REPORT OF THE ASTRONOMER ROYAL

TO THE

BOARD OF VISITORS,

Read at the Annual Visitation of the Royal Observatory, Greenwich, June 3, 1843.

I BEG leave to offer to the Board of Visitors, at this their Annual Meeting at the Royal Observatory, my Report on the general state of the Observatory, arranged in nearly the same form as those which I have had the honour of offering to them in preceding years.

1. Grounds and Buildings.—Under this head I have nothing of the smallest importance to communicate to the Visitors. No addition has been made to our erections, no alteration in the arrangement of rooms has been found necessary, and no expensive repair has been required. In the next year it will be proper to renew the painting, &c., of some parts of the interior of the dwelling-house, and of the Octagon-room: but I do not anticipate that any other repair, except of the most ordinary kind, will be needed.

2. Moveable Property in General.—No alteration has been made in the subjects of this division (so far as they are not included under the heads of Library and Instruments), except in the addition of some tables and chairs for computers. The whole of our property is at home, and is in serviceable order.

3. Manuscripts.—In former Reports I have alluded to the manuscripts of the Board of Longitude. No progress has been made in the arrangement of them since the date of the last Report.

Many of our manuscripts, which were in the state of loose papers or of thin copy-books, have been found to admit of being bound in firm binding: a process which contributes greatly both to the orderly arrangement and to the security of the papers. They have accordingly been bound, in all the instances in which it appeared practicable. All are marked with class-marks, and the names and references of all are entered in a manuscript catalogue: and great attention is given to the keeping up of this catalogue on the occasion of lodging fresh books or papers in the Safe-room. I think it proper to state to the Board, that I have paid great attention to the preservation and arrangement of all the papers relating to the Observatory which have passed before me during my own presidency in this establishment; and that originals or copies of the documents of every kind, and of correspondence with all parties, will be found in a state, it is hoped, of easy reference. As opportunity serves, these are bound: those volumes which

contain papers of a confidential nature are not allowed to leave the premises, but are bound by persons who come to the Observatory for that purpose. The books of observations and calculations are repaired, if necessary, before they are stowed away with the other manuscripts.

Once in each year, the manuscripts are examined with their catalogue.

I had hoped before this time to have made an addition to our manuscripts, which, though not of original papers, would nevertheless have been one of importance. In spite of the care with which the Oxford edition of Bradley's and Bliss's Observations was prepared, I have had reason to think that in several instances valuable elucidation would have been obtained if we had been able at once to consult the originals. This power would be secured, with a degree of assurance next only to absolute certainty, by reference to a transcript made with great care by persons who are generally well acquainted with the subjects of the manuscripts. The circumstance, that there are at this time several persons in daily employment at the Royal Observatory who are well acquainted with Bradley's and Bliss's Observations, appeared to me unusually favourable for obtaining such a transcript with accuracy and at small expense, provided the originals could be intrusted to me. I therefore stated my views to Dr. Wynter, President of St. John's College, Oxford, and now Vice-Chancellor of the University, and requested him to lay my application before the Delegates of the Clarendon Press, in which body it is understood that the property in Bradley's and Bliss's manuscripts is vested. My application was received with the utmost courtesy by Dr. Wynter and the Delegates; and their full assent was given to it, with no other reservation than the cautions for the security of the manuscripts which I had myself indicated as probably desirable. My best thanks are due to Dr. Wynter, to Dr. Bandinel (Principal Librarian of the Bodleian Library), and to Dr. Bliss (Registrar of the University), for the liberality with which they have received and responded to my application. An agent has been sent by me to Oxford to examine the manuscripts, and the work of copying would have been commenced by this time, but for an accident in the preparation of the paper.

4. Library.—No remarkable addition has been made to the library since the last meeting of the Visitors, although the usual attention has been given to maintaining it in a respectable state as regards physical science in general and Astronomy in particular. I may however state, that both the progress of the science and the devotion of so large a portion of our establishment to it have required that attention should also be given to keeping the Magnetical division of the library in the most forward state possible.

Attention is given to the binding of the books and to their orderly arrangement, in order to make the library really useful. The arranged catalogue is kept up with care. Once in each year all the books are compared with the catalogue.

5. Instruments.—In the principal instruments of the Astronomical department, no change has been made. I have had it in contemplation for some time past to change the micrometer in the eye-piece of Troughton's Circle, not because it is defective, but because the value of its screw is inconvenient. One turn is equivalent to $53\frac{1}{4}$ seconds. From this it frequently happens that, when an observation is found to be erroneous, we are left in doubt as to whether an error of one minute of arc or an error of one turn of the micrometer has been committed.

