REPORT OF THE ASTRONOMER ROYAL

TO THE

BOARD OF VISITORS,

Read at the Annual Visitation of the Royal Observatory, Greenwich, June 5, 1841.

For the sixth time, I have the honour to present to the notice of the Board of Visitors some remarks, intended to explain to them the general state of the Royal Observatory, and the course of its current work. Although it is probable that in such a statement, given by a person who is much occupied with the routine duties, various matters will be omitted which might have considerable interest for the Visitors; yet I should hope that it will be found to possess some value, as a full account of all that appears to me worthy of mention, and as possessing for future history that degree of authenticity which nothing can give so completely as annals written by the officer in principal charge. I shall follow nearly the same order as in the preceding Reports.

1. Grounds and Buildings.—No alteration whatever has been made in the grounds of the Observatory since the last Report. No progress, so far as I am aware, has been made in the arrangements for the Chatham Railway, noticed in the last Report. I have, however, understood that a line a little more distant than that there alluded to is at present meditated. No other external circumstance occurs to me as worthy of notice.

The front wall of the North Terrace has been rebuilt: and a flagged pavement has been laid round the foundation of that part of the Court Wall which appeared to be in the greatest danger. The old Camera Obscura has been removed from the north-western turret of the Great Room, to make way for the Anemometer, which I shall mention further below. Some additional shelves have been fitted in the library, and some of the old ones have been altered, for the reception of additional books. A small wooden house,

the property of Capt. Fitzroy, R.N., which was carried by him, in the Beagle, in his circumnavigation of the globe, has been planted in the southern part of the Magnetic Ground for observations of the dipping-needle, and any other observations which would be prejudiced by the action of the large magnets in the Magnetic Observatory.

2. Moveable Property in general.—No addition has been made to this, excepting the furniture which was necessary for the convenience of the Magnetic Assistants, and which is placed in the ante-room of the Magnetic Observatory. Additions have been made in the classes of Instruments and Books, which will be hereafter mentioned.

3. Manuscripts. — The whole of the Manuscripts which I found in the Observatory have been arranged, marked, and catalogued; and I have the pleasure now of laying before the Board a copy of the catalogue, to be deposited, if they shall think fit, among the papers of the Board. A few only of the books of the calculations made during my own superintendence of the Observatory are not yet duly entered.

Having ascertained that the Manuscripts of the late Board of Longitude were separated, some being in the custody of the Admiralty, and the others in that of the Royal Society, I had the honour of representing to the Lords Commissioners of the Admiralty and the President of the Royal Society respectively, the great inconvenience of this separation, and of suggesting that it would be advantageous that the whole should be lodged at the Royal Observatory. In consequence of these applications, the whole of the Board of Longitude papers have been transferred hither; and Mr. Main, my first assistant, is now engaged, at leisure times, in taking a list of them, in preparation for a complete arrangement of the whole.

4. Library.—No remarkable addition has been made to the books in our Library, although I have lost no opportunity of adding such as appeared necessary to keep up the series of works of which the first parts were already in the Library, and such as should be found in a collection whose character ought to be emphatically astronomical.

I ought not, however, to omit to state that, within a short time, the Royal Society of Edinburgh have presented the Observatory with a complete set of their valuable Transactions. For this we are indebted, I believe, in the first instance, to the intercession of Professor Henderson.

5. Instruments.—Confining myself for the present to the Astronomical department, I have only the following remarks to make:—

As regards the Transit, nothing worthy of notice has happened, except a change in the mounting of its object-glass. It will be in the recollection of the Board, that, at their last Visitation, I stated that it had been found necessary to separate the crown and flint lenses of the transit object-glass, for the purpose of cleaning them. The lenses were originally burnished into their cell: and after the cleaning, they were again burnished into their cell, but not so tightly as before. The performance of the object-glass was then most admirable.

In no long time after this, the object-glass (from a fault in the shutters) was twice drenched with water; and on each occasion a considerable quantity insinuated itself between the two lenses. There were no means of getting rid of it, but by long-continued heating: an operation attended with some risk, and likely to interrupt those observations which above all others ought to be as little as possible interrupted — I mean the observations of the Moon. At length, I directed Mr. Simms to construct a new cell, in which the two lenses should be screwed together. The definition of stars, since the object-glass was mounted in this cell, though by no means bad, has not been so good as it was after its first cleaning. By a few trials (which can be attempted only on very fine evenings, and when there is no risk of losing observations of the Moon), I have no doubt of being able to restore the object-glass to its former excellence.

