REPORT

OF

THE ASTRONOMER ROYAL

TO THE

BOARD OF VISITORS

OF THE

ROYAL OBSERVATORY, GREENWICH,

Read at the Annual Visitation of the Royal Observatory, 1882, *June* 3.

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The Report here presented refers to the period of twelve months ending 1882 May 20, a fixed date being taken, conveniently near to the Visitation Day. Sir G. B. Airy resigned his office on 1881 August 15, and a portion of the observations here referred to were made under his superintendence. There seems to be no occasion to separate these from the remainder, as the course of observation which Sir G. B. Airy has carried out for so many years has been continued without essential alteration in its main features.

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

The new Library, a building 55 feet long and 18 feet broad, was erected at the end of last year, but the walls were so damp that the whitewashing of the ceiling had to be deferred till the middle of May, and it is only now ready for the reception of books. It is proposed to transfer to the new building, which is close to the Magnetic Observatory, the sections Magnetism and Meteorology, as well as books in other sections, and manuscripts from the Record room, to which reference is seldom made. Sufficient space will thus be gained for the proper arrangement of books in the two rooms forming the old library, which is more conveniently placed for the use of the Astronomical Department. The usual annual comparison of books and manuscripts with the catalogue has been made. The missing manuscript book of Altazimuth Zenith Points has at length been found at the binder's, where it had been mislaid.

The rooms of the Magnetic Observatory have been whitewashed, and some repairs to the buildings generally have been carried out preparatory to the outside painting.

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A subsidence of the ground having taken place last summer in the garden south of the transit-circle, close to one of the supposed sites of the well dug by Flamsteed for observation of stars in the daytime, an excavation was made, but no traces of the well could be discovered.

Of the Transit of Venus instruments, two transits, three altazimuths, five 6-inch equatoreals, two photoheliograph mountings, nine clocks, and one Transit of Venus model have been sent to Mr. Stone at Oxford for use in the forthcoming Transit of Venus, and three transits, an altazimuth, a photoheliograph, and two clocks are at the Cape of Good Hope, where they will be available for the Transit of Venus. A photoheliograph is mounted here for daily use, another is at South Kensington, and the telescopic part of another (without the mounting) is in India. There are also three Transit of Venus models in our hands. The "Naylor" equatoreal, which is in use here for observations of comets and other occasional phenomena, has been moved to a more convenient position in the lower part of the South Ground, at a much greater distance from the dip instrument. This equatoreal will also be available for the coming Transit of Venus. Two four-inch telescopes on tripod stands have been lent to Capt. Wharton, R.N., for observation of the Transit of Venus during his cruise in the Straits of Magellan.

The portable transit with axis-view has been lent to Capt. Mackinlay, R.A., for practice at Woolwich in preparation for the Transit of Venus.

The copy of the Imperial standard yard deposited at the Royal Observatory was transferred in November last to the Standards Department for the purpose of comparing it with the other Parliamentary copies, and returned to the Observatory in February. The comparison appears to be satisfactory, as showing that no appreciable change has taken place.

A series of pendulum observations was made in the Record room last autumn by Major Herschel, R.E.

II. Astronomical Observations:—

Transit-Circle.—There are no changes of any importance to record in this instrument. The level-error having become inconveniently large, the sheet of paper which had been placed under the east Y in 1870 was taken away at the end of last July, and the accumulation of oil and dirt on the base plate was removed. The level-error was thus reduced by 6″, being as nearly as possible the amount required.

No alteration has been made in the subjects of observation, which continue to be, as in past years, the Sun, Moon, planets, and fundamental stars, with other stars from a working catalogue of about 2,500 stars. Special attention is given to the observation of long groups of clock-stars and of stars by reflexion. The

working catalogue, which contains all stars down to the third magnitude, stars of the fourth and fifth magnitudes which had not been observed in the last two Greenwich Catalogues, and other stars required for special purposes, is now nearly cleared off, and it is proposed soon to prepare a new working list, extending the catalogue to stars of the sixth magnitude. About 1,000 stars were observed in 1881.

