

R E P O R T  
OF  
THE ASTRONOMER ROYAL  
TO THE  
BOARD OF VISITORS  
OF THE  
ROYAL OBSERVATORY, GREENWICH,

*Read at the Annual Visitation of the Royal Observatory, 1862, June 7.*



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THE interval between 1861, May 10, the date of my last Report to the Board of Visitors, and 1862, May 13, includes the convenient period of  $12\frac{1}{2}$  lunations. I have, therefore, adopted 1862, May 13, as epoch for the Report which I have the honour now to offer to the Board.

I. Buildings and Grounds.—As the pressure of the large number of Computers in the ordinary Computing Room began to be felt as a severe inconvenience, I have had the Middle Room of the S.E. Dome fitted up with desks, &c., and the Supernumerary Computers under their Superintendent (Mr. Lynn) are now located there. I have thus been enabled to assign a larger portion of the Computing Room to the Superintendent of Chronometers and Galvanic Time Communications (Mr. Ellis); and nearly the whole of the apparatus of Galvanic Chronometers, Clock Regulators, and Galvanometers, is now collected there. Other parts of the Computing Room are greatly relieved.

For improving and extending the accommodation required for the various operations of Magnetism, Meteorology, and Photography, a new range of wooden buildings is in progress at the S.S.E. extremity of the Magnetic Ground. It will include seven rooms. When these are completed, Struve's Observatory (which was well adapted to its original purpose, but whose place and position are very inconvenient for the

present uses of the Magnetic Ground), and the present Dip House and Deflexion House (whose positions interfere with the new plan), will be removed.

The ante-room of the Magnetic Observatory has been lengthened 8 feet. Although the want of the new buildings above mentioned was more pressing, it was found necessary to proceed first with this room, because it was slightly injured by an accidental fire, in the very part in which the alteration was to be made, and the immediate removal of the Computers became necessary. For the operation of naphthalizing the illuminating gas, a new building of zinc, external to the Magnetic Observatory, is in preparation; and thus one of the possible sources of accidental fire will be removed.

The water pipe, from the large main of the Kent Waterworks Company on Blackheath (which is always charged and under heavy pressure), to the Observatory, has been entirely relaid with tubes of 3 inches internal diameter. I took this opportunity of establishing two powerful fire-plugs (one in the Front Court and one in the Magnetic Ground); a stock of fire-hose adapted to the "Brigade-screw" having been previously secured in the Observatory.

I propose in the present year to make some alterations in the stoves for warming the lower and middle rooms of the S.E. Dome.

No new Map of the Grounds and Buildings has yet been prepared for engraving.

Two wires, intended for the examination of spontaneous earth-currents, have been carried from the Magnetic Observatory to the Railway Station in the town of Greenwich. From this point (by the permission of the South-Eastern Railway Company, and with the friendly assistance of their Superintendent of Telegraphs, Charles V. Walker, Esq.,) one wire is to be led to a point in the neighbourhood of Croydon, the other to a point in the neighbourhood of Dartford. Each wire is to be connected at its two extremities with the earth. The angle included between the general directions of these two lines is nearly a right angle. The erection of the wires has been delayed by the tardiness of a manufacturer in furnishing the insulators; but I have reason to think that the whole will speedily be completed.

II. Moveable Property.—No material change has taken place either in the amount or in the disposal of our moveable property since the last Report. The principal instruments within our walls which are not strictly the property of the Observatory, are some of the Standards of Length and Weight constructed by Mr. Sheepshanks and

Professor Miller ; and the principal articles of our property not now within our walls, are the clocks, &c. connected with the transmission of time-signals to Deal.

The Parliamentary Copies of the Yard Standard and Pound Standard are in good order.

III. Manuscripts.—The arrangement of current papers is now kept up at intervals not exceeding a few weeks ; and the binding, where necessary, is effected about once in a year. In both these classes of work our customary provisions for order had been allowed to drop too much behind, and in consequence we have had a rather oppressive accumulation in the present spring. Since I first put the Manuscripts in order (about 20 years ago), a necessity for changes of classification has occurred ; and Mr. Carpenter is now engaged with a thorough revision of the arrangement and cataloguing of the bound Manuscripts. When this troublesome work shall be completed, I expect that our papers will be preserved in excellent order.

I regret that the Minutes of the Board of Visitors from 1784 to 1830 have not yet been found.