Jones's Circle has been adjusted to the meridian, and is in a state in which it can be used in case of disablement of Troughton's Circle. It has not however been actually used yet.

In my last Report I alluded to an alteration made in the arrangements of the Zenith Tube, by which the two observations in opposite positions of the instrument could be made at a single transit. I am happy to state that this alteration is on the whole effective: the results of observation having been more consistent since the change was made than they ever were before.

In my Report for the year 1838, I stated that, on the occasion of sending Bradley's Sector to the Cape of Good Hope, I had caused detailed drawings of every part of the instrument to be made. These drawings are now placed in the hands of an engraver, for preparation of engravings to illustrate the account of Mr. Maclear's operations at the Cape of Good Hope: and I trust therefore that a complete description of this celebrated instrument will shortly be within the reach of every person interested in astronomy or in geodesy.

In my Report for the year 1840, I stated to the Visitors that the escapement of Hardy's Clock had, by command of the Board of Admiralty, been delivered to the Secretary of the Admiralty. The long detention of this apparatus makes me anxious now for its return.

As regards the Magnetic and Meteorological department, I have to remark as follows:—

In my last Report, I alluded to the construction of double wooden boxes with gilt surfaces for the principal magnetometers. In one respect this construction has been perfectly successful: the small vibrations which so much increased the labour of observation have been completely suppressed without affecting the changes originating from terrestrial magnetism: and there is now no difficulty in observing all the instruments in every five minutes, or even more frequently. With regard to the perfect coincidence in the movements of two magnets, I am not able yet to pronounce with certainty.

On removing the Vertical Force Magnet lately, for the purpose of investigating its thermometrical correction, its knife-edge was found to be worn off, apparently because the steel was too hard. It has been reground at a more obtuse angle than before by Mr. Barrow.

The Dipping Needle, which was in use at the time when my last Report was read, was judged, after long and careful trial, to be insufficient for the determinations which magnetism now requires. A new one (one of the last works of Robinson) was purchased in the last year, and appears to be in every respect competent to the most delicate observations.

Preparations are now nearly completed for observing with accuracy the deflections which one magnet produces in the position of another, on the plan proposed by Lamont.

In my last Report I stated that we had been generally successful in the insulation of our Electrometer and its wires. I may state now that the insulation still appears to be effectual: and I cannot perhaps give a better proof of it than by relating that on Sunday last, May 28, the dry-pile apparatus then in communication was disabled, in my presence, by the effects of a flash of lightning.

In my last Report I stated that a pith-ball Electrometer, and no other instrument, was connected with the electric wires. Since that time, the mounting of the pith-ball apparatus has been improved, so that the kind of electricity can be examined with facility and without danger of a shock: and besides this there have been connected a delicate dry-pile apparatus (made by Watkins and Hill) and a Galvanometer (by Gourjon of Paris). The former of these is an admirable instrument for exhibiting the kind as well as the quantity of those accumulations of electric effect which occur in the conspicuous disturbances of the electric state of the atmosphere. The latter is capable only of showing the slow and long-continued currents of galvanic electricity from the upper atmosphere to the earth: it has not been sensibly affected more than two or three times since it was mounted.

A large copper ball has also been mounted in such a manner that it can be raised or dropped quickly, in order to give the means of estimating the effect of the earth's induction at different elevations. Nothing certain has yet been obtained from the observation of this ball.

On the Meteorological instruments I have no remark to make. Osler's self-registering Anemometer continues to perform well, with the exception only of its total inability to record the values of the pressure

of the light winds. In reference to this subject, I would beg to submit for the consideration of the Visitors whether they would think proper to recommend that a Whewell's Anemometer be mounted on the Observatory. An instrument of this class (which, however, imperatively requires extensive alterations in the mechanical arrangements of its different parts) is now placed on the magnetic ground.

6. Observations. — The general course of Astronomical observations has been nearly the same as in several past years. The Stars of the Nautical Almanac List have been carefully observed: the rule, that in every three years 20 observations at least of each star, with each of the meridional instruments, should be secured, being attended to as carefully as possible. The Sun, the Moon, the Planets, and the Moon-culminating Stars of the Nautical Almanac, have been observed at every practicable opportunity, except on Sundays, when the Moon and accompanying stars only are observed. Of Small Stars which have been observed, the principal are the Moon-culminating Stars of the Nautical Almanac, and stars which have been compared with Comets. The equatoreals have been used for measuring the Moon's Diameter, for observing Laugier's Comet before as well as after its perihelion passage, for one observation of the Great Comet, and for several observations of Mauvais' Comet (which is still under observation). With the double-image micrometer, several measures of the Diameters of Planets and some of the Distances and Positions of Double Stars have been made: γ Virginis has been lately measured. With the detached telescopes and the equatoreals, observations of Occultations and of Eclipses, &c., of Jupiter's Satellites, have been made at every opportunity.