The following is a statement of the number of observations with the Transit-Circle made in the year ending 1882, May 20 :—

Transits, the separate limbs being counted as separate observations	4374
Determinations of collimation error	304
Determinations of level error	312
Circle observations	4283
Determinations of nadir point (included in the number of circle-observations)	311
Reflexion-observations of stars (similarly included)	394

Fifteen observations of Comet *b* 1881, four of Comet *c* 1881, and six of Comet *a* 1882, have been obtained on the meridan S.P. up to the date of this Report. The observations of the last-named comet are being continued.

As regards the computations, the transits are reduced so as to exhibit mean right ascensions on 1882 January 1 as far as May 2, with the exception of the corrections for defective illumination, which have only been applied to 1881 December 31. The mean solar times for transits of Sun, Moon, and planets are prepared as far as 1882 April 14. The investigation of personal equations has been completed for the year 1881, Mr. Downing being taken as the standard observer in place of Mr. Criswick, who has given up regular observing on undertaking the superintendence of the computers.

The circle observations are completely reduced so as to form mean N. P. D. for 1882 January 1, and the corrections for defective illumination are applied as far as May 14.

A new determination of the flexure was made on 1882 January 2, the resulting value being $+0''{\cdot}03$. The mean of nine determinations since the beginning of 1879 is $+0''{\cdot}13$. No correction for flexure, as determined by the collimators, has been applied to the observations.

The correction for R—D, the error of assumed colatitude, and the position of the ecliptic have been investigated for 1881. The planetary results are entered into the ledgers to the end of 1881, but the calculation of geocentric and heliocentric errors is not yet completed.

In regard to the R—D correction, the law assumed for 1881 is $a + b$ Sin z, as in years preceding 1862, instead of $a + b$ Sin z . Cos$^2 z$, which had been used from 1862 to 1880. The former law, which would treat the R—D correction simply as residual flexure, appears to make the N.P.D.'s determined with the transit-circle throughout the whole range of years since 1851 harmonize better on the whole.

In order to extend the range of the reflexion observations, which are at present confined within an arc of 40° from the zenith, and thus to determine the true law of the R—D discordance, I have arranged with Mr. Simms to have the collimators mounted on upright arms turning about centres below, which will allow them to be swung on one side when not in use, the piers being cut away so as to offer no obstruction to reflexion observations as far as Z.D. 71°.

The R—D correction found for 1881 is $+ 0''{\cdot}02 + 0''{\cdot}55$ Sin z, a correction of $+0''{\cdot}16$ Sin z having been first applied to the reflexion observations for inclination of the vertical at the mercury trough, which describes a circle of radius 8 feet about the axis of the instrument.

The value found for the co-latitude from the observations of 1881 is 38°. 31′. 21″·99, slightly larger than the assumed value; the correction to the obliquity of the ecliptic is $+0''{\cdot}13$; and the discordance between the results from the summer and winter solstices is $+0''{\cdot}03$.

Altazimuth.—The instrument is in good working order and has required nothing beyond ordinary repairs during the year. The observations of the azimuth-mark on the parapet of the Naval College have proved so satisfactory that it has been considered unnecessary to continue the observation of a low star, a high star and the mark being found sufficient for the determination of zero of azimuth. The azimuth of the mark was originally determined by low stars as well as high, and is now checked by high stars. The mark is usually observed at sunset when the observations of the Moon are made early in the evening, and at sunrise when the Moon rises in the early morning.

The following observations have been made with the Altazimuth from 1881 May 20 to 1882 May 20:—

Azimuths of the Moon and stars	697
Azimuths of the azimuth-mark	404
Azimuths of the collimating-mark	410
Zenith-distances of the Moon	404
Zenith-distances of the collimating-mark . . .	406

Azimuths and zenith distances of Comet *b* 1881 were observed on 10 days.

