REPORT

OF THE

ASTRONOMER ROYAL

TO THE

BOARD OF VISITORS.

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Read at the Annual Visitation of the Royal Observatory, Greenwich, 1845, *June* 7.

In pursuance of the custom which I have followed since I have had the honour of meeting the Board of Visitors in the character of Superintendant of the Royal Observatory, I beg leave to offer the following Report on the present state of the Observatory, and on the history of the Observatory since the Visitation of 1844.

1. Grounds and Buildings.—At the last Visitation, the walls, floors, and pier for the tower erected on the site of the Advanced Building were completed, but the flat topped dome was not constructed. This was completed shortly after that time. The dome turns upon common balls, moving freely between concave channels: a construction which allows of easier motion and is less likely to interruption by accident than any other. The sides and top of the dome are double, the inner lining being of wood and the outer casing of zinc. The space between them is about 6 inches wide, and throughout this space there are no fillets or continuous bars of wood, but merely isolated blocks, to which the zinc casing is attached. The zinc top is not connected with the zinc sides, and the zinc sides are not connected with the lower curb of the dome, a space of about 4 inches being left in each of these places: so that there is ample facility for the circulation of air throughout the space between the inner lining and the outside casing. This construction appears to answer the purpose for which it was intended exceedingly well. The temperature seems to be uniform in all parts of the room, and appears to correspond nearly with that of the free air, even when the sun is scorching hot. The doubleness of walls and roof makes it necessary to use, for the shutters, instead of hinge motion, which is usually best in practice, a motion of sliding laterally. This is made to work well, by attaching a rack to each end of the shutter and causing these racks to work in pinions fixed at opposite ends of the same spindle. This machinery is concealed in the space between the inner lining and the outer casing. The same principle is adopted for the

wall shutter and for the roof shutter. The whole construction appears to answer well. The stationary parts of the mounting for the instrument to be placed in this dome have been long fixed, but the instrument itself is not yet mounted.

The small Observatory, upon the Magnetic Ground, intended for Mr. Struve's use, which was already erected at the last Visitation, and which was employed for its original purpose during the last summer, has since that time been unoccupied. I propose, however, to retain the building in its present state until some strong reason for its removal shall present itself, as it is sufficiently probable that occasions may again arise requiring the use of a portable transit instrument.

No important change has been made in the grounds and buildings, and no repairs requiring mention, except that the Octagon Room and some other parts have been painted, an operation which implies a great number of trifling repairs.

In the last winter I received authority from the Board of Admiralty to prepare a proper map of the Observatory and grounds, with a notice that their Lordships would provide for its being engraved. The measures of all kinds have been made, and most of them have been laid down, but the ill health of the person employed as draughtsman has delayed the completion.

2. Moveable Property in General.—The whole of the moveable property entered in the Observatory catalogues is now, I believe, at home and in good order, with the exception only of a Journeyman Clock, which has not been used for at least ten years, and which I have lent to the Kew Observatory, to be used in conjunction with the electric apparatus mounted there.

3. Manuscripts.—The manuscripts of Bradley's Observations, to which allusion has been made in the two last Annual Reports, are now completely copied, excepting only some rough computations upon loose papers of which it is not possible now to discover the meaning. These manuscripts would have been returned some time ago to the authorities of the University of Oxford from whom they were borrowed, but for the ill health of the person who has usually been employed as my accredited messenger on this business.

I have lately revised with much care, and have prepared for binding, a large collection of papers which have accumulated since the commencement of my own residence. It is, however, scarcely possible to pronounce that any one set is ready until I have gone through the whole of the papers of every department; and this consideration, in addition to the circumstance that it is necessary for me to examine every paper myself, has delayed the employment of the binder.

The manuscripts of the Board of Longitude have been put in order by Mr. Main; and I propose, when opportunity offers, to take measures for binding them also.

4. Library.—The usual attention has been given to maintaining the Library in an efficient state, in reference particularly to the subjects of Astronomy and Magnetism.

The principal purchases, however, made in the last year, have been from the libraries of my lamented friends Mr. Baily and Professor Henderson. The books are classified and catalogued, and great attention is given to the keeping of them in order.

5. Instruments.—The Transit, the Circles, the Equatoreals, and the Zenith Tube (comprising all the large Astronomical instruments), are in perfectly good order.