IV. Library.—With moderate attention, and small purchases, the Library is maintained in an efficient and very useful state. Nothing, however, has occurred requiring special remark.

#### V. Astronomical Instruments :—

The Transit-Circle is in excellent condition. The tin plates which, as I stated in my last Report, had been mounted in order to intercept the heat radiating from the gas-lights upon the stone capping of the Collimator Piers, appear to be perfectly successful in effecting their final purpose of preventing the disturbance of the Collimators by the heat of the flame. The intervals of the Transit Wires have been investigated from a great number of observed transits of the Pole-star, and they differ by a small but sensible quantity from those which have been found by use of the Collimator. I know not whether any error may have been produced by the optical circumstance that, in making determinations of this kind by the use of the Collimator, the same portion of the object-glass is not used for the comparison of different wires. Between February 19 and February 20 of the present year, a remarkable change took place in the horizontal position of the North Collimator ; no cause could be suggested for it, and it is believed that it must have been occasioned by some yielding of the pier or its foundation, caused by disturbed weather. The steel-work of the Transit-Clock

(which is almost buried in the South Collimator Pier) had been found extremely liable to rust ; but holes have been made through those parts of the Pier which encase the clock, permitting a much more free ventilation of the clock than it formerly received : and the rusting seems to have been in great measure prevented.

The Reflex-Zenith-Tube is in good order. A small addition has been made to it, consisting merely of a lens for the better reading of the whole number of revolutions of Microscope A. The bands of vulcanized caoutchouc which support the quicksilver-trough occasionally stretch a little, but are readily adjusted to the indications of the float.

The Altazimuth is in good order ; no change of any kind has been made in it.

The Chronographic Barrel Apparatus continues in the excellent order which was described in the last Report. Some slight changes of rate are possibly due to error of compensation for thermal changes. As the pendulum-suspension and the wheel-mechanism are not carried by the same foundation, a trifling error of adjustment sometimes occurs, which is easily remedied by use of the adjustment-screws.

A small change has been made in the Galvanic Apparatus by which hourly signals are given to external offices, in order to remedy two inconveniences. One was, that the transmission of external signals formerly depended on the movement of the Ball-Detent ; and erroneous signals have sometimes been given by mere manual mismanagement of that Detent. The other was, that it appeared probable that we might be requested to give hourly signals on several different lines, for which our former apparatus was not competent. A relay-apparatus has therefore been fitted up in the Computing Room, completing six circuits at every hour of the Motor Clock, without reference to the Ball-Detent.

A delicate Galvanometer, the property of C. V. Walker, Esq., has been mounted in the Computing Room, with intention of ascertaining whether spontaneous Earth-Currents are exhibited by a wire whose ends are connected with earth at London and at Greenwich. Hitherto, it has failed entirely for its legitimate purpose, although it has exhibited great sensitiveness to other currents, induced by signal-currents on wires parallel to it, or reflected from wires whose earth-connexion is near to its earth-connexion.

The Shuckburgh Equatoreal is in the same state as at the last visitation ; no application of it, requiring the use of the hour-circle-microscopes, having occurred ; and the microscopes being still unmounted.

The Sheepshanks Equatoreal is in its usual efficient state.

The South-East Equatoreal has been furnished with a set of negative eye-pieces. In other respects its equipment remains as it was last year. A severe examination of the divisions of the Declination-Circle gave me reason to think that there is a slight yielding in the support of one of the Declination-Pivots, and at the same time it led me to believe that this yielding strictly follows a simple law depending on hour-angle. On examining with care the instrumental north polar distances of stars in eight different hour-angles (at nearly 3<sup>h</sup> intervals), I found that the polar distance could be measured with no greater uncertainty than 1'' or 2'', a degree of accuracy which, I suppose, no equatoreal has before attained. A series of taps has been established on the pipe supplying water to the reaction-machine of the clock-work, for the easier preliminary regulation of the pressure of the water.

I have prepared a Prism-Apparatus, to be used in conjunction with the S.E. Equatoreal, for examination of the spectra of fixed stars; but hitherto I have been able to do little more than adjust its parts.

The Ancient Instruments have not been specially examined, but appear to be in their usual state.

No steps have been taken for preparing an Orbit-Sweeper, as suggested in my last Report.

