

REPORT
OF
THE ASTRONOMER ROYAL
TO THE
BOARD OF VISITORS
OF THE
ROYAL OBSERVATORY, GREENWICH,

Read at the Annual Visitation of the Royal Observatory, 1861, June 1.

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FOR convenience, I have this year included in the period to which my Annual Report to the Board of Visitors applies, 12 complete lunations (instead of $12\frac{1}{2}$, as in several late years). The Report which I have now the honour to offer exhibits generally the state of the Observatory on 1861, May 10, and the proceedings in the Observatory from 1860, May 20, to that date.

I. Buildings and Grounds.—The changes to be recorded, in the interior of our inclosure, are unusually small. I have lately found it necessary to erect some new slate shelves for Manuscripts on the west wall of the Upper Record Room, and some wooden shelves for stores of printed books are fixed in the Lower Record Room.

A change has been made in the direction of the galvanic wires, suspended in the open air, which lead from the top of the Octagon Room to the top of a house in George Street. These wires, as originally placed, passed over a part of the dwelling of a resident on Croom's Hill. The owner naturally desired to secure himself against intrusion on his rights as proprietor, but expressed the strongest wish to aid in promoting the objects of the Observatory. With this feeling, I did not anticipate the least difficulty in making a satisfactory arrangement. Unfortunately, the business was

placed in the hands of solicitors ; and it was soon found that all accommodation was hopeless. A lease was offered, but such conditions were attached to it that the London District Telegraph Company declined to take it, that I could not advise the Admiralty to take it, and that I was unwilling to take it on my personal responsibility. Accordingly, the wires were removed, and a new course was adopted for them, by which, in three steps instead of one, we arrive at the same point which was reached before.

I anticipate that in no very long time considerable extension of our buildings will be found necessary, and it is not easy to say where the requisite space can be found. In Flamsteed's time, one half of the nearly-insulated Observatory Hill sufficed for the nascent Observatory. The successive extensions for Bradley, Maskelyne, and Pond, almost occupied the whole peninsula. My additions of the Record Room and the South-East Equatoreal have covered the isthmus. From the peculiar form of the ground, we cannot add buildings on any point nearer than the Magnetic Ground. Yet, with increase of computations, we want more room for computers ; with our greatly increased business of Chronometers and Time-Distribution, we are in want of a nearly separate series of rooms for the Time-Department ; we want rooms for book-stores ; and we require rooms for the photographic operations and the computations of the Magnetic Department. Whatever plan may be ultimately proposed, I presume on the feeling of the Visitors, that the Observatory Hill must never be abandoned as the place where the fundamental Meridional Observations are to be made.

I have lately had a reduced copy of the Observatory Map taken by photography, which I propose to use as basis for an engraved Map, to be attached to some Volume of Observations.

II. Moveable Property.—No alteration has been made, worthy of record.

The copies of the National Standards of Length and Weight have not been disturbed. They are in good order.

The Catalogue of Moveable Property is kept up, by additions (as may be required) from year to year.

III. Manuscripts.—I have to make a communication to the Visitors which, though not possessing the astronomical importance which it would have had many years ago, is still one of singular interest for the Observatory. The Visitors are aware that, at

the decease of Dr. Bradley, his Executor, Mr. Peach, acting professedly in the interest of Miss Bradley (then a minor) carried off the whole of Dr. Bradley's Observations. The son of Mr. Peach subsequently married Miss Bradley, and retained the Observations: refusing to give them up, except on condition of receiving a handsome gratuity. Legal proceedings for their recovery were commenced by the Board of Longitude, and these appear to have been sufficiently onerous to the Messrs. Peach to make them desire to evade the consequences. In some manner and on some terms which I am unable to trace, they transferred the Observations to Lord North, then Chancellor of the University of Oxford; and Lord North in 1776 transferred them to the University, in some way which implied that they should be printed. But so negligent was the person (Dr. Hornsby) who had them in charge, that in 1792 no steps had been taken for printing them; and the Board of Longitude made a formal complaint of the delay. The first volume did not appear till 1798. I need not point out to the Visitors the calamitous effect of the iniquitous proceeding of Mr. Peach and the negligence of Dr. Hornsby, which, at the most critical epoch that we have known in the history of Astronomy, cut off all access to the only observations on which reliance could be placed, and ultimately retarded the progress of accurate astronomy by nearly forty years.