On Troughton's Circle I have nothing to remark. Jones's second Circle (that originally mounted at the Cape) has not yet been mounted here. The condition of this instrument deserves notice. I stated in my last Report, that observations had been made with a fühl-hebel for ascertaining the form of its large steel pivot. These observations being finished, it was thought desirable to proceed with the re-turning of the steel pivot, and Mr. Simms came to Greenwich to make the proper arrangements for that purpose. To our great astonishment, the steel collar was found to be so loose that the hand of a child could turn it. Mr. Jones, in explanation, has stated to me (verbally) that this part of the construction of the Circle was managed by Messrs. Maudslay, and that the steel collar, instead of being pinned on, as is usual in such instruments, had been fastened only with soft solder. And thus, by the incompetency of some person who had the immediate charge of the work, an instrument has been produced which, I believe, may truly be said to have shortened the life of one zealous astronomer, and to have given years of vexation and labour to two others. The whole affair reflects little credit on the construction of English instruments. Mr. Simms has at present in charge to construct a new steel collar, and other necessary parts of the Circle; and I am in daily expectation of his coming here to attach them.

The results of the Zenith-Tube observations are not yet sufficiently examined to enable me to say whether the construction, to which I alluded in my last Report, has completely stopped the irregularities which I conceived to arise from the twist of the plumb-line. I perceive that there remain irregularities in the results at the stage to which they are at present arrived; but I cannot yet decide on the cause of them.

Nothing has yet been done to that quadrant of the Declination-Circle of the Eastern Equatoreal which had a small defect in its graduation. I have not, however, lost sight of this, and shall be prepared to attend to it as soon as leisure permits.

The old clock for observing Right Ascensions in Arc, presented (I believe) by Sir George Shuckburgh, has lately been put in order.

The three large models of Chronometers, constructed by Harrison, which have been in

the hands of Messrs. Arnold and Dent some years for examination and repair, have been restored to the Observatory. A detailed description of them, with elaborate plans, was transmitted by Messrs. Arnold and Dent to the Lords Commissioners of the Admiralty; by whose command the description and plans were lodged in the Safe-Room of the Observatory.

6. Observations.—The subjects of observation, since I last reported to the Board, have been principally the following:—With the Meridional Instruments: Observations on the stars of the Nautical Almanac list, determined in number by the rule which I some years ago laid down, that in any consecutive three years each star should, if possible, be observed twenty times with each instrument; Observations of the Sun, the Moon, and all the Planets, at every opportunity; Moon-culminating Stars in the Nautical Almanac lists, as far as 1843; Stars observed with Gallé's second Comet, with Bremicker's Comet, and with Mars in the Opposition of 1841; Stars observed by Col. Everest at the stations of the Great Indian Arc of Meridian; Circumpolar Stars, intended for determination of low refractions; and some Stars remaining from former lists. With the Equatoreals: Transits of Moon's diameter; Observations of Bremicker's Comet and stars near it; Observations of Mars and stars near him at the late opposition; and Occasional Observations. With the Zenith-Tube: regular Observations of γ Draconis. With the Double-image-Micrometer: Observations of distance and position of circumpolar double stars to the end of 1840; and occasional Measures of the diameters of planets in 1841. With the detached Telescopes: Observations of the Occultations marked in the Nautical Almanac; and of the Eclipses, &c. of Jupiter's Satellites, at every opportunity. Of the Magnetic and Meteorological Observations I shall speak separately hereafter.

7. The Reductions are at present in the following state. The Transits are completely reduced, and their results entered in ledger, to the end of October 1840: the reduction as far as True Time of Transit is finished to the end of December. The Circle Observations are reduced and their results entered in ledger, to the end of 1840. The investigation of the difference between direct-results and reflexion-results, and that of the correction of latitude, are lately finished: the former seems to show (as has been remarked with Troughton's circle for several years past) that the difference in question is insensible: the latter gives the same quantity as in the last three years. The observations with the Zenith-Tube are nearly, but not quite, reduced. The computations of the Equatoreal Observations of 1840 are nearly finished. The computations of the observations of Eclipses and Occultations are scarcely begun. The distances observed with the double-image micrometer are completely reduced, but the angles of position are not yet fully reduced. Since the last Report, it will be perceived, we have not entirely kept up our reductions: this will be amply explained by circumstances to be mentioned hereafter.

8. Printing.—The state of the printing is nearly as follows. The Transits are printed to the extent of 80 pages (latter part of August 1840), and the Circle Observations to 64

pages (end of May). It is proceeding in the same form as in the last years: I propose, however, to make a small alteration in the arrangement of the mean places of stars in A.R. and in N.P.D., so that the results from observations of the two classes will be included in one form containing a complete catalogue both of A.R. and of N.P.D.

