GREENWICH ASTRONOMICAL OBSERVATIONS.

1843.

INTRODUCTION.

1. *Personal Establishment and Arrangements.*

THE establishment of Assistants in the Astronomical department of the Royal Observatory during the year 1843 consisted of the following persons:—The Rev. Robert Main, M.A., First Assistant; Mr. John Henry, Mr. William Richardson, Mr. Thomas Ellis, and Mr. William Rogerson. The only changes which have occurred during the superintendance of the present Astronomer Royal, which commenced on the 1st of October, 1835, are the following:—In the autumn of 1835 Mr. Frederick Simms, one of the assistants, resigned, and his situation was filled by Mr. James Glaisher, who continued attached to the Astronomical department of the Observatory till the autumn of the year 1840, when he was transferred to the superintendance of the Magnetical and Meteorological department, then established. His place in the Astronomical department was filled by Mr. James Paul till the end of the year 1842. About that time it became evident that the personal establishment of the Magnetical and Meteorological department was insufficient, and Mr. Paul was then regularly attached to that department (which he has since quitted). The Lords of the Treasury have been pleased to allow, since that time, the services of occasional computers, for forwarding the reduction of the Observations, in lieu of filling up the situation thus left vacant; and the personal establishment of the Astronomical Observatory remains as above stated.

The duties of the establishment are distributed in the following manner:—

Mr. Main superintends the calculations generally, and observes, occasionally, with any of the instruments; principally, however, with those which are not employed in the daily routine of meridional observations. The observations made by Mr. Main are distinguished by the signature M. In the absence of the Astronomer Royal, he is empowered to act in all respects as his representative.

Mr. Henry, assisted by Mr. Ellis, conducts the observations with the Transit instrument, the reduction of the observations with that instrument, the rating of the clocks, the comparisons of chronometers belonging to the Royal Navy, or on trial for purchase by the Government, and the dropping of the Signal Ball at 1^h mean time every day. Their initials, attached as signatures to the observations made by them, are H. and E.

Mr. Richardson, assisted by Mr. Rogerson, makes observations with the Mural Circles, Zenith Sector, and Equatoreals, and reduces those observations. Their initials are W. R. and R.

During the absence of some of the assistants, Mr. Richard Harris and Mr. Hugh Breen, Jun., who were employed in the computations connected with the reduction of the ancient Greenwich Planetary and Lunar Observations, have been occasionally employed with the Meridian instruments. Their initials are R. H. and H. B. The assistants attached to the Magnetic Observatory, Mr. Glaisher, Mr. Hind, Mr. Dunkin, and Mr. Paul, have also occasionally observed with the Meridian instruments. Their initials are G., J. H., D., and P.

The observations, &c., are prepared for press, and the proof-sheets read, by the assistants who are regularly attached to the respective departments.

The whole of these works are under the immediate direction of the Astronomer Royal, who is responsible for every part. Correspondence relating to the affairs of the Observatory, not transacted by the Astronomer Royal himself, is managed by the First Assistant, but only at the command of the Astronomer Royal.

The course of observations, and the succession of observers, is arranged every Monday by the Astronomer Royal. In general, each assistant who makes the observations with either instrument is charged with all the observations that may occur from 15^h mean time (3 o'clock in the morning) to the next 15^h; and it is established as a rule, to be adhered to as closely as circumstances permit, that no assistant be occupied on two successive days with astronomical observations. And it is always arranged, if possible, when the Moon's time of transit passes 15^h, that the same assistant should not be required to observe the Moon and accompanying stars late in the night when the Moon passes last before 15^h, and early in the morning when the Moon passes first after 15^h.

II. *Instruments.*

The principal instruments used by Halley, Bradley, Bliss, and Maskelyne, are still preserved in the Royal Observatory, namely, Halley's Transit with pivots unequally distant from the Telescope, Bradley's Transit, and the two Mural Quadrants mounted on their piers; the Quadrant on the Western pier being now included in the safe or fireproof room of the Observatory. The Zenith Sector of Bradley and Maskelyne was removed to the Cape of Good Hope in the year 1837, to be used in the survey carrying on by Mr. Maclear for the verification and extension of La Caille's Arc, and for the mapping of a part of the Cape colony. The fixed telescope, used by Mr. Pond for investigating the parallax of α Aquilæ, is still attached to the West side of the circle pier, and, it is believed, fit for service, though it has not been used for several years. The corresponding telescope, for investigating the parallax of α Cygni, which was attached to the Western Quadrant pier, has been taken down, and deposited in the Octagon Room of the Observatory.

The instruments now in use are the following:—

The Transit instrument, constructed by Troughton, and erected in the year 1816.