Some years ago, I was led to suspect that there were inaccuracies in Dr. Hornsby's printed book: and on my application, leave was most courteously granted by the Vice-Chancellor of the University of Oxford for taking a Copy of the manuscript. On examining this copy with M. Le Verrier (then engaged in discussing Bradley's observations), we found that corrections were required in several places.

More lately, I applied (in the first instance through Lord Wrottesley) to the Vice-Chancellor, Dr. Jeune, in reference to the possibility of transferring these manuscripts to the Royal Observatory. Dr. Jeune entertained my application with the utmost kindness, although under the very peculiar circumstances of the tenure of the manuscripts by the University, it was necessary to act with great caution. My application was aided in various ways by Professor Bartholomew Price; and my late confidential Assistant, Mr. Main (now Radcliffe Observer) gave the assistance of his official and technical knowledge. Finally, a decree for the transfer of the manuscript observations to the Royal Observatory, without any condition, was proposed to Convocation on May 2, and was passed unanimously. And on May 7 my Assistant, Mr. Dunkin, was sent to Oxford to receive them. And thus, after a delay of very nearly a century, the great act of justice is at length completed, and the great gap in our manuscript observations is at length filled up.

I am confident that the Visitors will recognize the liberality of the University of Oxford, and the attention and courtesy of the Vice-Chancellor, Dr. Jeune, in acceding to my application for this transfer.

The Manuscripts which continue to accumulate in the current proceedings of the Observatory (and which are by no means confined to purely Astronomical subjects) are carefully put in order and bound.

The Minutes of the Board of Visitors from 1784 to 1830 are not yet found. I am very anxious to promote the search for this Document in every possible way.

IV. Library.—The Library has received no change or addition worthy of remark. A few books have been bought, but a greater number have been presented by foreign and British institutions.

V. Astronomical Instruments :—

The Transit-Circle is in excellent condition. At the end of 1859, observations were made on the Telescope-Micrometer; which give the most positive assurance that it is absolutely indifferent, for the reading of the micrometer, whether the screw be turned, in an observation, backward or forward: and which show that there is no discernable difference in successive half-turns of the screw.—It had been formerly remarked, in some careful observations, that the Collimators of the Transit-Circle were slightly disturbed by the proximity of the gas-flames of their illuminators; and care had been taken so to shape the observations that their results should be sensibly unaffected by this cause. Upon the mode of action of the flame, to produce this effect, I was in the utmost ignorance: as I had carefully guarded the metallic supports and tube of each Collimator against the radiation from the flame, by the interposition of two sheets of bright tin and one plate of wood, with free circulation of air between them. A few months ago, the subject was brought prominently to my notice by my First Assistant, Mr. Stone; and I instituted experiments upon the effect of the radiation on different parts of the support of a Collimator. To my great surprise, I found that the disturbance was entirely due to the radiation of the flame upon a very small corner (about 16 square inches) of the large and massive stone on which the Collimator is planted. The tin plates were subsequently shaped in such a manner as to protect the stone as well as the metal; and the disturbance has entirely ceased. Warned by this discovery, I have now interposed double tin screens in every place in which the central illuminating lamp of the Transit-Circle can radiate upon the great western pier; and I think that we are now entirely out of danger of disturbance from radiant heat.—A very careful series of observations for the astronomical flexure of the telescope was made on 1860, September 1; its result agrees well with the mean of former results.

The Reflex-Zenith Tube and the Altazimuth are in the same state as at the last Report. They are in perfectly good order.

The Chronographic Barrel Apparatus has received the changes which I suggested in my last Report. The fly is made to revolve five times in one second; and the maintaining power upon the pendulum is resisted by a spade rotating with the pendulum, which the increase of the diameter of the pendulum-cone causes to dip into an annular trough of water. As the apparatus was not adapted in its original plan for this addition, a little trouble was experienced in fitting the spade with a proper counterpoise. The movement is now extremely uniform, and very accurate. The only remaining chance of inaccuracy in the subdivision of seconds of time by the barrel-movement arises from the use of toothed wheels in the communication of motion from the clock to the barrel.

The Galvanic Apparatus has received no change, except that we have connected with the wires of the sympathetic system an oscillating magnet, whose oscillations complete at every second the contacts of several pairs of springs, and thus enable us to send currents every second in several different directions. The method of adjusting the Motor-clock by galvanic action, in the manner described in the last Report, is now in daily use, and is found very efficient and convenient.