The altazimuth observations are completely reduced to April 14, so as to exhibit errors of Moon's tabular R.A., N.P.D., longitude, and ecliptic N.P.D. In the altazimuth reductions for 1882, the computations have been carried to $0^s{\cdot}01$ and $0''{\cdot}1$ only, instead of to $0^s{\cdot}01$ and $0''{\cdot}01$ as formerly, thereby effecting a saving of some unnecessary figures.

The following is a comparison of the number of days on which the Moon was observed with the transit-circle and altazimuth respectively:—

Moon's Time of Meridian Passage.	Transit-Circle.	Altazimuth.
0^h to 1^h mean solar time . . .	0	1
1^h to 2^h „ . . .	0	5
2^h to 3^h „ . . .	0	6
3^h to 4^h „ . . .	3	4
4^h to 5^h „ . . .	4	9
5^h to 6^h „ . . .	8	10
6^h to 9^h „ . . .	23	33
9^h to 12^h „ . . .	22	29
12^h to 15^h „ . . .	19	34
15^h to 18^h „ . . .	16	22
18^h to 19^h „ . . .	7	9
19^h to 20^h „ . . .	4	8
20^h to 21^h „ . . .	2	9
21^h to 22^h „ . . .	0	9
22^h to 23^h „ . . .	0	2
23^h to 24^h „ . . .	0	0

The whole number of places of the Moon observed is—

With the transit-circle, 108, or 8·8 per lunation.
With the altazimuth, 190, or 15·4 per lunation.

The Moon's diameter has been measured—

With the transit-circle, 3 times in R.A., 13 times in N.P.D.
With the altazimuth, 13 times in azimuth, 35 times in Z.D.

Clocks and Chronograph.—After a number of experiments in the regulation of a secondary clock by the Sidereal Standard, for registration of seconds on the chronograph, in which great difficulties were experienced from the shortness of the contact, the system has been given up, and since November 3 the Sidereal Standard has been

used to register every alternate second directly on the chronograph, the 0^s being omitted as formerly to mark the beginning of the minute. The long break of four seconds from 58^s to 2^s was found inconvenient, and the arrangement by which the contact was broken at the commencement of the minute has now been modified so as to give a supplementary signal through another circuit, to check the indications of the sympathetic clocks. The numeration of seconds on the chronograph is readily obtained from the signals sent in the course of each night's observations by the clock "Hardy." The registration of each second in these signals serves as a check on the sub-division of the two seconds' intervals into seconds. A scale has been prepared to read off the transits, and the system appears to work well.

Reflex Zenith Tube.—In order to afford data for applying a correction for the effect of temperature on the wire frame of the instrument, a thermometer has been placed near the zenith-tube to be read at the time of observation. The observations of γ Draconis are completely reduced to the end of 1881, and the copy for press is prepared.

Equatoreals.—The South-East, the Sheepshanks, and the Naylor equatoreals are in good order, and have required merely trifling repairs. The Shuckburgh equatoreal is kept in tolerable repair, so as to allow of its occasional use for such phenomena as are visible from its unfavourable position.

With one or more of these equatoreals or with the altazimuth, 13 occultations of stars by the Moon (10 disappearances and 3 reappearances) and 30 phenomena of Jupiter's satellites have been observed in the twelve months ending 1882 May 20, and the observations of occultations have been reduced as far as 1881 September 3. Comet *a*, 1882, has been observed on 7 nights with the Naylor equatoreal, a bar eye-piece being used, and the apparent R. A. and N. P. D. of the comet have been calculated with provisionally assumed places of the comparison stars.

The Solar Eclipse of May 17 was observed with the South-East equatoreal for determination of the corrections to the Moon's R. A. and N. P. D. and to the diameters of the Sun and Moon. During the eclipse, which only lasted an hour and twelve minutes, 18 differences of R. A. of cusps, 10 differences of N. P. D. of limbs, and 9 differences of N. P. D. of cusps were observed. The beginning and ending were also recorded by several observers.

A few sketches of Mars were made with the South-East equatoreal last December, and on December 30 a measure was obtained of an object supposed to be Deimos, the outer satellite.