Several of the skeleton forms, used in the ordinary calculations, have been reprinted in the last year, and I have reserved copies for binding with the volume of Observations now in hand.

Application having been made by the President and Council of the Royal Society, for twenty-five additional copies of the printed Observations for distribution, I directed Mr. Murray (the Admiralty publisher) to supply the Society with that number of copies of the Observations from 1836 to 1839, and requested him to transmit to me a statement of the number of copies now in his hands. It appears that he has now in store 18 copies of the Observations for 1836, 16 of those for 1837, 22 of those for 1838, and 33 of those for 1839. About 20 copies of each are in my own hands. It may, perhaps, be a matter for the consideration of this Board, whether the impression, beginning with the volume for 1841, should be enlarged.

9. Chronometers.—The number of chronometers on hand for constant rating, from the beginning of the present year, has usually exceeded one hundred. When it is considered that each of these is rated twice every day, that the rates are regularly reported in duplicate, and that besides this there is the whole charge of selection of chronometers for purchase, and of repairs of the Government chronometers, with occasional trouble in the issues of chronometers to the navy, it will be acknowledged that the labour of this department is a fearful load upon the energies of the Observatory. I do not speak of this with any bitterness, for the arrangements made by the Lords Commissioners of the Admiralty and by the Hydrographer, since my accession to this office, have removed several of the inconveniences which caused so much personal annoyance to myself, and interfered so severely with my personal attention to the Observatory: but I am desirous that it should be known to this Board, and to the scientific world, that our establishment of Assistants, nominally large, is really not large: and that about one-third of our whole strength is employed upon the business of chronometers.

It was understood last year to be the wish of this Board, that steps should be taken for making public the relative merits of different chronometer-makers. For this purpose, two measures have been undertaken under my direction. The first is, the printing of an abstract of the rates of all the chronometers purchased by the Board of Admiralty, digested in the form in which I had usually arranged them for assisting my own judgment. This was done after the annual purchase in August last; and I propose, if it is approved by the Board, to continue it in future. The second measure is, a digest of the expense of repair of every chronometer whose repairs have passed through my hands. This has not been pressed, as it is hardly possible that the experience of this number of years can afford sure grounds for

discrimination among the different makers: but the Board will see, from the prepared books now placed before them, that all the preliminary arrangements are completed and can be followed up at any time.

10. Magnetism and Meteorology.—It will be remembered by the Visitors that, in the beginning of 1836, a scheme for the erection of a Magnetical Observatory was by me brought before the Board of Visitors: and that, in consequence of the interest taken by the Board in this proposal, the Magnetical Observatory in the south-east part of the grounds was constructed, and in it were made the observations contained in the printed Volume for 1839. . In the summer of last year I heard indirectly that the Council of the Royal Society had it in contemplation to recommend to the Government the prosecution of magnetical and meteorological observations at some place near to London, in general correspondence with the observations of Capt. Ross's expedition. I therefore addressed to the President of the Royal Society a statement, of the facilities which already existed at Greenwich for the prosecution of the proposed observations, and of the great reduction of expense which might, in my opinion, be insured by locating the observations there. These reasons weighed so strongly with the Council of the Royal Society, that they were induced to recommend to the Lords of the Treasury, that the plan which I had suggested should be followed out by their Lordships. On their Lordships assenting, measures were immediately taken by me for carrying out the whole plan; but it was not till November last that the new assistants were engaged in regular observation with the meteorological apparatus and the two principal magnetic instruments (that for declination or deviation, and that for horizontal force); and the third magnetical instrument (that for vertical force), was mounted only in time for the term-observations of last week. The following account will give the Visitors a general idea of the Magnetical and Meteorological Establishment. Three additional assistants were engaged (Mr. Dunkin, Mr. Hind, and Mr. Paul). Of these, Mr. Paul is usually employed in the astronomical department; Messrs. Dunkin and Hind are placed under the directions of Mr. Glaisher, who is entirely charged with the care of the magnetical and meteorological department, and is for the present withdrawn from the astronomical department. Occasional superintendence is intrusted to Mr. Main. The regular work of the establishment is, to observe the meridional needle, the bifilar needle (for variations of horizontal force), the horizontal needle mounted on knife-edges (for variations of vertical force), the barometer, and the wet and dry thermometers, every two hours (night and day) except on Sundays; to observe the dew-point four times every day; to observe the dipping-needle twice each week: to observe circumpolar stars occasionally for the verification of the zero of the theodolite; to pursue incessantly the magnetic observations when aurora, thunder-storm, or any other unusual circumstances seem to make it desirable; to observe two of the three instruments at intervals of five minutes during twenty-four hours on one term day in each month; to adjust the papers, &c. for the self-registering anemometer and rain-gauge every day; and to make occasional observations on the measure