Our external Galvanic communications are in the best possible order; as far as London Bridge, for the various connexions there required (to the South-Eastern Railway and Deal, and to the Electric Telegraph Company); and as far as Deptford, (for connexion with the Magnetic and Submarine Company's wires, and with the Admiralty wires).

The graduation of the Hour-Circle of the North or Shuckburgh's Equatoreal has been restored in a clear and accurate form by Mr. James Simms. The Hour-Circle-Microscopes are not yet remounted, as I contemplate making a change in them, as soon as I shall have leisure to attend to it.

The East or Sheepshanks' Equatoreal is in its usual state, and is perfectly serviceable as a gazing or micrometrical instrument. Its micrometers are in good order.

The South-East Equatoreal is thoroughly efficient for ordinary observations, though some small things are wanting to make it quite complete, principally in the equipment of eyepieces, to which I have not, for want of leisure, given adequate attention. No examination of its state of adjustment has been made in the last year. Its various micrometer-microscope-readings, and its galvanic contact, were used with entire success in the extensive series of measures made on occasion of the Solar Eclipse of 1860, July 18.

On the character of its object-glass I am now able to speak, first, from the examination of Mr. Otto Struve, made in a favorable state of atmosphere, secondly, from the examinations of my Assistants: (I have not myself obtained a sight of a test-object on a night of very good definition). It appears to be of the highest order. The small star of γ Andromedæ is so far separated as to show a broad dark space between its components. Some blue colour is shown about the bright planets.

The water-clock is now brought so completely under command that we use the direct power of the water from the water-mains, under any variation of pressure. The quantity of water required is thus much diminished. In the late severe winter, the water-main of the Observatory (which is in a very bad position and bad state) was frozen, and the water used for regulating the pendulum movement was also frozen; and the clock could not be used for a few weeks. I trust however that the pipes will be laid in a better state, and that the winters will not often be so severe; and I attach no importance to this hindrance.

The ancient instruments are maintained in a state of tolerable cleanliness; but have not been made the subjects of strict examination.

In a late communication to the Royal Astronomical Society, I suggested the advantage of constructing an instrument to which I proposed to give the name "Orbit Sweeper," adapted to sweep along any given direction in the celestial sphere. I think that it may be desirable to mount such an instrument, constructed of cheap material and with inexpensive workmanship, in this Observatory.

VI. Astronomical Observations. — The fundamental meridional observations are still considered as our peculiar and sacred charge. The stars observed are principally the following: 192 clock-stars; stars generally to the 5th magnitude; new circumpolar stars; Moon-conculminating stars, and occultation-stars; stars supposed to have a large proper motion, and variable stars; stars near Sirius; low stars for refraction; stars observed with Mars at opposition; and stars used in defining the Oregon boundary. The moveable bodies observed on the meridian are: the Moon at every opportunity; the Sun and Inferior Planets on every day except Sundays; the Superior Planets when they pass before 15^h solar time, and the large ones also when they pass with the Moon after 15^h.

The increased labour of observations and calculations, from the increase of the number of small planets, has induced me lately to restrict the observations of the small planets to the hours before 14^h.

(9)

The number of meridional observations during the period to which this Report applies, is as follows :—

Transits (two limbs, or two different systems of wires being counted as two)	4,034
Pairs of observations of the collimators by the Transit-Circle	298
Observations of transit-wires by reflexion	297
Observations of Collimator by Collimator	51
Circle-observations of all kinds	3,335
Observations of zenith-distance-wire by reflexion (included in the last number)	282

With the Reflex-Zenith-Tube, the following observations of γ Draconis have been made :—

Pairs of observations in reversed positions	55
Single observations	2

With the Altazimuth, the following observations have been made :—

Azimuths of Moon and Stars	616
Azimuths of the Collimator	342
Zenith-distances of the Moon	328
Zenith-distances of the Collimator	342

The numbers of complete observations of the Moon near the conjunctions with the Sun are as follows :—

When meridian-passage occurred between 21 ^h and 22 ^h , solar time	3
Between 22 ^h and 23 ^h	1
Between 23 ^h and 24 ^h	0
Between 0 ^h and 1 ^h	1
Between 1 ^h and 2 ^h	4
Between 2 ^h and 3 ^h	3

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

With the Altazimuth, 168, or 14·0 per lunation.
On the Meridian, 87, or 7·3 per lunation.

The diminution, in this year, of the number of Meridional observations of all objects, and of Altazimuthal observations of the objects peculiar to the Altazimuth, is most remarkable. It has arisen entirely from the excessive badness of the weather which prevailed through the summer and autumn of 1860, and through the spring of 1861.