III. Spectroscopic and Photographic Observations:—

During the twelve months ending 1882 May 20 the Sun's chromosphere has been examined with the half-prism spectroscope on 36 days, and on every occasion prominences were seen. On one day a detailed examination of the whole spectrum of the chromosphere was made at 24 points of the Sun's limb. Several prominences have shown great changes in the course of two or three minutes, and large displacements or contortions of the bright lines, indicating very rapid motions of approach or recession, have been noted. In particular, a prominence examined on 1882 May 13 was observed to rise through a space of about 30″ in less than two minutes, being at the rate of about 110 miles a second, whilst the C line showed a displacement towards the red gradually increasing from $1\frac{1}{4}$ to 11·4 tenth-metres, corresponding to a motion of recession increasing in two minutes from 36 to 330 miles a second. Thirteen sun spots have been examined on 20 days with reference to the broadening of the lines in their spectra. The strong black lines or bands in the part of the spectrum between *b* and F, first noticed in the spectrum of a spot on 1880 November 27, have been generally observed to be present in the spectra of spots during the last twelve months, besides several fine lines in the same region of the spectrum to which there is nothing corresponding in the solar spectrum.

For the determination of motions of stars in the line of sight, 177 measures have been made of the displacement of the F line in the spectra of 41 stars, 68 of the b_1 line in 19 stars, and 9 of the b_4 line in 5 stars. Of the 61 stars observed, 15 had not previously been examined, and the total number of stars of which the motions have been spectroscopically determined is now 106. In the case of three of the stars observed in the last year, a dispersive power equivalent to that given by sixteen prisms of 60° has been used. A comparison of the successive determinations of the motion of Sirius indicates a progressive diminution from about 22 miles a second in 1877 and 1878 to about 7 miles a second or less this year, and as other stars do not show anything similar, it appears likely that the change is due to the orbital motion of Sirius. Further observations will, however, be required to settle the point.

The spectrum of Comet *b* 1881, was examined on six nights, that of Comet *c* 1881, on three nights, and that of Comet *a* 1882, on three nights. The spectra of the first two objects showed the usual cometary bands corresponding to those of the first spectrum of carbon, and a continuous spectrum from the nucleus and brighter portions of the head. Comet *a* 1882, has hitherto shown only a continuous spectrum with two irregular ill-defined maxima of light. The observations of this comet are being continued.

The spectra of the eclipsed Moon on December 5 and of Uranus have also been examined.

The spectroscopic observations of all kinds have been completely reduced to 1882 May 5.

In the year ending 1882 May 20 photographs of the Sun have been taken on 200 days, and of these 352 have been selected for preservation. Since the end of last August photographs have been taken on Sundays as well as on week days. There were only 2 days out of 200 on which the Sun's disk was observed to be free from spots. There has been a large increase in the number and size of spots and faculæ, the mean of the daily areas for each in 1881 being nearly double of the corresponding quantities for 1880, and the increase is still continuing, though with well-marked fluctuations. A very remarkable outbreak of spots occurred in April last.

As regards the photographic reductions:

The photographs have been measured in duplicate, and the measures entered, to	1882, May 9
The areas of spots and faculæ have been completely reduced, so as to exhibit areas in millionths of the Sun's visible surface, to	March 19
Radii of the Sun, Corrections for zero of position-circle, and Heliographic elements, have been computed to . .	May 9
Distances from the Sun's centre and Position-angles of spots and faculæ, corrected for distortion and refraction, have been formed to	March 19
Heliographic longitudes and latitudes of spots have been computed to	March 19

In order to save labour, without appreciable loss of accuracy, the reductions, since the beginning of this year, have been carried only to tenths of a degree instead of to minutes in position-angles and heliographic longitudes and latitudes, and to thousandths of an inch instead of to ten-thousandths in measures of distance from Sun's centre. To facilitate the computations, tables of sines and log sines, cosines and secants for degrees and tenths have been printed on a card, and the time occupied in the reductions is thus very materially shortened.

