part was not started until May 8, being greatly delayed by an interruption of the cable; it was finished on May 16. Exchanges of signals were made on 10 nights in the first part, and on 8 nights in the second part.

Captain C. E. Monro, R.N., and Lieutenant Gibson, R.N., of H.M.S. "Mutine," were attached to the Observatory from July 15 to August 18 for the purpose of reducing the observations made for determining the longitude, Greenwich–Ascension–Cape. Captain Monro returned on September 9 to write his report, and the result, which is subject to some small corrections, was communicated to the Royal Astronomical Society in November.

VIII.—Personal Establishment:—

The permanent staff at the present time is constituted as follows, the names in each class being arranged in alphabetical order:—

Chief Assistants—Mr. Cowell, Mr. Eddington.

Assistants—Mr. Bryant, Mr. Crommelin, Mr. Hollis, Mr. Lewis, Mr. Maunder, Mr. Thackeray.

Clerical Assistant—Mr. Outhwaite.

Established Computer (Higher Grade)—Mr. Davidson.

Established Computers—Mr. Bowyer, Mr. Burkett, Mr. Cullen, Mr. Edney, Mr. B. Evans, Mr. J. Evans, Mr. Furner, Mr. Melotte, Mr. Stevens, Mr. Witchell.

Mr. Benjamin D. Evans was appointed Established Computer on 1909 February 19 in place of Mr. John Storey, who went to Edinburgh Observatory as Assistant in May 1908.

The following table shows the arrangement of the Staff (permanent and temporary) under the general superintendence of the Chief Assistants:—

Branch.	Established Staff.		Temporary Staff.
	Assistants.	Established Computers.	Supernumerary Computers.
Transit Circle:—			
1. Meridian Computations	Thackeray	Cullen	T. Wheate, Kemp, Rotherham.
2. Transits		Witchell	*Daniels, *Acton.
3. Zenith Distances		B. Evans	*Cody, and a vacancy.
Reflex Zenith Tube	*nil*	Witchell	*Daniels.
Altazimuth	Crommelin	Furner	*Jeffries.
Time Signals, Chronometers, and 28-inch Refractor.	Lewis	Bowyer	*Witney, *Green, *Shepperd.
Astrographic Equatorial	Hollis	Stevens J. Evans	*Higgitt, Oake, Peirce. Passfield.
Thompson Photographic Equatorial.	*nil*	Davidson (Higher Grade). Melotte.	Richards, A. Wheate.
Photoheliograph	Maunder	*nil*	*Smith, *Lait, *Saville.
Magnetic and Meteorological	Bryant	Edney	*Kirby, *Timbury, *Loomes, *Richardson.
Clerical	Outhwaite	Burkett	*Lyne.
Summary—Nine Branches	Seven	One (Higher Grade) Ten (Lower Grade).	† Twenty-four and a vacancy.

* Qualified as Observers with one or more of the instruments.

† 16 of the 24 are qualified as Observers.

A foreman of works, with 2 carpenters and 2 labourers; a foreman mechanic, with 2 assistants; a gate-porter, 2 messengers, a watchman, a gardener, a labourer, and a charwoman are also attached to the Observatory.

The whole number of persons regularly employed at the Observatory is 60.

The Staff as constituted in 1836 consisted of the Astronomer Royal, Chief Assistant, and five Assistants without any Computers.

The Magnetic and Meteorological Branch was established from 1841 to 1848 on a temporary basis; and afterwards on a permanent footing with one Superintendent and one Subordinate Assistant.

In 1847 the Altazimuth was introduced, a Junior Assistant being added to the Staff. This only partially provided for the extra work involved, which required two Assistants to observe regularly on alternate nights.

The Time Signal System was introduced in 1854 without any addition to the Staff, and this has since greatly developed and become a source of considerable revenue to the Post Office. At that time Sir G. B. Airy said:—

"I am impressed with the feeling that the strength of our Establishment is now loaded to the utmost that it can bear. A brief review of the progress of the science of Astronomy and of the arts related to it will show that this must be expected."

Notwithstanding the continued growth of work, no addition was made to the staff of Assistants till 1873, when an Assistant was added on the introduction of Spectroscopic and Solar photographic observations. In this case, again, the extra work involved was thus only partially provided for.

In 1890 the addition of one First Class Assistant and one Second Class instead of an additional Chief Assistant and a First Class Assistant was authorised, the Admiralty considering "that though the whole of the additional supervising power "sought will not thus be provided, the additional assistance granted by the "Treasury will so far strengthen the Staff of the Observatory as to enable you "to keep pace with the increasing demands in certain sections of the work."