of radiation, &c. Indeed, I believe I may state that the whole of the observations recommended in the Report of the Royal Society are fully marked out, excepting only those which apply to electricity. Great care is taken in the periodical examination of the adjustments. The reduction of the observations is carried so far as to free them from arbitrary constants: thus the changes of deviation are expressed in minutes and seconds; the changes of horizontal force in parts of the whole horizontal force; and the changes of vertical force are to be expressed in parts of the whole vertical force. The whole of the reductions, and the exhibition of the results in a tabular form, are nearly complete to the present time, as well as the formation of the curves, &c. for exhibiting to the eye the general law of results. The amount of work which has been done in this department is very great. My best thanks are due to Mr. Main and Mr. Glaisher for the steadiness and the vigour with which it has been carried on; but more particularly to Mr. Glaisher, whose energy and perseverance, displayed as well in his own share of the harassing observations and tedious reductions, as in the order which he has maintained in the operations of his subordinates, require my special acknowledgment. I am not yet prepared to describe the plan which I should propose to follow in printing these observations.

11. Personal Establishment.—I have already noticed the addition made to the regular party of Assistants. I have only to add, that I continue to have every reason to be satisfied with the regularity and zeal of every one of the Assistants. And in publicly acknowledging my obligations to those who are subordinate to me, I must not omit to state that I am deeply indebted to my official superiors for the readiness with which they have listened to my suggestions on points affecting the efficiency of the Observatory. The Board of Admiralty, on my representation of the interruption to our business caused by the labour of rating so many chronometers, and by my own employment on public business unconnected with the Observatory, immediately sanctioned the employment of an additional computer; and by his assistance only we have been able to keep the reductions to their present advanced state.

12. Reduction of Ancient Observations.—Although the subject to which I am now about to allude has not usually been noticed in my annual Reports, I trust it will be thought that the present is a fitting occasion for its mention. It is probably known to several Members of this Board, that, at my instance, the British Association applied several years since to the Government for pecuniary assistance, for the reduction of all the Greenwich Observations of Planets from 1750 to 1830; and the same body, at the instance of Sir J. W. Lubbock, applied at a later time for similar assistance for the reduction of the Lunar Observations. The superintendence of the computations was in both cases undertaken by me. The labour of this superintendence has probably been far greater than would be imagined by any one who has not had to rectify all the blunders made by old observers, who have never fully reduced their own observations. I am happy, however, to state, that

the reduction of the Planetary Observations is now finished, and that the whole is written out for the press, wanting only some prefaces, &c., which must be written by myself. Every observation of every planet is completely reduced, with uniform elements of reduction, to longitude and latitude; and every one (except those of the small planets) is compared with the place computed from the best modern tables, altered in some places for better agreement with theory; and, finally, an equation is obtained in longitude, expressing the relation between the errors of heliocentric longitude and radius vector of the planet and the earth, and another expression is found for the absolute error of the heliocentric latitude. These are the most complete results possible, not proceeding to correction of the elements of the tables. The reduction of the Lunar Observations has been for some time in hand, but a much smaller comparative progress is yet made in it. This will not appear surprising when the total amount of labour is considered. Eight thousand places of the Moon are to be deduced from observation, under the same difficulties to which I have alluded as applying in the planetary observations, and with many others peculiar to the Moon: and eight thousand places are to be computed in duplicate, from tables exhibiting the complicated results of the most advanced modern theory. In extent and in importance this work may be considered comparable to any that has yet been undertaken in Astronomy.

I may, perhaps, be allowed to speculate one moment on the tendency of these works as affecting the character of this institution. Within the last few years we have advanced little, or perhaps nothing, in the extent of our observations; but we have advanced greatly in the extent of our reductions. It is not only in our printed books, but also in the habits of our minds, that we have learned to give an important place to the interpretation of our instrumental results, as bearing upon the grand questions of the system of the world. This feeling is greatly strengthened by the reduction of the ancient observations. In a word, we have made little or no progress in the character of Observers, but we have advanced very much in the character of Astronomers. The Board whom I am addressing will, I am confident, sympathize with me in satisfaction at this change.

G. B. AIRY.

Royal Observatory, Greenwich,
June 3, 1841.