RESULTS OF ASTRONOMICAL OBSERVATIONS, MADE AT THE OBSERVATORY OF THE UNIVERSITY, DURHAM, FROM OCTOBER, 1984 TO APRIL, 1852

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Trieste

RESULTS

OF

ASTRONOMICAL OBSERVATIONS,

MADE

AT THE OBSERVATORY OF THE UNIVERSITY,

DURHAM,

FROM OCTOBER, 1849, TO APRIL, 1852,

UNDER THE GENERAL DIRECTION OF

THE REV. TEMPLE CHEVALLIER, B.D., F.R.A.S.,

PROFESSOR OF MATHEMATICS AND ASTRONOMY.

BY

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OBSERVER IN THE UNIVERSITY.

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1855.

INTRODUCTION.

The Observatory of the University of Durham was built in the year 1841, principally by private subscription. The regulations of the University (Title XV., Section iii.) provide that its affairs be under the direction of a Board of Curators, consisting of the Warden, the Professor of Mathematics and Astronomy, the Proctors, the Reader in Natural Philosophy, and two other persons nominated annually; that the Warden shall convene the Board once at least in every Term; that the Curators shall visit the Observatory once at least in every year; that the Observer shall reside at the Observatory, shall be an unmarried man, nominated by the Professor of Mathematics and Astronomy, with the concurrence of the Curators and the approval of Convocation; and that he shall be removable by the same authorities.

This second volume of the Durham Observations comprises the period during which I held the appointment of Observer; namely, from October 1849, to April 1852.

My acquaintance with the use of astronomical instruments commenced in the autumn of 1849, when my valued friend Professor Challis allowed me, during a temporary residence at Cambridge, to make myself familiar with the use of the instruments under his charge, and with the processes of reduction there followed. My practice has consequently been very closely similar to that pursued at Cambridge, modified gradually in some particulars by my own experience of the peculiar necessities of the instruments at Durham. Such points as it appears desirable to notice specially will be found under the head of the separate instruments.

From October, 1849, to the beginning of May, 1850, the observations were almost exclusively meridianal; thenceforward, with little exception, equatoreal. The objects observed in the meridian during 1849 and the spring of 1850 were for the most part stars from the catalogue of the British Association, of which modern observations were wanted, the moon and moon-culminating stars, and the planets Mars, Jupiter, Saturn, Uranus, and Neptune. After April, 1850, the objects were mainly such of the comparison-stars used for the Equatoreal as were not too faint for the transit. The objects observed with the Equatoreal were the planets Pallas, Juno, Hebe, Iris, Flora, Metis, Hygeia, Parthenope, Victoria, Egeria, Irene, and Eunomia, and the comets commonly called Petersen's third, Bond's, D'Arrest's, Brorsen's fourth, and Encke's.

The publication of the Equatoreal observations in a provisional state took place from time to time in the monthly notices of the Royal Astronomical Society of London, and in the pages of the Astronomische Nachrichten of Altona. The collective final publication has been since then delayed by the necessity of looking elsewhere for aid in determining the positions of the comparison-stars, the transit-circle at Durham being of too small size for observing by far the greater portion. At the last meeting of the Curators, before my connexion with the University ceased, I made an offer to provide for this want as far as I was able, and to superintend the future revision and publication of my observations in a final form, so soon as the star-places were supplied. In consequence of my application, Professor Smyth, of Edinburgh, has most kindly observed 76 of those stars in both elements, and 55 others in right ascension. The Astronomer Royal also supplied me with the places of 44; and I have determined 53 myself at the Observatory since erected by me at Redhill, in Surrey. A few of the number have been observed at two Observatories; some few others did not need re-observation; the total number being 221. Two years and a half have elapsed in waiting for these star-places, and the value of the Equatoreal observations to the computer has been necessarily much lessened thereby; but this circumstance was beyond my control. It is hardly necessary to instance the case of the first comet of 1850, the observations of which now appear many months after the definitive conclusion of its orbit. I have nevertheless continued to regard it as a professional duty to watch over my old observations to the last, although now sufficiently occupied elsewhere.

Meteorological observations were also constantly kept up at the hours of 9 A.M. and 9 P.M. (in my absences on vacation, by deputy); the barometer, dry and wet-bulb hygrometer, maximum and minimum thermometers, direction and force of wind, and the fall of rain, being noted. These observations were communicated quarterly to the Registrar-General of Births, Marriages, and Deaths, at Somerset House, London, in tables prepared under the direction of James Glaisher, Esq.