The length of the telescope is about ten feet, and the clear aperture of the object-glass five inches; the length of the axis (between the extremities of the pivots) four feet. The telescope is directed to a given N.P.D. by means of circles carried by the eye-end of the telescope, whose moveable index is a spirit-level. The pivots of the axis of the transit are of steel, fixed in 1825, and fresh turned in 1832; and the severest level-examinations have never detected any want of perfect circularity of form. They continue in excellent condition. The seven wires inserted in 1836 have continued in use, without alteration, since that time. The eye-piece has also two micrometer-wires, at a small interval, carried by the same micrometer, and moving parallel to the fixed wires on which the observations are made. Two fixed horizontal wires serve to define the middle of the field, and the object observed is usually placed between them.

Two Mural Circles, of six feet diameter, constructed, one by Troughton, the other by Jones.

The Circle by Troughton has for some years been used alone, as, after a long trial of the use of both instruments simultaneously, I have come to the conclusion that, except in cases when it is necessary to observe an unusually large number of stars, nothing is gained in point of convenience or accuracy. In the year 1839 the Circle by Jones, which was in use to that time, was sent to the Cape of Good Hope, for the use of the Observatory near Cape Town, and a considerable interval elapsed before the damaged Circle (also by Jones), which was sent home by Mr. Maclear, was made ready for use. It is now fully adjusted, yet I have not felt it necessary to recur to the use of two circles. Each circle is read by six microscopes, and the diameter of the object-glass of the telescope of each is four inches.

The five-feet Equatoreal, constructed by Ramsden.

This instrument was the property of Sir George Shuckburgh, and is fully described by him in the Philosophical Transactions for 1793. It was presented to the Observatory in the year 1811. The instrument is one of that class in which the two pivots of the polar axis are at the two extremities of the polar axis, and the two pivots of the declination-axis are at the two extremities of the declination-axis. The whole length of the polar axis, between the extremities of the pivots, is about 9 feet. These pivots turn in Y's (having proper adjustments), which are carried by two piers on opposite sides of the dome. The North pivot is at the center of a circular frame; the South pivot is at the apex of a cone; and the polar frame consists of six pillars connecting the base of this cone with the circular frame. Three pillars are united by intervening bars to form the eastern side of the polar frame, and three to form the western side: they carry the Y's for the declination-axis, and the microscopes for reading the declination-circle. The length of the declination-axis between the extremities of its pivots is about $2^{ft}.\ 2^{in}$; the diameter of the declination-circle is 4 feet, and the circle is divided to 5′ of arc. The telescope is $5^{ft}.4^{in}$ in length, and has an object-glass of $4^{in}\cdot 1$ aperture. The hour-circle is connected with the cone, its diameter is 4 feet, and it is divided to 10′ of arc: these divisions are read by fixed micrometer-microscopes. This instrument is mounted in the Eastern Dome (now, 1845, denominated the North-Eastern Dome), the situation of which is most unfavourable, as the whole south-western sky, to the altitude of 35°, and a considerable extent to the altitude of 53°, is concealed by the Octagon Room of the original building of the Observatory.

The Equatoreal in the Western Dome.

This is a small telescope mounted on a long polar axis; the two pivots of the polar axis being at the two extremities of the polar axis, and the pivots of the short declination-axis being both on the same side of the telescope. The length of the polar axis is about $10^{ft}.\ 3^{in}$; the diameter of the declination-circle and that of the hour-circle 2 feet. The subdivision is effected by verniers. The length of the telescope is $2^{ft}.\ 10^{in}$; the aperture of its object-glass $3^{in}\cdot 5$. This is an instrument of an inferior class. The south-eastern sky is concealed from the Western Dome nearly in the same manner as the south-western sky from the Eastern Dome.

The Equatoreal in the South Dome (now, 1845, denominated the South-Eastern Dome).