VI. Astronomical Observations.—We still regard as our peculiar duty, the incessant and orderly observation of those bodies which are best observed on the meridian, especially the principal fixed stars and the principal bodies of the solar system; and the observations, both meridional and extrameridional, of the Moon. Other subjects of observation are considered as occupying the second rank.

For the list of stars observed on the meridian, I may nearly repeat the terms of the last Report: stars to the 5th magnitude, including 192 clock-stars; circumpolar stars, stars culminating with the Moon, stars occulted by the Moon, stars whose proper motion is to be investigated, stars aiding to establish the laws of refraction, stars near Sirius, and some stars remaining from the comparison with Mars. In this class are also to be included the observations of  $\gamma$  Draconis with the Reflex-Zenith-Tube, which are made at every practicable opportunity. The moveable bodies are; the Sun, Mercury, and Venus, on every weekday; the small planets when they pass the meridian before 14<sup>h</sup>; the large superior planets when they pass before 15<sup>h</sup>, or when at the times of their morning-transit the Moon is near; the Moon at every opportunity.

The number of meridional observations with the Transit-Circle between 1861, May 10, and 1862, May 13, is as follows :—

|                                                                                                              |       |
|--------------------------------------------------------------------------------------------------------------|-------|
| Transits (two different systems of wires being counted as one, but two limbs being counted as two) . . . . . | 3,445 |
| Pairs of observations of the collimator by the Transit-Circle . . .                                          | 311   |
| Reflexion-observations of transit-wires . . . . .                                                            | 303   |
| Observations of Collimator by Collimator . . . . .                                                           | 53    |
| Circle-observations of all kinds . . . . .                                                                   | 3,686 |
| Reflexion-observations of zenith-distance-wire . . . . .                                                     | 293   |

The observations of  $\gamma$  Draconis with the Reflex-Zenith-Tube are as follows :—

|                                                                     |    |
|---------------------------------------------------------------------|----|
| Pairs of observations in reversed positions of the instrument . . . | 61 |
| Single observations . . . . .                                       | 3  |

Of extra-meridional observations, the most important are those made with the Altazimuth ; their number is as follows :—

|                                                 |     |
|-------------------------------------------------|-----|
| Azimuths of Moon and Stars . . . . .            | 715 |
| Azimuths of Comet II. of 1861 . . . . .         | 11  |
| Azimuths of the Collimator . . . . .            | 398 |
| Zenith-distances of the Moon . . . . .          | 385 |
| Zenith-distances of Comet II. of 1861 . . . . . | 11  |
| Zenith-distances of the Collimator . . . . .    | 398 |

The number of complete altazimuth-observations of the Moon near conjunction with the Sun is as follows ; the arrangement being referred to the hour of solar time at which the Moon passed the meridian on the same day :—

|                                                       |   |
|-------------------------------------------------------|---|
| Between 21 <sup>h</sup> and 22 <sup>h</sup> . . . . . | 3 |
| Between 22 <sup>h</sup> and 23 <sup>h</sup> . . . . . | 1 |
| Between 23 <sup>h</sup> and 24 <sup>h</sup> . . . . . | 0 |
| Between 0 <sup>h</sup> and 1 <sup>h</sup> . . . . .   | 1 |
| Between 1 <sup>h</sup> and 2 <sup>h</sup> . . . . .   | 2 |
| Between 2 <sup>h</sup> and 3 <sup>h</sup> . . . . .   | 8 |

And the whole number of days of complete observations of the Moon with both instruments is,—

|                                                    |
|----------------------------------------------------|
| With the Altazimuth, 197, or 15·8 per lunation.    |
| With the Transit-Circle, 120, or 9·6 per lunation. |

The South-East Equatoreal was used for observing Comet II. of 1861 on 27 days. The number of observations of the Comet was 84, and that of comparison-stars 56.



The Double-Image-Micrometer was used for 3 measures of Saturn when his ring was invisible.

The number of observed occultations of stars by the Moon is 13. The number of phenomena of Jupiter's Satellites is 26.

Ten careful drawings have been made of Jupiter, four of Saturn, and six of Comet II. 1861. On four days, the positions of some of Saturn's Satellites have been measured.

No observation of Saturn could be made very near to the time of the winter-disappearance of his ring. In general, the weather has been unfavourable for scrutiny-observations; and the late weather of spring has been unfavourable for all observations.