ON THE LATITUDE, LONGITUDE, AND HEIGHT ABOVE SEA-LEVEL OF THE OBSERVATORY.

The latitude was determined in the year 1843 from a large number of direct and reflected observations of α, δ, and λ Ursæ Minoris, and found to be 54°. 46′. 6″, 2. On the 25th of March, 1850, I took a single series of ten consecutive direct and reflected observations of Polaris, from which there resulted the value 54°. 46′. 6″, 4, in sufficiently close agreement with the adopted value. As this element was never made use of in the reduction of circle observations, it was considered unnecessary to bestow more labour upon its correction.

The longitude was concluded by my predecessor from observations of the moon and moon-culminating stars, compared with corresponding Greenwich observations, to be $6^m\ 19^s$, 1 West. Additional observations of the same kind were from time to time made by myself, of which 20 are available for longitude. The mean result of these, given on page 20, is $6^m\ 17^s$, 3 with a considerable probable error. But a result on which much more reliance may be placed was obtained in the months of January and February, 1851, by means of chronometers conveyed twice to and from Greenwich by railway. The result of this operation, an account of which is given in the present volume, was $6^m\ 19^s$, 75, which has since been adopted as preferable to any other determination hitherto obtained.

The height of the Observatory above the mean sea-level depends on two series of levellings. The officers of the Ordnance Survey have, among their other fixed marks in the city, a crow-foot mark cut in the N.E. face of the N.W. tower of the Cathedral, at about two feet above the soil. The height of this mark above sea-level they call 215,8 feet. Arthur Beanlands, Esq., C.E., and formerly Observer in the University, many years ago made a careful level survey of the whole town of Durham, and at the same time determined the difference of height of certain points in the Observatory above certain of his bench-marks in the town. On receiving from the survey in 1851 their determination of the height of the Cathedral mark, Mr. Beanlands was requested to connect this point with his own marks, which he at once did. The result of this compound operation is, that the upper surface of the stone caps of the piers of the transit-circle is 354,5 feet above the mean sea-level, that the floor of the transit room is very nearly 350 feet, and the barometer cistern 352,4 feet above the same.

Thus are obtained the following data for determining the position of the Observatory:—

Astronomical latitude .... 54°. 46′. 6″, 2, North.
Longitude from Greenwich............ 6^m. 19^s, 75 West.
Height of the Barometer cistern above
mean sea-level .... 352, 4 feet.

OF THE INSTRUMENTS.

The Observatory possesses a small transit-circle, an astronomical clock by Hardy, an 8 feet Equatoreal by Fraunhofer, and a second Equatoreal of 7 feet presented by the late Duke of Northumberland, besides some smaller instruments not in actual use.

1. Of the Transit-circle. The object-glass is of 3½ inches aperture, and 4 feet 2 inches focal length. The eye-piece commonly used magnifies about 100 times. The horizontal axis is of gun-metal, 30 inches in length: the pivots 1½ inch in diameter, one bored, the other not. On the half-axis which has the unbored pivot is placed the divided circle, at 3 inches from the bearing, there being no corresponding load on the other half, no clamps, and no counterpoise arrangement. The diameter of the circle is 2 feet. It is independently divided on silver to every 5′, and read by one pair of microscopes at the extremities of a horizontal diameter. There is one pair of microscopes fixed on the upper surface of one pier, and another pair on the other pier, which are not moved when the instrument is reversed; one pair being in use, and the other out of use for the time. The system of wires consists of seven vertical fixed wires, two fixed horizontal wires, and one carried by a micrometer screw. There was no contrivance by which the observer could regulate the amount of light admitted into the field for the purpose of illumination: this defect was frequently felt, and limited the use of the instrument. The transit-circle room is on the second floor of the building. A single massive pier is built to within a few inches of the floor, on which are placed two solid blocks of stone supporting the East and West ends of the axis. Directly facing the East pier, and at a distance of three feet six inches from it, is a window, which latterly was screened by a stout storm-blind. The Ys on which the pivots rested were of brass, and of a construction not unusual, the one admitting of adjustment in level, the other in azimuth. These arrangements experience has shown to be objectionable, the instrumental adjustments being liable to constant fluctuation of a most troublesome amount: and they are