With the Double-Image-Micrometer, no observations have been made.

The number of occultations by the Moon, observed in the past year (counting a disappearance and a reappearance as two), is, 8 occultations of stars, and 2 of Jupiter

(which occurred between the writing and the presentation of the last Report). The number of phænomena of Jupiter's Satellites is 42.

The South-east Equatoreal was used at the Eclipse of 1860, July 18, for observing 46 differences of right ascension, and 30 differences of polar distance, of cusps and limbs, in conformity with a plan previously arranged, with the view of determining the errors of the place of the Moon as referred to the Sun, and the errors of the diameters of Sun and Moon. It has also been employed in making 14 careful drawings of Mars, 30 of Jupiter, and 3 of Saturn; and several measures of the positions of the satellites of Saturn on 6 evenings.

It was found impossible to make the observations of Mars proposed for determination of his parallax. The position of the planet was unfavourable, the weather was unusually bad, and the general system was disturbed by the Eclipse and by the unsettled personal arrangements of the Observatory.

VII. Reduction of Astronomical Observations.—In the computation of Right Ascensions as deduced from Meridional Observations; True Transits and Clock Errors and Rates are computed to 1861, May 4; Apparent Right Ascensions of Center of Object to April 25; Stars' Corrections are prepared to May 6, and applied to April 24; Corrections for want of illumination on the Moon's limb, &c., to end of 1860; Mean Solar Times to 1861, March 28. In the computation of North Polar Distances as deduced from Meridional Observations, True Zenith Distances are found to May 1; Star-Corrections are computed (with a few exceptions) to May 9 and applied to January 21.

The Ledgers of Stars' Mean R.A. and Mean N.P.D. are finished for 1860. The Star-Catalogue for 1860 is not yet formed. The number of stars is 775.

The comparisons of Observed and Tabular Diameters, Right Ascensions, and N.P.D., of Planets, are completed to end of 1860. The investigation of the Position of the Ecliptic, the Errors of Sun, Moon, and Planets in Longitude and E.P.D., and the Heliocentric Errors of the Planets, are finished to end of 1859.

For the Reflex-Zenith-Tube, the calculations are complete to end of 1860; introductory calculations to 1861, March 21 (the last observation).

For the Altazimuth observations, the Azimuths and Zenith Distances are completely reduced to April 4 and April 25, respectively; and all the introductory calculations which admit of being made immediately after the observation are finished to the present time. The Tabular Computations are made to April 4, and the Moon's Errors in

R.A. and N.P.D., and the Errors in Longitude and E.P.D., are found to the same day.

The observations with the Double-Image-Micrometer are reduced to end of 1859.

The computation of the Occultations for 1860 is completed.

The Equatoreal observations of the Solar Eclipse are completely reduced ; and the results are valuable. It appears from [them] that the error in right ascension of Burckhardt's Lunar Tables at the time of the eclipse amounted to about 38" ; while that of Hansen's (ultimately adopted by Mr. Hind for the calculation of the eclipse) did not exceed 3".

The drawings of Jupiter have shown the quasi-permanent existence of a belt inclined to the ordinary belts. With the view of giving accuracy to these physical observations, I have prepared tables, by which the Jovial longitude of the point of Jupiter's surface turned towards the earth is readily computed ; and the numerical value of the longitude is attached to each drawing.

Saturn has sometimes appeared to exhibit the square-shouldered figure which Sir W. Herschel long ago attributed to him, and sometimes has not shown it. The satellites which have been observed are not yet fully identified.

The following remarks are suggested by the discussion of the various observations :—

The personal equations of observers in taking transits are nearly as they were in the last year. The greatest apparent change is $0^s.04$.

The Transit-Circle and Collimators still present those appearances, of agreement between themselves and of change with respect to the stars, which seem explicable only on one of two suppositions,—that the ground itself shifts with respect to the general Earth,—or that the axis of rotation changes its position. I use this language only for the sake of embodying my description of the observed facts ; as I can scarcely doubt that the real cause is some peculiarity of the instrument.