Perhaps it is proper here to mention, that, immediately after the last meeting of the Board, I made a journey to Turin, for the purpose of observing the wonderful phænomena of a Total Eclipse of the Sun; and that, under circumstances of weather apparently very disadvantageous, I was so far favoured by fortune that I saw the Eclipse in the utmost perfection. The results of this observation have been laid before the Royal Astronomical Society.

Our daily Magnetical and Meteorological observations have been continued on the same plan as in the last year. The principal magnetometers, the barometer, and the wet and dry thermometers, are observed every two hours, day and night (Sundays excepted); the dew point four times every day; the self-registering instruments are constantly in action. The term observations of the magnetometers at every five minutes on a certain day of each month, the hourly observations of the barometer on certain days, and the irregular observations, are fully kept up. Care is given to the adjustments of the instruments. The thermometrical corrections for the horizontal force and vertical-force magnetometers have been lately determined, and it is hoped with accuracy, by the method of deflections proposed by Lamont. No observations have lately been made for the measure of absolute intensity; but, the power of observing great deflections being obtained in Lamont's method, I propose shortly to resume experiments for this object.

7. Reduction of Observations. — In the Report of last year, I stated that our reductions had dropped considerably in arrear. I have the satisfaction now of stating, that this arrear and very much more have been completely recovered, and that the reductions are now in as forward a state as at any time since my connexion with the Observatory. For the year 1842, the meridional work is entirely cleared off; the observations with the zenith tube are reduced; all that is wanting for the complete printing of the Observations is the Equatoreal Observations and the Occultations (which are commenced). For the present year, the Transits are cleared of instrumental errors, but not of clock error: the Circle Observations are cleared of instrumental errors, but not of zenith point: the observations with the zenith tube are completely reduced: all these reductions are made nearly to the present day.

The results of the observations of Stars, from 1836 to 1841 (including both years), have been collected

for the purpose of forming a Catalogue of Stars, depending for their right ascensions on our own determinations of the position of the equinox. Very little work is now necessary for the completion of this Catalogue. The number of stars included in it is about 1400.

The Magnetic Observations are completely reduced, almost to the present time, with the exception of the observations of the vertical-force instrument, which are a little behind. The Abstracts of the Magnetical and Meteorological Results for 1842 are advancing.

8. Printing.—The Observations of 1841, and those of subsequent years, will necessarily appear in two volumes; one containing the Astronomical and the other containing the Magnetical and Meteorological Observations. The Astronomical volume for 1841 is published, and ten sheets of that for 1842 are received. Of the Magnetical and Meteorological volume for 1841, the whole of the Magnetical observations and the Meteorological observations, to April, are printed: the Introduction is far advanced, and the Abstracts are begun. I beg to exhibit to the Visitors the sheets of the Magnetical, &c., observations, as far as they are printed, and the Plan of the Abstracts now in the printers' hands; and to solicit their sanction for printing the work in this form, or their directions for the alterations which they desire to make in the plan of publication.

On referring to the published volume for 1841, it will be seen that the results of rating the Chronometers on trial have been printed in a more extended shape than in former volumes.

The number of copies of the Observations now struck off is 350.

9. Chronometers.—The number of Chronometers on trial in the present year is considerably less than in the last year.

In my last Report, I stated the probability that great interest would be excited among Chronometer makers by the publication of the account of Eiffe's and Molyneux's construction of Chronometers. This expectation has been fully borne out: many different schemes for the same purpose having been proposed to the Hydrographer and to me. The necessity of subjecting Chronometers, constructed on these principles, to trials in extreme temperatures, has led me to make arrangements for heating the Chronometer-room, and thereby rendering ourselves comparatively independent of the season, at least as far as warmth is concerned.

The Digest of the Estimates of Expense of Repairs to Government Chronometers has been regularly kept up, in obedience to the directions of the Board.

10. Personal Establishment.—In my last Report, I alluded to the necessity of additional assistance to the Magnetic Department: a necessity which was urged upon me not more by the accumulation of calculations, &c., than by the personal oppression of the severe night duty upon the Magnetic Assistants. I had the honour of transmitting to the Government, through the Marquis of Northampton, President of the Royal Society, an application for the continuance of the Magnetic Establishment to the same term as the other Magnetic Observatories, namely, the end of 1845, and for the assistance of another Observer. This application did not fully engage the notice of the Government until the winter; and I then requested their sanction to a small alteration in the terms of my application, namely, that instead of adding an assistant to the Establishment, I should be permitted to employ occasional computers to the same pecuniary amount. I was induced to make this alteration by the consideration that the computers usually employed, under the eye of Mr. Breen, in the Planetary and Lunar Work, could be employed under his eye for the occasional computations of the Observatory; and that, both in the number of hours of employment, and in the lower scale of payment, very great advantage would result to the Observatory. This proposal received the sanction of the Lords of the Treasury and the Lords of the Admiralty. The observations are still divided

among the same nine Assistants as before; but four of them are appropriated to the Magnetic Department, and only five to the Astronomical Department (instead of six, as formerly); and occasional computers, under Mr. Breen's superintendance, are employed as need requires on the heavy masses of calculation in either department.