commented on here that those who require information on such subjects may avoid proved sources of perplexity. The first change made was to substitute a new pair of Ys, of more massive construction, admitting of no screw-adjustment in azimuth, but both furnished with precisely similar means of adjustment in level. The object was to equalise expansions by studying symmetry. The effect was that, whereas formerly the adjustment-screws were frequently in requisition, from the time that the final adjustment was effected after the mounting of the new Ys till the time that I left the Observatory, no re-adjustment was required, and the fluctuations were decidedly lessened in amount. We were led to block up the East window, by noticing that the fluctuations in level were accountable for, in a general way, on the supposition that, from some cause, the East pier expanded and contracted relatively more readily than the West, and this was naturally attributed to the facility of radiation afforded by the window. The success of this alteration was not so well ascertained from its having been carried out after I had turned from meridian to equatoreal observations; but it was believed to have contributed sensibly to the increased stability of the instrument. Turning from the construction to the state of the instrument, it must be mentioned that I found the pivots to be greatly worn; and as the working level admitted of being applied only in certain positions of the telescope, I applied for and was supplied with another, furnished with legs of sufficient length to allow of the telescope being turned completely round beneath it. The result of three experiments with this striding-level exhibited the following differences of apparent level error, for different settings of the telescope, from the mean level error at any time:

C. R.	Diff.	C. R.	Diff.	C. R.	Diff.	C. R.	Diff.
°	"	°	"	°	"	°	"
0	− 1, 01	90	− 1, 60	180	+ 0, 04	270	+ 0, 35
10	− 0, 94	100	− 1, 74	190	+ 0, 15	280	+ 0, 35
20	− 1, 03	110	− 1, 50	200	+ 1, 03	290	+ 0, 42
30	− 0, 81	120	− 0, 64	210	+ 1, 43	300	+ 0, 48
40	− 0, 52	130	+ 0, 09	220	+ 1, 60	310	+ 0, 52
50	− 0, 28	140	+ 0, 37	230	+ 1, 58	320	+ 0, 61
60	− 0, 40	150	+ 0, 24	240	+ 1, 34	330	+ 0, 42
70	− 0, 94	160	+ 0, 18	250	+ 0, 88	340	− 0, 13
80	− 1, 38	170	− 0, 04	260	+ 0, 61	350	− 0, 50

the pierced pivot being East at the time. Roughly speaking, one-half of the above quantities are due to error of form of that part of the pivots which was beneath the inverted Y feet of the level, the other half only being effective. No corrections were applied to observations for error of form of pivots But the evil was in a great degree got rid of latterly, by taking advantage of the substitution of new Ys, and by having the surface of the Y made of double its former width, and then cutting away the part nearest to the flange of the horizontal axis, so as to bring a new portion of the pivot into use. This change was not made till after the observations of stars on pages 3, 4, and 5 were finished; but happily it was carried out before the chronometric comparison of our longitude with Greenwich was effected, in which the absolute determination of time, unaffected by such source of error, was essential. The divided circle was a good deal tarnished, and at times there was some difficulty in reading off the divisions; but, on the whole, there was little to say against it.

In the circumstances related above, the only course to pursue appeared to be to use the instrument more strictly as a differential instrument, and this idea was always kept in view. The level-error was taken as often as twice a week, and the azimuth error found from Polar stars on almost every night of observation; and by further selecting for the determination of clock-error and circle-reading of the Polar point such Nautical Almanac stars as lay most nearly on a parallel with the objects whose positions were to be found, results were obtained on which very fair reliance could be placed, although work of any pretension could not be hoped for.

2. The clock (by Hardy) did its part most satisfactorily. It was once cleaned during the time that I used it. The beat was very sharp and audible, and the average difference of two consecutive daily rates not more than $0^s,15$; double that quantity being an extreme value. This clock stood in the S.E. angle of the transit-room, and, being visible from the dome above, was also used in Equatoreal observations. As, however, from the elevated position of the Observatory, noise caused by wind was a frequent source of annoyance, a hearing-tube of gutta percha, about thirty-five feet in length, was supplied at my request, and led from the clock-case into the dome, which was often of essential use.

3. Of the Fraunhofer Equatoreal. The object glass is of 6½ inches aperture, and 8 feet 3 inches focal length. The tube is of mahogany. The mounting is of the kind commonly called the German: the length of the polar axis between its upper and lower bearings 2 feet 4 inches, its diameter 1¾ inches; the hour circle is of 11 inches diameter, the circles for clamping in R.A. and N.P.D. of 9 inches diameter only. The whole is placed on a massive stone pillar passing through the centre of the building, the dome being on the top of the house. The insufficient size of the clamping circles, and a want