The discordance between the results of Direct Observations and Reflexion Observations still exists. The conviction is rising in my mind that this discordance is entirely due to some peculiarity in the observations of stars by reflexion, and that our long-employed correction for $R - D$ ought to be removed from our computed results, at least since the year 1850. So long as the Mural Circle was used, there appeared to be no sufficient reason for doubting that the discordance was due to flexure ; but since we have had the means (in the collimators of the Transit-Circle) of investigating the flexure of the telescope in its horizontal position, the possibility of founding an expla-

nation of the phenomenon on flexure, in its ordinary sense, is destroyed. It is not inconceivable (as was long since suggested to me by M. Faye) that the atmosphere in the neighbourhood of the observing pit is in a state which may derange the direction of the rays of light, and that the atmosphere through which the direct view is taken may be free from this peculiarity. The removal of this correction would entail a revision of our latitude and of our Tables of Refraction.

The colatitude, from the corrected observations of Polaris in 1860, is about $38^{\circ}.31'.21''.80$. I scarcely doubt that this is erroneously affected by the correction to which I have alluded; and that its value ought to be $38^{\circ}.31'.22''.01$, the value which is given by the observations uncorrected.

I propose to form a 7-years' Catalogue from the observations of the seven years terminating with 1860; but no steps have yet been taken to combine the observations.

Great confidence is given to the results of the Reflex-Zenith-Tube (not greater, however, than is due to the principles of its construction) by an investigation made by Mr. Main and communicated to the Royal Astronomical Society, on the Coefficient of Aberration deduced from the observations made with the Reflex-Zenith-Tube. The Visitors will perhaps remember that the observations with the ancient Zenith-Tube appeared, on a similar investigation, to be nearly worthless.

The Zero of Azimuth of the Altazimuth is still liable to changes, while the reading for its Collimator remains nearly invariable.

VIII. Printing of Astronomical Observations. — The volume for 1859 is not yet absolutely completed, although the whole of the tabular part relating to 1859 has long been finished. But there remained, requiring my personal attention,—the tabular exhibition of the comparison of Burckhardt's and Hansen's Lunar Tables,—the discussion and preparation for press of the Reduction of the Magnetic Observations from 1848 to 1857,—and the writing of the Introduction (which I could not devolve upon a First Assistant new to the duties of his office). The preparation of these, occurring when I was distracted with extra-observatorial work for the Government, and with the correspondence on the Eclipse, have necessarily caused much delay. The whole manuscript, however, is now in the Printers' hands. In the mean time, the printing for 1860 has been begun, and is in the following state:—The Transits with the Transit-Circle are printed to February 12 (2 sheets); the Zenith Distances with the Transit-Circle to February 9 (2 sheets); the Azimuths with the Altazimuth to February 14 (1 sheet). The printing, as usual at this season, advances slowly. The number of copies, as for late years, is 350 for the complete volume, and 150 additional separate copies of the last Section, containing Results.

In October last, I issued the Circular Letter to which I alluded in the last Report, requesting the principal Observatories, Scientific Institutions, and Libraries, to send me a list of their deficiencies in Greenwich Publications. To this Circular I have had about 80 answers. We are now engaged in sending out the volumes required, as far as we are able. When this distribution shall be finished, I shall perhaps be in a position to lay before the Board a statement as to the probable extent of impression which may be required for the future.

From Dr. Jeune, Vice-Chancellor of the University of Oxford, I learned that the entire Remainder of the Impression of Bradley's Observations (about 30 copies) had been sold to Messrs. Parker, booksellers. Having ascertained that this firm was willing to dispose of them at a reasonable price, and being furnished by the Admiralty with the requisite funds, I purchased the whole. These enter into the Distribution to which I have adverted.

IX. Magnetical and Meteorological Instruments.—The three magnetometers, which carry collimator or plane mirror for eye-observations and concave mirror for photographic registration, are in good order. In particular, the vertical-force magnetometer, since the grinding of its knife-edges by Mr. Simms, continues to give the greatest satisfaction. Vertical perturbations are exhibited now, which were not shown formerly; the dislocation of curves has almost entirely ceased, and the elements of adjustment are nearly constant.

The instrument which has been used for determination of horizontal force in absolute measure is of rather rough construction, but has been used with care; and I was much struck (on a late examination) with the orderly progression of its results from year to year. But I have thought it better now to introduce an instrument of the most approved form; and a Kew unifilar magnet, adapted to absolute measure, constructed under the kind direction of General Sabine, will shortly be mounted at the Royal Observatory.

The dipping-needles give the same discordance as formerly; one of the needles (the same as in the last year) giving a dip eight minutes greater than the others.