The Board of Visitors thereupon passed a resolution "that the addition of " one First Class Assistant and one Second Class Assistant is not a strengthening " of the Staff in the direction required."

In the result a Second Class Assistant was promoted, and two new Second Class Assistants were appointed in 1891–2, one to fill the vacancy and the other as the additional Second Class Assistant.

About the same time the Astrographic Equatorial was introduced for the photographic mapping of the Heavens, a work involving the application of new principles of astronomical measurement, and therefore requiring the special attention of the Astronomer Royal and Chief Assistant.

Shortly afterwards three new instruments were added to the Observatory equipment, viz.:—the 28-inch telescope in 1893, the Thompson photographic equatorial in 1897, and the new Altazimuth in 1898.

A scheme for reorganising the staff to provide the additional observers required for the development of the work by substituting two Junior Assistants for one Second Class Assistant and one temporary Computer gradually as vacancies arose was recommended in 1893 by the Board of Visitors, and ultimately sanctioned by the Treasury in 1896, when owing to the long delay there were three vacancies in the staff of five Second Class Assistants. Thus six so-called "Established Computers" acting as Junior Assistants were substituted, without any increase of expenditure, for three Second Class Assistants and three temporary Computers.

At the same time the appointment of an additional Chief Assistant was sanctioned to strengthen "the staff in its higher departments as rendered necessary " by the growing demands of astronomical science."

In 1902 two additional Established Computers were appointed to replace two Temporary Computers, in order to give greater permanency to the staff, the Board of Visitors having expressed the opinion that "the number of Established " Computers should be gradually increased."

Shortly after this an Established Computer was added to the staff to assist in the Clerical Branch, the work of which had increased greatly in recent years.

In order to provide for the publication and distribution to other Observatories of copies of the astronomical photographs taken at the Royal Observatory, the Board of Visitors recommended in 1902 that two additional Established Computers be appointed. But in view of an unexpected vacancy caused by the resignation of an Established Computer on his appointment as Senior Assistant at the Natal Government Observatory, and of the limited number of qualified candidates from among the Temporary Computers, only one additional Established Computer was appointed in 1903, his services being required for the publication of the Greenwich section of the Photographic Map of the Heavens, so that the publication of other astronomical photographs was left unprovided for.

While new branches have thus in the course of years been added to the Observatory work, each of them has greatly developed, this development being very marked even in the old established meridian and chronometer branches.

This development has been met as far as the more mechanical work is concerned by an increase in the number of Boy Computers temporarily employed, as may be seen from the following statement:—

Date.	No. of Boy Computers employed.
1850	3
1860	7
1870	9
1880	12
1890	17
1900	23
1909	26

The employment in an Astronomical Observatory of a temporary staff of boys so large relatively to the permanent staff is open to grave objection.

IX.—General Remarks:—

During the past year there has been a serious dislocation in the meridian work of the Observatory owing to the loss of the services of Mr. Storey who resigned his post as "Established Computer" last May on appointment as Assistant at the Royal Observatory, Edinburgh. His successor was not appointed till February 19. This

resignation of one of the Permanent Staff and the delay in filling the vacancy have accentuated the long-standing difficulty that has been experienced in carrying on and developing the work of the Observatory with a disproportionately large temporary staff of Boy Computers. A large proportion of these boys leave the Observatory after less than three years' service, being attracted by the better prospects offered by posts in the Civil Service (of which they have obtained twenty-one since 1881) and in other outside careers.

The statement in the preceding section shows how the purely temporary staff of Boy Computers has grown with the development of the Observatory work and how it has been necessary gradually to increase the Permanent Staff, which was found inadequate to provide for the increase in the higher duties resulting from the addition of new instruments and the introduction of new methods of research.

The work of the Observatory has been greatly hampered for many years past by the inadequacy of the Permanent Staff and the delay in providing the additions to it, which were necessary to secure the continuity of the work both in observations and calculations. The Observatory has thus been placed at a disadvantage as compared with other National Observatories, where an adequate permanent staff of Assistants is provided for the regular observations, and it is not necessary to entrust these to boys who have had only a short period of training, as is the case at Greenwich. The frequent changes in the temporary staff add to the difficulties in carrying on the observations and in keeping the calculations up to date. It is much to the credit of the whole staff that these difficulties have been overcome and that arrears have not been allowed to accumulate, when, as has frequently happened, a large number of the Temporary Computers were new to their work.

W. H. M. CHRISTIE.

Royal Observatory, Greenwich,
1909 May 27.