This instrument was erected in the year 1838. The aperture of the object-glass is about 6·7 inches, and its focal length about 8 feet 2 inches. This object-glass was made by M. Cauchoix, of Paris, and was presented to the Observatory by the Rev. R. Sheepshanks. Its definition is very good: a small quantity of colour from the secondary spectrum being the only perceptible defect. It is mounted in the South Dome, with a mounting similar in general form to that of the Dorpat telescope. A stone pier is erected, whose extreme breadth from E. to W. is 1 foot 4 inches, and from N. to S. is 5 feet 4 inches: the southern part of the upper surface of this pier is sloped so that its plane produced passes through the celestial pole: upon this surface is fixed a cradle of cast-iron, having the lower bearing of the polar axis in a projection from its lower end, and the upper bearing at its upper end: the distance between the two bearings is 3 feet 7 inches. The axis is of cast-iron; its form is nearly conical: the end which rests in the lower bearing is a more obtuse cone. The diameter of the axis where it turns in the upper bearing is 6 inches: it rests here in a Y upon two plates of agate. At a small distance below the upper bearing, a strong circular plate parallel to the equator, 14 inches in diameter, is fixed to the axis; and close above it, another plate of the same size is mounted, parallel to the former, turning freely round the axis: in that surface of each of these two plates which is nearest to the other plate, a dove-tailed groove is turned, and a moveable clamping-piece has one clamp in the groove of one plate, and the other clamp in the groove of the other plate. By means of this clamping-piece the two circular plates can be fixed together at pleasure, in any relative position. The moveable circular plate is inseparably connected with a long flat arm, or sector, of 24 inches in length (measured from the circumference of the plate), in the plane of the equator: the edge of this sector is cut into teeth, in which works the endless screw carried by the clock, which is fixed to the North side of the pier. Therefore, if the clamping-piece above mentioned is not fixed to either plate, or is fixed to only one, the action of the clock-work upon the sector, though it turns the moveable circular plate, does not turn the fixed circular plate: but if the clamping-piece is fixed to both plates, the action of the clock-work on the sector carries the moveable plate and the fixed plate (now connected with it), and therefore turns the polar axis, and the telescope, &c, which is supported by the polar axis. Between that part of the clamping-piece which is connected with the fixed plate, and that part which is connected with the moveable plate, there is a slow-motion-screw, turned by means of a hook's-joint and long handle. Immediately above the upper bearing, the polar axis carries the hour-circle, 12 inches in diameter; it is divided on its edge to 1^m of time, and is read off to 2^s by two verniers. Above this, a square box is firmly fixed to the axis; perforated in one direction parallel to the equator for the insertion of the declination-axis. The diameter of the declination-axis at each of its two bearings is about 4 inches: it is supported at each in a Y. To one end of the declination-axis is fixed the cradle, carrying the telescope; to the other end is fixed the declination-circle, and the counterpoise. The diameter of the declination-circle is 11 inches; it is divided on its edge to $15'$ of arc, and is read off to $30''$ by two verniers attached to the square box. The telescope-tube is of wood; its form is square in the middle, chamfered off towards the ends so as to become octagonal; several stops, or transversal plates with holes of the proper magnitude, are fixed in it; it is very firm and free from tremours. Upon a large ring which is fixed to the square box there turns with stiff friction another ring, carrying two sector arms, graduated at their extremities: these graduations are read by micrometer-microscopes, carried one by the eye-end of the telescope-tube, and one by the object-end: the use of this graduated double sector is, to measure small differences of declination (not exceeding 10°) with great accuracy; as, being brought by the hand under the microscope, it is then retained in its position by the friction, and is not affected by the motion of the telescope. Upon another ring, which is fixed to the square box, there turns a ring-clamp, or brake, that admits of being fastened to it in any position; with this ring-clamp the telescope-cradle is connected by means of a slow-motion-screw, which fixes the telescope in declination, or gives the means of imparting to it a slow-motion in declination. The speed of the clock is regulated by two balls, suspended to the end of a horizontal arm of $4\frac{3}{4}$ inches length, which is carried by a vertical spindle; when the velocity is so great as to cause the suspending rods to make a certain angle with the vertical, small projections carried by the balls are thereby made to rub against the lower surface of a fixed horizontal ring, and the friction thus caused prevents the weight which urges the clock from increasing the velocity. This mounting was constructed by Mr. T. Grubb, of Dublin.

The great Zenith Sector.

The focal length of the vertical telescope is about 25 feet, and its aperture 5 inches. It turns horizontally upon a conical pivot at its lower end, and in a collar with steadying springs at nearly 5 feet from its upper end. This collar is carried by the upper extremity of a very large iron tube, within which the tube of the telescope revolves without touching it: the iron tube is supported by four curved iron legs diverging from its lower extremity, which is 4 feet 8 inches above the lower extremity of the telescope: the iron tube has no other support; and neither the iron tube nor its legs is connected with the walls of the building. At $3\frac{1}{2}$ inches below the object-glass, the wire of the plumb-line is attached to a reel exterior to the telescope-tube (carried by the tube), and, passing over a screw whose axis is horizontal, depends in the interior of the tube. The use of the screw is, to enable the observer to move the point of suspension laterally, either for the convenience of bringing the wire to the center of the field of the microscopes, or for the estimation of the relative values of the micrometers (to be mentioned hereafter). The wire in the greater part of its length passes within a small tube fixed within the telescope-tube: the plumb-bob hangs in a pot of water attached below the plate closing the lower end of the telescope-tube. At $5\frac{1}{2}$ inches below the screw, a micrometer-microscope is fixed on the same side of the tube, for observing the upper part of the wire: at the opposite side of the tube is an aperture with a reflector, for illuminating the microscope. At $1\frac{1}{2}$ inches above the lower end of the telescope, another micrometer-microscope is fixed on the opposite side of the tube, for observing the lower part of the wire. In the eye-piece of the telescope there are, carried by a fixed plate, ten pairs of wires arranged as acute crosses; and, carried by the moveable micrometer-plate, eleven single wires, whose intervals are not very different from those of the fixed crosses. This moveable plate is made to slide by a micrometer-screw acting in opposition to a spring in the usual way: its range is such as will carry any one of the moveable wires to touch the adjacent fixed wires on each side. The eye-piece is a four-glass eye-piece with a diagonal reflector: it is carried by a separate slider.