The stationary dipping-needle-apparatus, to which I have formerly alluded, after some delay, has been constructed by Mr. Simms; but it is doubtful whether it will be adjusted in place for the view of the Visitors. Its peculiarities are; that each point of the needle is viewed by a microscope perpendicular to its plane of vibration (as in those made in late years under General Sabine's direction); that the eyepiece is so arranged that the needle can be observed while in a state of vibration; and that the revolving frame will carry its own gaslight, so that observations can be made at any hours.

I alluded in the last Report to the possible establishment of galvanic wires which would record, perhaps upon the same photographic sheet which bears the declination and horizontal force, the magnitude and direction of earth-currents in two directions. I conceive that this may be justly regarded as an important physical experiment ; and I hope to be able shortly to lay before the Visitors some details of plan, and to ask their opinion in a more precise form.

The Meteorological instruments operating by eye-observation and photographic registration for atmospheric pressure, temperature (of the air, the ground, and the Thames), moisture, electricity, and wind, are all in good order. After several trials, we have now a Robinson's anemometer established as a part of our permanent apparatus. In order to verify its scale, we mounted it on a long wooden bar rotating in azimuth, and carried it round through a certain number of rotations, sometimes in one direction, sometimes in the opposite. These experiments fully support the accuracy of the inventor's theory. The daily comparison with the results of Whewell's anemometer shews that the factor which was used in past years for interpretation of the readings of Whewell's anemometer is much too small ; that in ordinary strong winds it ought to be doubled, and in light winds ought to be increased much more, in order to deduce the measure of movement of the air ; but the ratio is so systematic that nearly every past result can be made available.

X. Magnetical and Meteorological Observations.—All the instruments are fully employed. With proper zeros determined by eye-observations, the various self-registering instruments are always at work. For the magnet-thermometers, several readings are taken every day, and additional readings once every week. Magnetic dip is observed twice or thrice in a week, and absolute measure of horizontal magnetic force about once a month. Barometer and Thermometers of all kinds are read at least once a day, but the barometer and the wet-bulb and dry-bulb thermometers are incessantly registered by the photographic operations.

Observations, partially reduced, are now sent every day to M. Le Verrier's Bulletin. I cannot speak too highly of the liberality of the Telegraph Companies whose assistance was required for the transmission of the observations, who have modified their own office-arrangements, and have gratuitously given the use of their apparatus and the time of their officers, in what was understood to be the cause of science.

XI. Reduction of Magnetical and Meteorological Observations.—For the eye-observations of the three magnetometers, equivalents are prepared for declination, and equivalents and temperature-corrections for horizontal force, to the present time ; and equivalents and temperature-corrections for vertical force, to the end of 1860.

The Theodolite-observations, which give the point of astronomical meridian on the circle of magnetic declination, are reduced to 1861, February 6. The Deflexion-observations, for absolute measure of horizontal force, are reduced to the end of 1860. The Dip-observations, to the present time.

For the photographic records, time-scales and new base-lines are laid down on the declination and horizontal-force-sheets to the end of 1860, and time-scales only on the vertical-force-sheets to the same epoch. The ordinates for declination and horizontal force are read out to 1860, June 30 ; those for the vertical force are not begun for 1860.

The mean magnetic declination for 1860 is about $21^{\circ}. 14'. 20''$ (9' less than that for 1859). The mean dip is about $68^{\circ}. 29'$ (4' greater than in 1859). The results from the different needles vary from $68^{\circ}. 26'$ to $68^{\circ}. 35'$.

The vane of Osler's anemometer turned on the whole, in the year 1860, rather more than twice in the retrograde direction, or N, W, S, E, N. This unusual circumstance having turned our attention to the similar records of past years, we have found the following remarkable series. The sign + denotes that the vane turned in the direction N, E, S, W, N ; the sign - denotes the opposite rotation.

In the year 1841, the vane made + 5.4 revolutions.

1842	+ 13.1
1843	+ 20.7
1844	+ 21.7
1845 ($10\frac{1}{2}$ months)	+ 8.9
1846	+ 1.8
1847	+ 11.0
1848	+ 12.1
1849	+ 23.3
1850	+ 15.9
1851	+ 19.1
1852	+ 8.8
1853	- 1.9
1854	+ 6.8
1855	+ 10.8
1856	+ 16.1
1857	+ 14.7
1858	+ 24.1
1859	+ 14.0
1860	- 2.1

There seems to be in these numbers a septennial period. If any such cycle should ever be confirmed (of which, however, I have very little confidence), I should suggest as possible cause, no cycle of actions of external bodies, but a periodical throb of temperature from the interior of the earth. It seems likely that a very small change of superficial temperature might sufficiently influence the currents of air to produce the effect which has been observed.