IV. Magnetical Observations:—

No important change has been made in the three magnetometers with which the changes in the magnetic declination, horizontal force, and vertical force are

continuously recorded by photography. The wooden stage carrying the declination and horizontal force cylinder, which had been supported by brackets fixed to the wall, gave way in September. It is now firmly planted on stumps fixed in the ground.

The large temperature correction for the vertical force magnet has made it impracticable to discuss satisfactorily the diurnal inequality of vertical force and its dependence on solar activity, notwithstanding the great care taken to keep the magnetic basement at as nearly uniform a temperature as possible. As the co-efficient has the opposite sign to that which it ought to have according to the law of decrease of magnetic power with increase of temperature, it appeared probable that it might be due to unsymmetrical expansion in the mounting of the magnet, which would affect the balance of the instrument. On examination it was found that the steel magnet was held by the brass carrier at some distance longitudinally from the line of the knife edges. Mr. Simms is now engaged in altering the mounting in this particular, so that the effect of expansion in the mounting may just compensate for the loss of magnetism with increase of temperature. The upper declination magnet, the dip instrument, and the deflexion apparatus, with which absolute values of the magnetic elements are obtained by eye-observations, are all in good order.

Reflecting prisms, generally similar to those in use for the declination and horizontal force magnets, have been applied to the earth-current apparatus, so as to bring the two traces into juxtaposition as regards time-scale. Advantage has been taken of the opportunity to thoroughly restore the apparatus and effect various desirable improvements by which the necessary adjustments, hitherto excessively tedious, can be readily performed. The renovated apparatus was brought into use in November, but the scale of the movements was found to be too large, and in February Mr. Ellis reduced it by placing in each circuit a shunt consisting of about 10 feet of wire. As regards the wires, the old circuits have been restored, the earth-plates of one circuit being at Angerstein Wharf and Ladywell, and those of the other at North Kent East Junction and Blackheath. The earth connection at North Kent East Junction was changed on July 18 to a piece of iron rail in the canal, far removed from the influence of currents from other wires, and very good indications are in general obtained, the former troublesome fluctuations having to a great extent disappeared, though there is frequently disturbance during rain, as if due to imperfect insulation. There was, however, a rather larger constant current through this circuit than through the other, which it was thought might be due to the circumstance that there is an iron

earth-plate at one end and a copper earth-plate at the other. A copper plate was therefore substituted on May 4 for the iron rail at North Kent East Junction.

We are troubled at times in the magnetic basement with discoloration of the photographic sheets, apparently caused by want of ventilation in a room which has to be kept from the influence of changes of temperature in the external air. Possibly the adoption of one of the newer photographic processes might meet the difficulty, or it might be removed by the construction of a subterranean channel of sufficient length to bring the air entering the room through it to the temperature of the soil, which at a depth of a few feet is sensibly constant.

As regards the magnetic reductions, the eye-observations of the upper declination magnet and of the horizontal and vertical force magnets, giving zeros for the ordinates of the photographic curves, are reduced to the end of the year 1881.

The time-scales for declination and horizontal and vertical forces are complete to the end of 1881, and the base line values are formed. These are entered on the photographic sheets, and new base lines laid down.

The hourly ordinates of the photographic curves are read out to the end of 1881 for declination and horizontal force, and the taking of hourly and monthly means is complete. The time-scales for the earth-currents are laid down for 1881. The observations of dip are completely reduced; those for absolute horizontal force are reduced to the end of 1881.

The following are the principal results for magnetic elements for 1881 :—

Approximate mean westerly declination . .	18°. 27′.
Mean horizontal force	3·915 (in English units). 1·805 (in Metric units).
Mean dip	67° 33′ 45″ (by 9-inch needles). 67. 34. 54 (by 6-inch needles). 67. 35. 5 (by 3-inch needles).