Of the Circles, Troughton's alone has been used, and in the use of this a small modification has been introduced. The fixed wire is removed, and all observations are now made on the moveable micrometer-wire. In many cases, for facility of reduction, the micrometer-wire is used at a certain standard reading. The observations are thus, in certain circumstances, more accurate than they were formerly (the eye being frequently distressed by the nearness of two wires), and the reductions are somewhat easier, as there is no need for using the reading of one wire at coincidence with the other. An eye-piece, by which the wires may be seen by reflexion, has been attached to this circle, and it appears likely to be useful in weather when stars cannot be seen by reflexion. The difference of results from direct-observations and from reflexion-observations appears now to be insensible.

The East Equatoreal (to which, since the erection of the New South Dome, it is necessary to give the distinctive name of North-East Equatoreal) and the South Equatoreal (now called the South-East Equatoreal) are in frequent use. The West Equatoreal, however, has not been used for several years; and if any necessity for the use of such an instrument, or of any parts of its mounting, should occur in any of the Government establishments, it might be considered as perfectly disposable, without injury to the powers of the Royal Observatory.

The Altitude and Azimuth Instrument is not yet out of the engineer's hands, but I am assured that its principal parts will be transferred to Mr. Simms in a few days. It is almost unnecessary to remark, that the work was, in several respects, different in some degree from that to which engineers are accustomed, and this has caused greater delay in its construction than I had anticipated.

The detached telescopes, and other small apparatus, are in good order. The ancient instruments are in the same state as for several years past.

The Declination Magnetometer and its theodolite, the Horizontal Force Magnetometer, the Vertical Force Magnetometer, the Dipping Needle, and the apparatus intended for the observation of large deflexions produced by one magnet in the position of another, in Lamont's method, for the absolute measure of terrestrial magnetism, or for the effects of heat, &c., on the power of magnets (comprising the principal magnetical instruments), appear to be in good order.

The Electric Apparatus is in the same state. It exhibits well the slightest disturbance of atmospheric electricity, but does not well display the diurnal changes in serene weather.

I am still of opinion that this failure is due mainly to the circumstances of locality. If an efficient self-registering apparatus could be arranged, preserving its records in a permanent form, I should propose to mount an electrical apparatus, nearly similar to that of the Kew Observatory, on the top of the Octagon-room.

The Galvanometer and the Induction Ball have been nearly useless.

The Osler's Anemometer and Whewell's Anemometer are perfectly effective.

The Barometer, the various Thermometers (including those for the temperature of the Thames), and the Actinometer, are all in good order. No alteration has been made in the instruments of this class since the last Visitation.

6. Observations.—The following have been the principal subjects of observation with the Astronomical Instruments: — First, with the Meridional Instruments. The Stars of the Nautical Almanac List are observed, the usual rule being followed of making twenty observations on each, both in right ascension and in declination, in any three consecutive years. The stars selected for Moon-culminators in the Nautical Almanac are observed, as also stars whose occultations by the Moon have been observed; stars observed in the operations of the Ordnance Survey; stars employed for the longitudes of Kingstown and Valentia; stars of comparison with Mauvais' Comets, Galle's Comets, Faye's, De Vico's, D'Arrest's, and other comets; some low stars have also been observed for refraction: and, lately, observations have been commenced for completing the deficient element (right ascension or north polar distance, as the case may be) of the stars collected in the Great Catalogue of 1439 Stars, as well as of the stars which appear in the partial catalogues of 1842 and 1843 (which have been prepared subsequently to the publication of the Great Catalogue). The Sun, Moon, and Planets, have been observed at every practicable opportunity, through all hours of the night. The general rule of the Observatory is, that no observations are taken on Sundays; and the only departure from this rule is for the observation of the Moon, and of stars used as Moon-culminators, or required for instrumental or clock-errors in the reduction of the observations of the Moon.

The Equatoreals have been used for occultations of stars, for eclipses, &c., of Jupiter's satellites, for measuring the Moon's diameter, and for observations of Mauvais' Second Comet (1st and 2nd appearances), De Vico's First Comet, D'Arrest's Comet, Wilmot's Comet, De Vico's Second Comet, the eclipse of the Sun (very imperfectly), and the transit of Mercury (very imperfectly).

The double-image Micrometer has been employed in measures of the planet's diameters and in measures of ϵ Bootis and σ Coronæ.

The Zenith-tube has been used for the zenith distance of γ Draconis as often as possible.