I have not yet ascertained whether any other broad meteorological phænomenon recurs in a period of the same length.

The Reductions of Magnetic Observations from 1848 to 1857, (undisturbed days,) have lately passed under my eye. They are at present (as I stated in my last Report) referred only to Months and to Solar Hours, and to Lunations and Lunar Hours; each year being treated separately. The results appear to me sufficiently remarkable to merit a short statement here.

First, for the Solar Inequalities of Declination and Horizontal Force. There is a great diminution of solar action (more than one-half, in Declination) from 1848 to 1857. Abstracting this general coefficient;—the magnitudes in the Summer months are much greater than those in the Winter months, and the law of the resultant of combination of the Declination-Inequality and Horizontal-Force-Inequality is a very peculiar one. On examining it carefully, I am led to the conclusion, that the Solar Diurnal Inequality is produced by the radiation of the Sun upon the sea, as distinguished from the land; and that the radiation upon the North Atlantic is the principal cause of Solar Inequality at Greenwich.

Secondly, for the Lunar Inequalities. There appears to be a distinct semi-luno-diurnal magnetic tide, in the direction 57° west of astronomical north, or in the direction of Hudson's Bay nearly. Whether this is to be explained by a tidal action upon the magnetic oxygen of the atmosphere, or by an induced magnetism in the Moon with axis on the whole parallel to the Earth's great magnetic axis, (either of which would produce a semi-luno-diurnal law,) or by any other assignable cause, I cannot certainly say.

It is very difficult to undertake at once to group all the observations in reference to all the laws, which either may be obviously given by the position of the Moon, or may be more obscurely indicated by magnetic theory. In regard to the former, it is probable that differences of the luno-diurnal inequality will be found, depending on the Moon's declination, for which will be required a grouping different from any yet used. In regard to the latter, the groupings which I have mentioned do not recognize the magnetic action of the Sun upon the Moon; if the Moon be a magnet whose pole

always points to the Sun, there will be inequalities depending upon an angle which differs only by periodic terms from "Moon's hour-angle west of meridian — Moon's longitude east of Sun," whose period is between 25 and 26 solar hours. It is probable, therefore, that further discussion of these observations will be necessary.

The inequalities of vertical force appear to follow simpler laws, different from those of the horizontal forces.

XII. Printing of Magnetical and Meteorological Observations.—The printing of the ordinary observations for 1859 has been long finished. The form is the same as in late years. The magnetometer results are given for every salient point of the photographic curves; for other magnetic observations, individual results are given. The meteorological results are given, partly in daily maxima and minima, partly in daily means, partly in monthly abstracts. It is impossible to print the whole of our results without an enormous waste of labour and money; but any separate classes of results which individuals may desire are readily furnished in manuscript.

The printing of the Reductions of Observations from 1848 to 1857 is begun.

The number of copies is 600, of which 350 are bound with the Astronomical volume.

Two copies of the Photographic Records of Declination, Horizontal Force, and Vertical Force, have been taken to 1859, December 31; wanting only Vertical Force for October, November, and December, 1858.

No part of the Magnetical or Meteorological Observations of 1860 is yet printed; but a great part of the manuscript is ready for Press.

XIII. Chronometers, Communications of Time, Longitudes, &c.—The demand for Chronometers for the service of the Royal Navy has continued, and in consequence we have been very much pressed with the business of all kinds attending their trials and the usual care of Navy Chronometers. The number of chronometers on hand has been as high as 220: it is now 120.

The chronometers are compared with the Motor Clock, which is every day adjusted to exact Mean Solar Time.

By use of the Chronometer Oven, to which I have formerly alluded, we have been able to give great attention to the compensation. I have reason to think that we are

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producing a most beneficial effect on the manufacture and adjustment of chronometers in general.

The decision on the merits of Chronometers tried for purchase by the Government, and the superintendence of repairs of Government Chronometers, still rest with me.

Since our open-air galvanic wires have been established, our communications with London and Deal have been perfect. The ball at Deal is regularly dropped by our current (as are also other balls, for which I am not responsible officially), and the regulation of the Post-Office Clocks is complete. Time signals are sent daily to almost every part of England.