No measures have been made of the Spectra of Stars, though several spectra have been pretty well seen, some lines being distinct.

VII. Reduction of Astronomical Observations.—In the successive steps of the formation of "Right Ascension from the Observations," as deduced from Meridional Observations, the following dates will show the degree of completeness of the reductions:—True Transits and Clock Errors and Rates are computed to 1862, May 3; Apparent Right Ascensions of Center of Object to May 2; Stars' Corrections are computed as far as May 11, but applied only to April 3; Corrections for deficient illumination of Limb of Moon, &c., to the end of 1861; Mean Solar Times to 1862, April 30. In the "North Polar Distances deduced from Observation," True Zenith Distances are found as far as May 3; Star-Corrections are computed to May 2, and applied to March 31; and Mean N.P.D. are formed to the same date; Corrections for deficient illumination of Limb, to the end of 1861.

The Ledgers of Stars' Mean R.A. and Mean N.P.D. are finished for 1861. The preparations for the Star-Catalogue for 1861 are in progress. The number of stars will be 674. The investigation for R — D is completed for 1861; that for Correction of Latitude for 1861 is this day finished.

The comparisons of Observed and Tabular R.A. and N.P.D. are in progress for 1861. Other usual investigations, applying to the Position of the Ecliptic, the Errors of Tabular Places of Sun, Moon, and Planets in Longitude and E.N.P.D., and the Heliocentric Errors of Planets, are completed to the end of 1860.

For the Reflex-Zenith-Tube, everything is complete to the present time.

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For observations with the Altazimuth, the Azimuths are completely reduced to 1862, March 18, and the Zenith Distances to April 22. The Tabular Azimuths and Zenith Distances are computed, the Errors of Azimuth and Zenith Distance formed, the Errors of R.A. and N.P.D. deduced from them, and the final Errors of Longitude and E.N.P.D. obtained, to March 18.

For the Equatoreal observations of Comet II., 1861, the computations of Refraction and Parallax are made, but the reductions are no farther completed.

The Double-Image-Micrometer-observations are not reduced. This auxiliary instrument was mounted on the South East Equatoreal, and a new determination of the value of its screw was necessary, which has not yet been made.

The Occultations of Stars by the Moon are reduced to the end of 1861.

The planetary drawings suggest at present no special remark, except that the square-shouldered appearance of Saturn seems not improbably to be due to the irradiation of a bright belt in middle latitudes.

The discussion of the ordinary reductions suggests the following remarks :—

The personal equations among the transit-observers are slightly changed. The extreme changes, as referred to Mr. Dunkin's habit of observing, are  $+ 0^s.04$  and  $- 0^s.06$ .

The azimuthal zeros of the Transit-Circle and the Altazimuth still give some trouble, the reference to the heavens indicating changes which do not appear in the comparison of the instruments with their collimators.

The discordance, between the results of direct-observations of stars and reflexion-observations, still exists, and is in fact twice as large as that in the preceding year. A review of the effects of this discordance in different years since 1836 has led me to a conclusion different from that which I announced at the last meeting of the Board. The quantity in question has changed its sign between the earlier and the later divisions of this period of years; and in the middle division it sensibly vanished. These phenomena correspond in date with different degrees of opening of the shutters of the Circle-Room. The latitudes in the three divisions are made to harmonize best; not by supposing the direct-observations correct, to the exclusion of the reflexion-observations, but by supposing the reflexion-observations to be more nearly correct; or, in practical computation, by applying to the results of direct observation a correction exceeding  $\frac{R-D}{2}$ . The colatitude exhibited in the different years thus harmonized is about  $38^{\circ}. 31'. 21''$ .83. That from the year 1861 alone is about  $38^{\circ}. 31'. 21''$ .60.

The state of reduction of observations which I have described, though not quite so far advanced as in some preceding years, is still very satisfactory. The cause of its somewhat defective condition will be found in the following statements.

The preparation of the 7-year Catalogue of Stars from the observations extending through the years 1854–1860 is commenced, and has occupied the time of two computers for some months; and will do so for some months longer. The mere bringing together and combining the results for star-places in different years is not a very heavy work; but so long a time has elapsed since the computation of precessions and reduction-constants was made, that it has become necessary, for the exhibition of a standard catalogue, to recompute the whole of these. Some errors in former computations will be corrected. The places of clock-stars, which were wanted for immediate use, have been found; the precessions of all the stars of the catalogue are computed; the star-constants and secular variations of precessions are yet imperfect. The number of stars is about 2,020. The year adopted for epoch is 1860.