In the use of the Magnetical and Meteorological Instruments the same system has been adopted as in the three preceding years. The declination, horizontal-force, and

vertical-force magnetometers, the barometer, the common dry thermometer, and the wet-bulb thermometer, are observed at every two hours, day and night, except in the interval between Saturday midnight and Sunday midnight; the dew-point four times every day; the dip four times every week (on the morning and afternoon of each of two days). On one term-day of each month magnetic observations are made at every five minutes, and on one day of each month the barometer is observed at every hour. Within a short time I have made the deflexion observations (necessary for the absolute estimation of terrestrial magnetic force) in a more satisfactory way than heretofore; and these observations are now repeated every fortnight, until full confidence shall be acquired in the method and its results. Anemometer-registers are read once a day (the sheets of Osler's Anemometer being regularly filed and bound); rain-gauges as often as their construction requires. The thermometers suspended from the Dreadnought hospital ship, in the Thames, are read every day, by Lieut. Sanders, R.N., Superintendant of that establishment. Actinometer observations, electrical observations, and extraordinary observations of all kinds, are made when circumstances require them, or are unusually favourable for them.

7. Reduction of Observations.—The state of the Astronomical Reductions is as follows:—For 1844, everything which relates to the stars is finished, the means of all the mean places for 1844, Jan. 1, having been taken, and the resulting catalogue for 1844 (copy for press) being in the copier's hands. Every individual planetary observation is reduced, but their errors are not yet grouped for the exhibition of normal errors in longitude and ecliptic polar distance. The observations of Mauvais' Second Comet are reduced, as far as is possible before adopting places for the stars of comparison; those of the other comets nearly as far. The computation of occultations is not commenced. For 1845, the completions for deficient wires of the transits, and the reductions of micrometer values, &c., for the circle observations, are kept up to the day of observation; the instrumental errors of the transit are applied, and the clock-errors made out and applied to all observations to Jan. 14; the zenith points of the circle are computed to April 8, but none are yet applied. The groups for application of errors, &c., are for the most part marked off, so that all that remains to be done is the work of mere computers. The Zenith-tube reductions are completed.

In the Magnetical and Meteorological reductions, everything is finished for 1843, except a small part of the Meteorological Abstracts (requiring, perhaps, one week's work). For 1844 the following is nearly the state of reductions:—The conversion of the first readings of the instrument is effected, wanting only some addition of numbers, to Sep. 22, and some steps of the conversion are finished to a later time. Term observations are reduced to June 20. Extraordinary observations to about the same time, but in different stages to different times. Observations for the Astronomical meridian of the theodolite, to October 17.

The observations of Dip, and most of the observations of the Meteorological instruments, are reduced to the present time.

In both departments our Reductions have in some measure fallen behind the state in which I reported them at the last Visitation, but more especially those of the Magnetic and Meteorological department. I believe the causes of this to be, that the usual assistance of extraordinary computers has not been given to this department (a part of our strength, in spite of the appropriation of special computers, having been given to the computations connected with the longitude of Valentia, and one assistant having been actually sent out for two months to make observations in that enterprise), and that a considerable loss of time is produced by the contribution of our weekly report on Meteorology to the Registrar-General's Report.

8. Printing.—The tabular part of the Astronomical volume for 1843 has been finished some time since, and the volume would have been published several weeks ago, but that, from my inadvertence, the manuscript of the Introduction was not prepared early enough. The printing of the Introduction is now nearly finished. Of the volume of 1844, seven sheets are already printed.

The number of copies of the volume for 1843 struck off by the printers (as for some years past) is 350. The impression in the last year has been distributed as follows:— To the Royal Society are sent 100 copies; to the Royal Astronomical Society, 140; to Mr. Murray, the Admiralty agent, 60; and 50 are retained at the Royal Observatory.

Of the Magnetical and Meteorological volume for 1843, thirty-four sheets are printed. They include the whole of the Magnetic observations, and nearly all the ordinary Meteorological observations. The Meteorological Term-day and Extraordinary Observations, the Introduction, and the Abstracts, are not yet begun.

The number of copies struck off is 350. The impressions of the two preceding volumes have been distributed as follows:— To the Royal Society, 150 copies; to the Royal Astronomical Society, 140; to Mr. Murray, 20; and 40 are retained at the Royal Observatory.

In regard to the state of Printing, it will appear that an advance has been made in the Astronomical department, and nearly an equal retardation has taken place in the Magnetical and Meteorological department.

In regard to the number of copies printed, it would appear that the wants of science, as manifested by the demands made on the Royal Society, require a larger impression of the Magnetical and Meteorological Observations. It will perhaps be matter for the consideration of the Board of Visitors, whether the impression of the next volume should be increased, or whether, remarking that in any case the observations are not likely to be kept up to the same extent for many years, the impression should be limited to the same number as in the three first volumes. It may also be matter for their consideration, whether any different rule should be adopted for the distribution of the printed copies.