In galvanic arrangements, I constantly bear in mind the probable exhibition of Daily Time-Signals at Portsmouth and Devonport, and of Hourly Time-Signals at the Start Point. These practical measures have so close a connexion with that subject for whose promotion the Observatory was mainly established, namely Nautical Astronomy, that I may perhaps with propriety ask an expression of the Visitors' opinion on their proposal.

No steps have been taken to determine the galvanic longitude of Lowestoft or of Valentia; the incessant employment of our whole personal force having rendered it impracticable. But the authority of the Treasury has been received, and active steps have been taken by Sir Henry James, for repeating the junction between England and Belgium; and when this shall be done, the British arcs to which I allude cannot be much longer delayed.

XIV. Personal Establishment.—In numbers, the personal establishment remains the same as at the last meeting of the Board; but one important individual change has been made. Mr. Main, who had for twenty-five years held the office of First Assistant, and to whose zeal and orderly assiduity and honourable conduct on every occasion the position of the Observatory is in no small degree due, accepted in the last summer the office of Radcliffe Observer at Oxford; and on September 30 resigned his occupation at the Royal Observatory. His successor is Mr. Edward James Stone, Fellow of Queen's College, Cambridge; and I have every reason to believe that Mr. Stone will well support the scientific honour of the Observatory, and its reputation for order and accuracy in the conduct of business. As First Assistant, Mr. Stone is intrusted with the fullest confidence from me and the fullest superintendence of the Observatory in general: observing and computing occasionally. Mr. Dunkin has special charge of the Altazimuth; Mr. Ellis and Mr. Criswick of time-operations and galvanism; and Mr. Carpenter of the South-East Equatoreal; but all occasionally take the meridional and altazimuthal observations. Mr. Lynn directs the supernumerary computers, and

generally superintends those parts of computations and printing which do not require the attention of principal Assistants. They are aided by seven supernumeraries.

The Magnetical and Meteorological Department is under the superintendence of Mr. Glaisher, Second Assistant of the Observatory; with whom are associated Mr. Downs, Magnetic Assistant, and three supernumeraries.

The examination of candidates for appointment or promotion is maintained.

XV. Extraneous Works.—The computations to which I alluded in the last Report, for determining from Proper Motions of Stars the Linear Motion of the Solar System, have been continued from time to time. But we have been much pressed with occupations which admitted no delay, and the amount of labour attending the calculation of complicated coefficients for 1,167 stars is great; and from these causes the work has not yet reached its termination. The whole of the coefficients, 16 in number, for each star, are, however, computed in duplicate; and the duplicate computations are compared for 5 of the coefficients.

Most of the Members of the Board are aware that, on my suggestion, the Admiralty appropriated the magnificent steam-ship “Himalaya” for the conveyance to Spain of an expedition composed partly of British amateur astronomers, partly of foreigners, for observation of the Total Solar Eclipse of 1860, June 18; and that the details of the organization rested in great measure on me. The enterprise was, on the whole, very successful; and when leisure shall permit us to give to the world the collation of the observations, I think it will be found that much has been gained by this expedition. It is not my intention here, however, to detail to the Board the liberality with which the Admiralty forwarded the undertaking and promoted the personal comfort of every one engaged in it; nor to point out the places and results of the observations of different observers. But I have to explain that the amount of correspondence to which it gave rise, and the amount of labour expended in arranging and to a certain degree comparing accounts, were very considerable, and that the Eclipse expedition on the whole has been felt as a load on the Observatory.

The demand on my time, for aid to the Government, in reference to the Act for Measures for the Sale of Gas, and to the Royal Commission on Lighthouses, has still been felt, though not so heavily as before.

XVI. General Remarks.—It will be remarked that, in spite of some diminution in the number of meridional and altazimuthal observations, no great advance has been

made in the state of our reductions. Several of the circumstances which have been mentioned (the change of First Assistant,—the working up of the Magnetical Reductions after the regular staff for those calculations had been paid off,— the preparation for Press and passing through Press of the largest volume that we have issued,— the Eclipse) will in great measure explain this. There is however another, to which I last year alluded by anticipation, the withdrawal of one principal Assistant for the service of the South-East Equatoreal. The experience, to this time, of the degree of derangement which it causes in our former or meridional system, confirms me in the opinion that no addition is at present required to the staff of Permanent Assistants. But it shows also that we may be compelled to ask for greater assistance in the persons of Supernumerary Computers; in which shape an increase of our establishment, when it may seem to be required, is much less objectionable.

Royal Observatory, Greenwich.
1861, *May* 14.

G. B. AIRY.