On four days during the year, viz., September 12 and 13 and April 16 and 19, magnetic storms have occurred. Those of April were of more marked character than any that have taken place since the great storms of the year 1872, and it is a significant fact that exceptionally large spots made their appearance on the Sun shortly before, viz., on April 11 and 17. Smaller magnetic movements are now also much more frequent, the traces exhibiting a marked contrast to their general appearance some two or three years ago. In regard to the long period variation of about 11 years, we are able now to say definitely that the minimum as regards

diurnal range of declination occurred at the commencement of 1879, whilst as regards diurnal range of horizontal force, it occurred unmistakeably earlier, about August 1878. Since the epochs mentioned each element has, with small fluctuations, continued regularly to increase again in magnitude, the daily range of declination having increased from 6′·59 at the beginning of 1879 to 9′·15 in 1881, and that of horizontal force from ·00110 (in parts of the whole H. F.) in 1878 to ·00181 in 1881.

We have frequent applications from mining surveyors for the values of the magnetic elements, and recently the wish has been expressed that information as to the diurnal inequality and particulars of magnetic storms observed here should be communicated from time to time to the "Colliery Guardian" newspaper, in order that mining surveys may be carried out with due allowance for the diurnal and other motions of the magnetic needle.

V. Meteorological Observations:—

The meteorological instruments and the Thomson electrometer are all in good order. The pencil carriers of Osler's anemometer have been entirely renovated by Mr. Simms, and are now perfectly free from shake. In order to have the means of verifying the position of the zero of the pressure pencil, which sometimes wanders to a small extent, possibly from the effect of damp on the silk connecting cord, an index has been fixed on the wire from the pressure plate, which can be viewed through slots cut in the upright tube, to which a scale is to be attached.

The maximum and minimum radiation thermometers have been moved from the South Ground, where they had been placed for the last two years, to their former position in the Magnetic Ground, and a new pair of radiation thermometers have been procured for the purpose of ascertaining what differences of readings are produced by the slightly different circumstances as regards exposure.

The following is the state of the meteorological reductions:—The observations of barometer, thermometer, anemometers, rain-gauges, and sunshine instrument (corrected, where necessary, for instrumental error) are reduced up to the present time, and a very full meteorological table of these results is published weekly in the Registrar-General's Reports. On the photographic sheets time-scales are laid down for the barometer, dry and wet bulb thermometers, and electrometer to the end of 1881. The barometer hourly ordinates are read out to September, those of the

dry bulb thermometer to June, of the wet bulb thermometer for January only, and of the electrometer to September. No hourly or monthly means are taken for 1881.

The mean temperature of the year 1881 was 48°·7, being 0°·6 lower than the average of the preceding 40 years. The highest air temperature was 97°·1 on July 15, and the lowest 12°·7 on January 17. The mean temperature was below the average, 6°·7 in January and 4°·8 in October, and above the average, 5°·9 in November. In other months the temperature in general differed little from the average. On four days in July the temperature rose above 90°.

The mean daily motion of the air in 1881 was 291 miles, being 12 miles greater than the average. In January and September the mean daily motion was 70 miles and 72 miles below the average respectively; in April, August, and November it was 70 miles, 60 miles, and 71 miles above the average respectively. The greatest daily motion was 999 miles on October 14, the day of the great storm, and the least 59 miles on May 25. A velocity of 61 miles an hour was recorded on October 14, and one of 58 miles an hour on April 29, these being both greater than any recorded in previous years. The greatest pressure was 53 lbs. on the square foot on October 14; pressures of 46, 47, 47, and 48 lbs. were also registered during the same gale. On April 29 a pressure of 49½ lbs. was recorded at a time when the hourly velocity was 50 miles; the pressures corresponding to the maximum velocity of 58 miles an hour were not registered, the cord of the pressure pencil having slipped off the pulley.

The vane of Osler's anemometer made in the year 1881 fourteen revolutions in the positive direction N, E, S, W, N.

The number of hours of bright sunshine recorded by Campbell's sunshine instrument during 1881 was 1301, which is more than 100 hours above the average of the four preceding years.