9. Chronometers.—The number of Chronometers at the Observatory, whose rates have been regularly taken during the last year, is about the average, the number being sometimes above one hundred, but more frequently below it. These Chronometers are compared every day by two assistants, at a small interval of time, and their rates are reported every week to the Hydrographer. Special comparisons are made on the occasion of issues of Chronometers to ships. The superintendance of the repairs of all Government Chronometers is managed solely by myself and the First Assistant.

The Signal Ball is dropped precisely at one o'clock on every day, Sundays as well as week days.

These operations, with all the comparisons of clocks, changes of sidereal time to mean solar time, and other calculations which they imply, occupy a very great part of the strength of our establishment.

An Abstract of the Rates of Chronometers on Trial for Purchase is printed, and is attached to the volume of Astronomical Observations. The Abstract of the Rates found in the trial of 1844 is attached to the Observations of 1843.

The Digest of the Estimates of Expense of Repairs to Government Chronometers is kept up in manuscript, but is not printed. It is nearly complete to the present time.

10. Personal Establishment.—As at the two last Visitations, the personal establishment regularly attached to the Observatory in subordination to myself consists of nine Assistants. Five of these (including the First Assistant) are attached to the Astronomical Department, and four to the Magnetical and Meteorological Department. The Assistants in one department are very rarely charged with observations or calculations relating to the other department (the First Assistant excepted, who occasionally takes an active part in the Magnetic, &c., observations and computations). The Assistants of the Astronomical Department are charged with all work relating to the Chronometers and Signal Ball, and with the care of Stationary Stores; those of the Magnetical Department with the care of the Manuscripts and Library. All work not included under these heads, and not forming part of the systematic observations and calculations, is managed by myself or by the First Assistant.

In addition to the regular establishment of Assistants, I am authorised by the Treasury to employ additional computers, under such regulations as I may think fit, to the amount of £120 per annum.

The establishment in this form is probably as efficient as can possibly be secured with the same expense. It may be considered as fairly adequate to our recognised wants: although when the various extraneous work incidental to the Observatory is taken into account, it is barely sufficient.

In regard to the Personal Establishment, there are two grave questions which will probably claim the attention of the Board at the present meeting.

The first relates to the continuance of the Magnetic and Meteorological establishment. The Treasury grant for this establishment expires (with the grants for the support of various Colonial observatories) at the end of the present year: and it becomes a question for the Board whether they should decide on recommending a continuance of the establishment in its present extent, or a continuance in a more limited extent, or a total suppression of the establishment. A Congress of distinguished Foreigners and of Englishmen, interested in the subjects of Magnetism and Meteorology, is to assemble shortly at Cambridge under the Presidency of Sir John Herschel, for the purpose of discussing the general question of the continuance of the European and Colonial Observatories; and it may be a matter of consideration for this Board whether they will think fit to express an opinion at the present time, which opinion must necessarily influence, in a material degree, the decisions of the Cambridge Congress; or whether they will wait for the expression of the opinion of the Congress before taking any active steps themselves.

The second question relates to the use of the Altitude and Azimuth Instrument, which will probably be mounted before the Board assembles again at one of its ordinary meetings. The opinion which I expressed to the Board, on the occasion of first submitting to them the proposal for procuring this instrument, implies, as its practical conclusion, that such an instrument if mounted must be used for the purpose indicated by me (the more frequent observation of the Moon) *at any cost*. In the address to the Board, to which I have alluded, I intimated my expectation that the proper use of this instrument would, in some shape, employ the whole time of one Assistant. And the question which I now submit for the consideration of the Board is, at what cost shall this instrument be used? at a cost of other observations, or at a cost of money? Do the members of the Board judge it best that the present system of observations should be so far contracted as to enable me to withdraw from it one active assistant? or are they prepared to recommend the addition of another assistant to our permanent establishment?

11. Reduction of Ancient Observations.—The whole of the Reductions of the Greenwich Planetary Observations have been printed several weeks; and before this time I should have been able to circulate copies of them, but that, in dismissing the book, it occurred to me that I should be acting up to the spirit of instructions formerly received from the Board, by attaching to the volume specimens of all the printed skeleton forms used in the computations. It was necessary for this purpose to compose all the forms anew: and this occupies a considerable time.