The distribution of Printed Observations on a large scale has occupied much of the time of an able Assistant. The occasional employment of an Assistant on the South-East Equatoreal has compelled me sometimes to withdraw supernumerary computers from their legitimate occupations in order to take a part in the Meridional observations.

These causes, which (except, perhaps, the last) are of exceptional character, will sufficiently explain the small retard of our reductions.

In closing the report on the condition of reductions, I will advert to a change in the form of one branch of computations. Many years ago, in order to avoid the errors almost inseparable from the great number of changes of sign in Bessel's form of star-reductions, I introduced a new form of Day Constants and Star Constants, by use of which the change of sign is entirely avoided; and this modification of calculations has been, as I believe, entirely successful. Following a nearly similar principle, I have lately altered the form of Interpolation with Second Differences, so as in all cases to avoid change of sign. The importance of any arrangement which tends to secure immunity from any one class of error in interpolation may be appreciated from this remark;—that every evening's Altazimuth-observation of the Moon requires for its reduction 16 interpolations.

VIII. Printing and Distribution of Astronomical Observations.—The printing of the volume for 1860 is finished, but no bound copies have yet been received. Its general plan is similar to that of late years. Of the volume for 1861, the manuscript for press of all the sections containing observations and their first reductions (Meridian

Transits, Meridian Zenith-Distances, Altazimuth-Azimuths, Altazimuth-Zenith-Distances, Altazimuth-Tabular-Computations), is ready; and 2 Meridian Transit sheets, 2 Meridian Zenith-Distance sheets, and 1 Altazimuth sheet, are printed.

The great Distribution of Observations, which was commenced by the issue of a Circular Letter in 1860, October, was in a great measure completed in the last summer; though even now occasional demands for the Observations are made and are supplied. Roughly speaking, I may say that about 100 Public Institutions and Observatories have been furnished with all or with a great part of the Greenwich Series; and, perhaps for the first time, we have done ourselves justice in the matter of notoriety. The review of the Stock now left on hand will give better foundation than we have hitherto had, for deciding on the maintenance or variation of the present extent of impression. The Stock on Hand is nearly as follows:—

#### Astronomical Observations.

For the years 1836–1840, the number of copies varies from 2 to 18.

For the years 1841–1859, the number varies from 64 to 98.

#### Magnetic and Meteorological Observations.

For the years 1841–1843, the number varies from 5 to 18.

For the years 1844–1847, the number varies from 106 to 143.

Magnetical and Meteorological Results, separate copies (the same matter being bound with the Astronomical volumes).

For the year 1848 there are 2 copies.

For the years 1849–1859, the number varies from 27 to 56.

It would appear from these numbers that the present extent of impression (350 copies of the comprehensive volume, 150 additional copies of Astronomical Results, 250 additional copies of Appendixes of special interest, 250 additional copies of Magnetical and Meteorological Results,) is well adapted to the present demand for the publication, with sufficient allowances for future contingent demands.

IX. Magnetical and Meteorological Instruments.—The three magnetometers, which are adapted both to continuous photographic registration and to occasional eye-observation, are in very good order. The vertical-force-magnetometer, whose knife-edges were reground by Mr. Simms in April, 1859, is in a most satisfactory state.

The Kew unifilar magnetometer, adapted to the determination of the horizontal part of terrestrial magnetic force in absolute measure (to which I alluded in my last Report), was mounted in the summer of 1861; and till 1862, February, occasional observations (14 in all) were taken simultaneously with the old and with the new instrument.

The comparison of results showed a steady but very small difference, not greater probably than may correspond to the omission of the inverse seventh powers of distance in the theoretical investigation ; proving that the old instrument had been quite efficient for its purpose. The frame of the old instrument was then cleared away, to make room for the new buildings ; and, since that time, the observations have been continued with the Kew instrument only.