A copy of the observations of the temperature of the air made at the Royal Observatory at fixed hours, and extending from the year 1807 to 1841, has been made and supplied to Mr. H. S. Eaton at his request and at his own expense.

VI. Printing and Distribution of the Volume of Greenwich Observations:—

The volume for 1879 was printed and distributed last autumn, and the volume for 1880 was passed for press in the middle of April. The copies are now in the binder's hands.

As regards the volume for 1881, the transits are printed to May 19, meridian zenith distances to April 27, azimuths with the altazimuth to March 31, and zenith distances to June 2. By the omission of several columns in the two sections of azimuths and zenith distances, which can be supplied at sight by simple addition or subtraction, space has been gained in these sections for the principal tabular elements of reduction and for the apparent errors of tabular azimuths and zenith distances, thus making it unnecessary to print the section of comparison of observed and tabular azimuths and zenith distances. It is proposed also to omit the table of errors of Moon's tabular R.A. and N.P.D. from altazimuth observations, as these errors are given in the Astronomical Results in juxtaposition with those obtained with the transit-circle. By these omissions and closer printing in some portions 60 or 70 pages may be saved in the section of altazimuth observations. Proofs have been received of the greater portion of the Spectroscopic Results for 1881, and the manuscript of the Photographic Results is ready for the printer.

A reduction has been made in the number of copies of the Greenwich Observations and Results for 1881 in consequence of the large stock left on hand in recent years and the amount of shelf room required for it—48 feet for the Greenwich Publications in 1879. The impression of the entire volume, including everything emanating from the Observatory, has been reduced from 300 copies to 250, of the Astronomical Results from 250 additional copies to 150, of the Magnetical and Meteorological Results from 250 to 200, and of the Introduction from 250 to 100. Of the Spectroscopic and Photographic Results 250 additional copies are printed as formerly, and of the Reports on Trial Chronometers and Reports to the Board of Visitors 650 additional copies. With this extent of impression it is expected that about 40 copies of the Volume and 50 or 60 copies of the separate parts will be left in stock after the usual distribution.

The printing is going on very satisfactorily, and it is hoped that the volume for 1881 may be passed for press by the end of this year.

VII. Chronometers and Time Signals :—

The number of chronometers now being tested at the Observatory is 214, 168 of which (120 box-chronometers, 23 pocket-chronometers, and 25 deck-watches) belong to the Government, and are being rated after repair previous to being issued to the Navy. The remaining 46 are placed here for the annual competitive trial, and of these 18 are fitted with Airy's supplementary compensation. In addition to the above, 6 chronometers have been placed on trial for the Mauritius Observatory, and 5 chronometers have been tested for the Japanese Government.

Notwithstanding the circumstance that the competitive trial of 1881 was more severe than usual, on account of the greater range of temperature, the first six chronometers performed on the average slightly better than those in any year since 1877, and the first chronometer was exceptionally good. The improvement shown was probably to some extent due to the prizes offered by the Clockmakers Company, for the first time last year, for the first two chronometers.

There has been only one case of accidental failure in the automatic drop of the Greenwich time-ball. On 4 days the ball was not raised on account of the violence of the wind.

The Deal ball has been dropped automatically at 1^h on every day throughout the year, with the exception of 15 days, on which there was either failure in the telegraphic connexion or interruption from telegraph signals continuing up to 1^h, and of one day when the current was too weak to release the trigger without the attendant's assistance. On 3 days high wind made it imprudent to raise the ball.

The Westminster Clock has continued to perform well, its errors having been under 1^s on 40 per cent. of the days of observation, between 1^s and 2^s on 44 per cent., between 2^s and 3^s on 14 per cent., and between 3^s and 4^s on 2 per cent.

Time-signals, originating in the Observatory, are distributed at 10^h a.m. and 1^h p.m. to all parts of the country by the Post Office Telegraphs.