It is owing principally to this arrangement that we have been enabled to make so great a step in bringing up our computations. I have, however, found it necessary to call on the established Assistants for a small addition to the times of their daily employments.

11. Reduction of Ancient Observations.—I have the pleasure of exhibiting to the Board 30 sheets of the Reductions of the Greenwich Planetary Observations from 1750 to 1830, which have been printed off. This extent embraces the first section (Investigation of Clock Errors and Clock Rates), the second section (Investigation of Index Errors, &c., for Quadrants and Circles), and the principal part of the third section (Deduction of the Planets' Observed Geocentric Place in Longitude and Ecliptic Polar Distance). The fourth section will contain the Tabular Heliocentric Places of the Earth and Planets, and the deduced Tabular Geocentric Places of the Planets; and the fifth will contain the Comparison of the Observed Places and the Tabular Places, with the means for groups, and with expressions for the discordance in terms of the Heliocentric Errors of the Earth and the Planets.

In the computation of the Lunar Observations, from 1750 to 1830, the following progress has been made. The Right Ascension of the Moon's Limb, from Observations, has long since been completed throughout; but the Right Ascension of the Center is no where obtained. The Zenith Distance is cleared of instrumental error, and corrected for refraction and parallax throughout. The principal mass of work, however, is in the computation of the Tabular Places: in these, the Longitude, Ecliptic Polar Distance, Change of Longitude and of Ecliptic Polar Distance, and Parallax, are computed throughout, and reduced to sexagesimals: the Change of Right Ascension and of North Polar Distance is under computation. When this is finished, the principal remaining work will be the Correction for Semidiameter in Right Ascension and the Conversion of the observed Right Ascensions and North Polar Distances into Longitudes and Ecliptic Polar Distances.

On the whole I may state, that this great work is going on well.

The investigations have lately been completed for comparing the tabular diameter of the Moon with the observed diameter as found (with due correction) from those observations in which both limbs were observed in Right Ascension or in North Polar Distance. And I have been much surprised to find that the correction to the tabular diameter given by the old observations coincides almost exactly with that given by the modern ones. What elements Burckhardt can have used for his tabular diameter (erroneous to the amount of nearly 6″) I am wholly unable to imagine.

12. General Remarks.—I should not be doing justice to the exertions of the various persons employed in this establishment, if I omitted to state that several employments, not closely connected with the routine of the Observatory duties, but not unfitting, I trust, to my position, have sometimes occupied their time, and more particularly my own. Among these I may mention the following:—Correspondence, of various kinds, connected with the subject of National Standards, although by no means so pressing as about two years since, has occasionally occupied my attention. The printing of the accounts of Mr. Maclear's work for the Reverification of La Caille's Arc at the Cape of Good Hope (of which the first section is finished, and the second is in progress), has required more time than could have been anticipated. In the last spring, the Officers of the Corps of Royal Engineers, who are now employed on the difficult task of tracing the Canadian Boundary under the Treaty of Washington, were located for several weeks at

Greenwich, for the purpose of receiving from me the instruction which I might consider adapted to that service. And lately I have received from Colonel Colby an enormous mass of Tide Observations made on the coast of Ireland, (the instructions for which were arranged in concert by Colonel Colby and myself), on the reduction of which my attention, and the time of some of my computers, are occasionally engaged. To these I may add an inconceivable amount of correspondence on schemes of all kinds, especially mechanical and astronomical. I think, however, as I have fully stated to this Board on a former occasion, that by giving my attention to subjects of these classes, but always with a jealous attention to the home-work of the Observatory, I am really increasing much the credit of the Observatory, and the utility of the Observatory and myself to the public.

In conclusion, I think it proper to state, that the conduct of the various Assistants employed under me has been unexceptionable. In particular, I can hardly express how much I am indebted to the ability, the zeal, and the regularity of my First Assistant, Mr. Main; and to the care, fidelity, and general skill of superintendance displayed by the heads of departments, especially of those (Mr. Glaisher and Mr. Breen) who are not immediately under my eye.

G. B. AIRY.

Royal Observatory, Greenwich, June 2, 1843.