To the month of October 1851, the dip-instrument by Robinson was still in use, with the same needles as before, 9.5 inches in length. They gave results with the same discordance as before, and for the same needles ; the dips ranging from  $68^{\circ}. 17'$  with one needle to  $68^{\circ}. 31'$  with another. The stationary dip apparatus, planned by myself, was mounted in the summer of 1861 ; but numerous inconsistencies were found in the results, which were ultimately traced to an erroneous form of the agate bearings. Since these were corrected, new axes also having been fixed in the needles, the instrument has appeared to work well. It must be remarked that the instrument is adapted to the observation of needles of different lengths, and that it is actually furnished with a system B of three 9-inch needles, C of three 6-inch needles, and D of three 3-inch needles. Their general results are as follows :—

B 1,  $68^{\circ}. 16'$  : B 2,  $68^{\circ}. 16'$  : B 3,  $68^{\circ}. 18'$ .

C 1,  $68^{\circ}. 10'$  : C 2,  $68^{\circ}. 12'$  : C 3,  $68^{\circ}. 1'$ .

The D needles have not been observed.

B 3 and C 3 are loaded needles, and these needles are subject to one cause of error, to which many observers have given scarcely sufficient attention ; namely, that the apparent result will be very inaccurate unless the charges of magnetism before and after reversion be precisely equal. The observations have been computed in a way which enables me to examine this point, and I find that the charges of magnetism are rarely equal, and are sometimes very unequal. I attach no importance, therefore, to the discordance of B 3 and C 3. The apparent systematic discordance between B and C suggests the possibility that there is some iron in the base plate of the instrument.

The ends of the wires intended for observation of earth-currents have been led into the Magnetic Observatory, but are not yet connected with any recording apparatus.

The Meteorological apparatus is in good order. It includes barometer, dry-bulb thermometer, wet-bulb thermometer, anemometers, and pluviometer, adapted both to eye-observations and to self-registration ; electrical apparatus for eye-observation only ; and thermometers in the Thames and in the air, exhibiting maxima and minima only.

The simultaneous indications of Whewell's and Robinson's anemometers have been compared, and a table has been formed for converting the daily movement of the air indicated by Whewell's into that which would have been indicated by Robinson's.



X. Magnetical and Meteorological Observations.—The instruments are all fully employed, on the same system as for several past years. For the photographic registers of three magnetometers, barometer, and dry and wet bulb thermometers, which are always in action, zeros are obtained by eye-observations made several times every day. Magnet-thermometers are also read several times every day. Maximum and minimum thermometers once every day. Magnetic dips, in favorable weather, are observed about twice in a week; and absolute magnetic force, once in a month.

The morning observations of barometer, thermometer, and general weather, are sent every day to M. Le Verrier, for publication in his *Bulletin Météorologique*.

XI. Reduction of Magnetical and Meteorological Observations.—In the exhibition of results of the photographic records of the three Magnetometers, it is necessary in the first place to reduce the eye-observations. The equivalents in declination-reductions, and the equivalents and temperature-corrections in horizontal-force-reductions, are prepared to the present time; those in vertical-force-reductions, to the end of 1861. The Theodolite observations for astronomical meridian are reduced to 1862, May 2.

The photographic records are furnished, to the end of 1861, with time-scales and new base-lines for the declination and horizontal-force-sheets, and with time-scales only on the vertical-force-sheets. The numerical values of the graphical ordinates are read into tabular arrangement, for the declination to 1861, October, for the horizontal-force to 1861, May, and for the vertical-force to 1860, December. The Deflexion observations for absolute measure of terrestrial horizontal force are reduced to 1862, April; the Dip-observations to the present time.

The mean magnetic declination for 1861 is about  $21^{\circ}.5'.25''$ , having diminished in the year  $8'$  or  $9'$ . The mean dip, as inferred from numbers already detailed, is not far from  $68^{\circ}.15'$ , having apparently diminished by  $14'$  since 1860.

The vane of Osler's anemometer made on the whole, in the year 1861, about 16 revolutions in the direct order; a number following in fair serial sequence to those exhibited in the last Report. No connexion has yet been established between the annual number of these rotations and any other meteorological phenomenon.

In the last Report, I adverted to the law of the resultant of the combination of Diurnal Inequalities in Declination and Horizontal Force, as deduced from the assemblage of all the observations from 1848 to 1857. On breaking up this large mass into smaller groups, changes of a most singular nature exhibit themselves. In one such grouping, I have formed the curves produced by taking separately the means of all the observations in 1848, of all the observations in 1849, and so on for

each year separately to 1857 ; in another grouping, I have taken separately the means of all January observations through the ten years, of all February observations through the ten years, and so on for each month through the year. The results are most amazing, for the variation in magnitude as well as in law. What cosmical change can be indicated by them is entirely beyond my power of conjecture.