VIII. Personal Establishment:—

The staff is at present constituted thus:—

Mr. Dunkin, Chief Assistant;
Mr. Ellis, Mr. Criswick, and Mr. Downing, First Class Assistants;
Mr. Maunder, Mr. Thackeray, Mr. Lewis, and Mr. Hollis, Second Class Assistants; and
Mr. Nash, Magnetical and Meteorological Assistant.

Mr. Dunkin has the general superintendence of all the departments of the Observatory, with full power to act during my absence. Mr. Criswick superintends the astronomical computers, and, with the assistance of three or four computers, takes charge of the transit-reductions and miscellaneous computations. Mr. Downing, assisted by one computer, has the charge of the altazimuth reductions.

Mr. Thackeray is principally employed on the ary and manuscripts, and has also charge of the chronograph and of the statio. Mr. Lewis, with one computer under him, has the charge of the time depaent and of the money accounts. Mr. Hollis undertakes the circle-reductions, w the assistance of one computer. Mr. Maunder is charged with the spectrosic and photographic reductions, in which he has the aid of one or two comers. Mr. Ellis, as superintendent, and Mr. Nash, as assistant, have charge of magnetical and meteorological department, and have three or four computers ssist them.

As will be remarked, there have been severhanges in the staff, consequent on the retirement of Sir G. B. Airy. Mr. Dunkin Mr. Downing were in the latter part of August promoted to be respectiveChief Assistant and First Class Assistant, and the vacancy thus occasioned ong the Second Class Assistants was filled up at the end of last November the appointment of Mr. Hollis. These changes, leading to changes in the enyment of other Assistants, have necessarily caused a pressure which has beelt by all the members of the staff, and it is due to these gentlemen to knowledge the zeal with which they have laboured to prevent the work of Observatory from suffering any interruption.

IX. General Remarks:—

Before considering any extension of the w of the Observatory, such as the progress of science may render desirable, I h thought it well to examine how the force at our disposal may be economized inious directions.

In the first place something may be gained he omission of unnecessary figures in the reductions. Thus in the case of the aimuth observations, where we are liable to errors of 3″ or 4″, it appears mere waof time to carry the computations beyond 0″·1. A material saving of labour is eted by this limitation, without any real loss of accuracy. It is a question wheth similar limitation might not be made with advantage in the circle-reductionsough the gain would not be so great. The transit-reductions have never b carried beyond $0^s·01$, and the proper equivalent of $0^s·01$ of time is 0″·1 arc, not 0″·01, as it is tacitly assumed to be in many star-catalogues. h has been saved too in the photographic reductions by limiting the calculns to tenths of a degree instead of to minutes.

Secondly, as regards observing, an importanonomy of force would result from the restriction of the altazimuth observations the Moon to the period from last quarter to first quarter. The other half of lunation is provided for by the

transit-circle, and, if we bear in mind the much greater accuracy of meridian observations, the addition of half as many more positions of the Moon with the altazimuth appears to be obtained at a disproportionate cost both in the labour of observing and of computing.

If two observers were thus set free during the half of each lunation, the Observatory would be able to meet the demands which are frequently made on it by the scientific public for equatoreal observations of a miscellaneous character. Our observing strength is now so severely taxed that drawings of comets, planets, &c., and observations of occasional phenomena can only be made at the cost of neglecting the more important meridian observations; and yet the Observatory can hardly maintain its position as a national institution if it gives no attention to objects which from time to time excite the interest of the astronomical world.

We are placed in a similar difficulty as regards our spectroscopic observations. With only one assistant available for observations, we can barely do half of the work which we have undertaken in deference to a widely-expressed wish, and we are continually forced to make a choice between observations with conflicting claims on our attention.

As regards Solar photography, the value of our results would be very greatly increased if the gaps in the Greenwich series were filled up by the help of the photographs taken in India and elsewhere under the auspices of the Solar Physics Committee, so that the areas and positions of sun spots and faculæ should be given for every day. I am in communication with the Committee on this matter, and am in hopes that the saving of labour recently effected in our photographic reductions will enable us to undertake the work with our existing staff.

W. H. M. CHRISTIE.

Royal Observatory, Greenwich,
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