The Lunar Reductions are in fact completed in all the parts which can be considered really useful; and the First Section of the Reductions is not yet sent to press only for the following reason:—Among the Observations of the Moon, there is a great number in which the determination of Right Ascensions is perfectly good, while that of North

Polar Distances is worthless. In order to extract from these all their possible utility, it is necessary to correct the transit of the limb for the semidiameter in right ascension; and for this purpose the semidiameter and the polar distance must be computed from the tables. This computation had not been made for these special instances, but it is now commenced, and the printing will not wait much longer for this cause.

The groups of observations having respect to the varying magnitudes of the different inequalities whose coefficients are to be corrected, have been formed by Mr. Breen, the superintendant of this work; and the addition of the numbers in the individual small groups, and the collection of the numerous small groups to form a few large groups, are begun. I shall be happy to exhibit to the Board the mechanical contrivance which we have found necessary for effecting the separate addition of these interfering groups with good security against errors.

12. General Remarks.—The Royal Observatory, and the persons connected with it, are not, in my opinion, rendering their best service to the country by confining themselves to the observations made in one building upon one system, although, in any case, these observations ought to have by far the most important part of their energies; and any other work to which they may give their remaining strength ought to be strictly related to their primary object. It will be found, I trust, that these principles have been kept in view in the deviations from our ordinary system, which I am about to mention. Some small interruption (bearing no comparison with the advantage which we derived from it) was caused by Mr. Struve's operations in the summer of 1844, for the determination of the longitude of Altona, by the transmission of chronometers. This determination was completed in the most satisfactory manner. The chronometers, forty-two in number, crossed the German Sea sixteen times. The transit observers were twice interchanged, in order to eliminate not only their personal equation, but also the gradual change of personal equation. The definitive result, as I understand from Mr. Struve, scarcely differs from that which had been obtained several years before by far less adequate means, a coincidence which of course is accidental as regards the older result. An expedition, which (with the assistance of Mr. Sheepshanks) I had planned for the determination of the longitude of Valentia, in Ireland, and for the incidental determination of the longitude of Liverpool and of Kingstown (by Dublin), was executed in the last summer, by the assistance of the Birmingham and Grand Junction Railway Companies, the Mail Packet Superintendant, and the Proprietors of the Contract Mail Packets between Liverpool and Kingstown, the Inspector of Mail Coaches in Ireland, the Inspector of Coast Guard, the Master-General of the Ordnance, and especially Colonel Colby, and the able and zealous officer (Lieutenant Gossett, R.E.) who was stationed at Valentia, but above all by the unwearied personal assistance of Mr. Sheepshanks. Upon the failure of Mr. Sheepshanks' health, from extreme fatigue and exposure,

I sent Mr. Hind (then one of the Assistants on the Magnetic establishment) to Kingstown to take his place. Thirty pocket chronometers traversed the line between Greenwich and Kingstown about twenty-two times, and that between Kingstown and Valentia twenty times. The results are most satisfactory as regards the weight which they deserve, and are interesting as compared with the deductions from the geodetic survey which connects all the points. The chronometrical longitudes of Liverpool Observatory, Kingstown Station, and Valentia Station, are $12^m.0^s{\cdot}05$, $24^m.31^s{\cdot}17$, $41^m.23^s{\cdot}25$; the geodetic longitudes, computed from elements which I published long ago, in the Encyclopædia Metropolitana, are $12^m.0^s{\cdot}34$, $24^m.31^s{\cdot}47$, $41^m.23^s{\cdot}06$. It appears from this that the elements to which I have alluded represent the form of the earth here as nearly as is possible, and at the same time that there is a center of disturbance somewhere in the eastern part of Ireland: which, geologically, seems sufficiently probable. It is certain that there is no error of azimuths which can account for the small discrepancy at the two intermediate stations, because the calculated and the observed latitude of Valentia agree accurately. On the whole, I think it probable that this is the best arc of parallel that has ever been measured. The observations of Tides on the Irish coast, to which I have alluded in former Reports, are completely reduced, and the reduction leads to some conclusions of great interest; the account of these is now printed in the "Philosophical Transactions," but is not yet published. I have only to add, as regards the direction of my Assistants, that the devotion of some of their time and labour to the preparation of the Meteorological Report attached to the Weekly Report of the Registrar-General is, in my opinion, justified by the bearing of the Meteorological facts upon the Medical facts, and by the attention which I understand that Report to have excited: and that, as regards myself, I think that the business of the Tidal Harbour Commission (of which I have become an official member) and of other matters of similar character, are well suited to the position which an Astronomer Royal ought to be able to maintain.

G. B. AIRY.

Royal Observatory, Greenwich.
1845, *June* 5.