Steps have been taken for investigation of the lunar inequality whose argument is nearly "Moon's hour-angle west of meridian — Moon's longitude east of Sun," but they have led to no certain inference.

XII. Printing of Magnetical and Meteorological Observations.—The printed Reductions of Observations from 1848 to 1857, unfinished at the date of the last Report, were soon after that time completed, and are bound with the volume for 1859. The printing of the ordinary Results of Observations and the Appendices for 1860 has been finished about two months since. No alteration has been made in the form of publication of the ordinary observations. For the photographic magnetometers, the numerical value of the ordinate of every salient point of the photographic curve is printed. Of other magnetic observations, the separate results are given. The meteorological results are not given in the same detail ; but a carefully-considered epitome, of considerable length, is printed, exhibiting in some cases monthly abstracts, in others daily means, and in others the maximum and minimum for each day.

To this collection of ordinary annual observations are attached two Appendices. The first is supplementary for several years past, containing :—Monthly means of the principal Meteorological elements, 1843 to 1853 ; Monthly abstracts of the directions of the Wind, 1841 to 1859 ; Monthly results of Whewell's Anemometer, translated into the corresponding indications of Robinson's Anemometer, 1843 to 1859 ; Weekly and Monthly Means of the Deep-sunk Thermometers, 1848 to 1855. The second Appendix contains a discussion by Professor J. D. Everett (of King's College, Windsor, Nova Scotia), of the observations of the Deep-sunk Thermometers from 1846 to 1859, leading to the determination of the conductive power of the soil of Greenwich Park.

As usual in past years, 350 copies of the ordinary Results of Magnetical and Meteorological Observations and the Appendices are to be bound with the Astronomical Volume, and 250 copies are for separate distribution.

Two copies of the Photographic Records of the three Magnetometers have been taken as far as 1860, December 31.

The printing of the Magnetical and Meteorological Results of 1861 has not commenced ; but the preparation of the manuscript is advancing.

**XIII. Chronometers, Communications of Time, Longitudes, &c.**—The number of chronometers on hand now and for some time past is about 160: of these 100 are compared every day, the others being compared once a week. The standard of comparison is a clock, sympathetic with the Motor Clock, which is adjusted to accurate Mean Solar Time. Every chronometer, whether the property of the Government or a maker's chronometer on competitive trial or trial for purchase, is tried in heat in the Chronometer Oven.

The Reports on the comparative merits of chronometers on trial are furnished to the Admiralty by me; and the management of repairs of chronometers generally is referred to me.

Our galvanic communication with Deal, by which the Time-Signal-Ball at that port is dropped every day, has been uninterrupted except by accidental failure of adjustment of the Clock at London Bridge, which changes the connexions of wires. The regulation of the Post-Office-Clocks is effective.

I have alluded, in the two last Reports, to the steps necessary, on the English side, for completing the great Arc of Parallel from Valentia to the Volga. The Russian portion of the work is far advanced, and will be finished (it is understood) in the coming summer. The improved geodetic junction between Britain and Belgium has been completed several months ago by Sir Henry James. It appeared to me therefore that the repetition of the measure of astronomical longitude between Greenwich and Valentia could be no longer delayed; and I have made arrangements, with the co-operation of Sir Henry James, and with the most liberal assistance of the Magnetic Telegraph Company, for the early completion of this work. Two Assistants of the Royal Observatory (Mr. Dunkin and Mr. Criswick) will at once proceed to Valentia, for the determination of local time and the management of galvanic signals. The Board of Admiralty have supplied funds to meet the contingent expenses. Some of the requisite instruments are lent by the Royal Astronomical Society and by Mr. Simms.

I have alluded, in former Reports, to the exhibition of Daily Time Signals at Portsmouth and Devonport, and of Hourly Time Signals at the Start Point, by means of galvanic currents originating at this Observatory, as matters which appear to merit the consideration of the Board of Visitors and the active care of the Astronomer Royal, and I now ask leave to press the subject of Hourly Time Signals at the Start Point on the attention of the Board, and to submit the advantage of their addressing the Board of Admiralty upon it. The great majority of outward-bound ships pass within sight of the Start, and, if an hourly signal were exhibited, would have the means of regulating their chronometers at a most critical part of their voyage. The plan of the entire system of operations is completely arranged. The estimated expense of outfit is



2,017*l.*, and the estimated annual expense is 326*l.*; both liable to some uncertainty, but sufficiently exact to show that the outlay is inconsiderable in comparison with the advantages which might be expected from it. I know no direction of the powers of the Observatory which would tend so energetically to carry out the great object of its establishment, "the finding out the so much desired Longitude at Sea."

XIV. Personal Establishment.—The establishment remains as at the last Report. The First Assistant, Mr. Edward James Stone, Fellow of Queens' College, Cambridge, has, in full confidence with me, the immediate control of the ordinary operations of the Observatory, and occasionally takes part in the observations and computations. The meridional and altazimuth observations are principally divided between Mr. Dunkin, Mr. Ellis, Mr. Criswick, and Mr. Carpenter (the aid of supernumeraries being, under extraordinary pressures, sometimes called in); the first of these gentlemen having the special care of the Altazimuth, the second and third conducting the business of the time-communications, galvanism, and chronometers; and the fourth taking charge of the Equatoreal. Mr. Lynn has the general control of the supernumerary computers, and the management of a large part of the computations. Five supernumeraries are at this time employed.

The Second Assistant, Mr. Glaisher, superintends immediately the Magnetical and Meteorological Department. Mr. Downs is attached as Assistant, and four supernumeraries are at present engaged in the work of that Department.

Candidates for appointment or promotion are subjected to examination. The experience, however, of these examinations makes me unwilling to accept the result of examination alone as sufficient criterion of the fitness of a candidate.

XV. Extraneous works.—The computations for inferring the Linear Motion of the Solar System from the apparent proper motions of the stars are far advanced (having been carried on, in part, at my private expense); but I am compelled, under heavy pressure of business, to lay them aside at present, with the hope in no very long time of resuming and completing them.

The collection and discussion of the accounts of the Total Solar Eclipse of 1860, as observed in the Himalaya Expedition and by other astronomers, has yet made little progress; in fact, one of the most important accounts was received only in the early part of the present year.

The formation of a General Catalogue of Nebulæ to the epoch 1860, from materials furnished by Sir John Herschel, is in progress at the Observatory; this is, however, merely an arrangement for effecting the computations at the place and under the superintendence most convenient for them; the funds being provided by the Royal Society.

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I have been compelled to employ a portion of my time on the operations for carrying out the Act for Measures for the Sale of Gas ; an employment ill suited to my office, and which I hope will soon terminate.

I propose to institute spectral observations of some of the principal fixed stars as soon as the S.E. Equatoreal shall be free from the observation of the disappearance of Saturn's Ring.

XVI. General Remarks.—I look forward to a season of most unusual pressure upon the computing powers of the Observatory, and to a consequent retardation of the state of reductions. The employment of two able Assistants at Valentia, and of two computers on the Seven-Year Catalogue, will interfere much with the regularity of routine calculations ; and if I shall find opportunity for putting in train the preparation of the Account of the Total Eclipse, the ordinary business may be still more interrupted.

I have been unwilling to solicit any addition to the funds usually granted for the employment of supernumeraries, in the hope that, when the immediate pressure of these works shall be removed, we may, by judicious direction of the ordinary force, recover our lost way. If, however, it should appear on another occasion of my meeting the Visitors, that the reductions are somewhat in arrear, I trust that a reference to the explanation which I have now given will prevent any feelings of surprise.

One of the employments of the Observatory which has grown up conspicuously in late years, and which, both in observation and in calculation, presses heavily upon our strength, is the observation of the small planets. At present, it is impossible for us to abandon this series of observations. On making a careful revision of all the published observations of the small planets, I lately found that the number of meridional observations made at Greenwich exceeded the aggregate number of meridional observations at all the other Observatories of the world, as far as I had access to them, in the proportion of 3 to 2. A cessation of our observations, which are systematically planned to secure places of all the visible planets, would probably amount to an absolute abandonment of some of the planets to oblivion. I shall, however, again endeavour to effect a partition of this labour with some other Observatory.

The policy of the Observatory at present ought to be directed, in my opinion, rather to a curtailment than to an extension of observations.

*Royal Observatory, Greenwich.*  
1862, May 21.

G. B. AIRY.