In order to guard against the chance of error which might arise from a rotation of the plumb-line on reversing the instrument, the following apparatus is added:—

Instead of supporting the weight of the bob upon one long plumb-line, two plumb-lines are used, one of them being the original long plumb-line without alteration of position, the other being a wire about 3 feet long at the distance of 11 inches from the former; the plane which passes through the two wires passing also through the axis of the microscope which views the lower part of the plumb-line. These two plumb-lines support the two ends of a horizontal bar, and to this the weights are suspended from two points. Near the commencement of this year the pulley over which the auxiliary plumb-line passes was attached to a plate sliding in grooves and moveable by a screw, by which a delicate motion can be given to it either towards or from the principal plumb-line; and this is used for insuring the perfect verticality of the principal plumb-line, by observing carefully whether the image of the principal plumb-line, as seen through the microscope, is equally good when free and when attached to the bar connecting it with the auxiliary plumb-line. The instrument is made capable of observing the same star in reversed positions at the same transit, chiefly by the insertion of two supplementary strong wires, moved by the micrometer, and placed at a distance from each other nearly corresponding to the double of the Zenith distance of γ Draconis. A handle placed at a convenient height enables the observer to reverse the tube rapidly, and the manner of making the double observation is therefore closely analagous to that of observing a star directly and by reflexion at the same transit with the Mural Circle.

Three detached Telescopes in the Advanced Building (formerly the place of Flamsteed's Mural Arc, and upon which now, 1845, the New South Dome is erected).

Their lengths are 46 inches, 62 inches, and 30 inches, and the diameters of their object-glasses 3·6 inches, 3·8 inches, and 2·7 inches respectively.

The Transit Clock, constructed by Hardy, and originally furnished with Hardy's escapement.

A dead-beat escapement was substituted for this by Dent in the year 1829. The jewelled holes were removed by Dent in 1836, and the pivots now turn in brass holes.

A clock in the Eastern Dome marked Arnold 1; one in the South Dome marked Earnshaw; one in the Advanced Building marked Graham 1; one in the Circle Room marked Graham 2; one near the bottom of the Zenith Tube marked Arnold 2; and some journeyman or assistant clocks.

There is also another achromatic telescope which has rarely been mounted, and two reflectors, the largest being one of 10 feet, by Sir W. Herschel.

III. *Subjects of Observation in the Year* 1843.

The Sun and Planets have been observed on the meridian at every practicable opportunity, except on Sundays: the Moon and moon-culminating stars have been observed at every opportunity without exception.

The occultations of stars by the Moon, and the eclipses of Jupiter's satellites, have been regularly looked for. The immersions and emersions of the satellites behind Jupiter, and the ingresses and egresses before him, have been looked for, when occurring at convenient hours.

In the meridional observations of stars, it has been considered as the first object to establish with indisputable accuracy the places of those included in the Nautical Almanac list (as far as they are visible in this latitude). For this purpose, the number of observations of each star made in the two preceding years is ascertained, and the additional number necessary to make this up to twenty is considered to be the number due from the present year. In far the greater number of instances this number is exceeded: in a few (especially of stars so near the pole that their transits are considered valueless except Polaris or δ Ursæ Minoris is observed above and below on the same day), the just number is not completed.

The other stars observed are: Stars remaining from the lists of former years, including those compared with Galle's second Comet, with Encke's Comet at its apparition in 1842, with Halley's Comet, with Laugier's Comet, and with Mars at its opposition in 1841; and stars observed for Colonel Everest in connexion with the Indian Survey: Stars whose occultations by the Moon have been observed at Greenwich: and, finally, Stars compared with Mauvais' First Comet and with Faye's Comet.

The Zenith Tube was used for observations of γ Draconis at every opportunity, exclusive of Sundays.

The East Equatoreal was employed in observing Mars at his opposition in 1843, Mauvais' First Comet, and Faye's Comet, and in taking transits of the Moon's limbs when both were nearly full for the comparison of her diameter with that given by Burckhardt's Tables. The South Equatoreal was used for observing Mauvais' First Comet and Faye's Comet. A few approximate observations made with it of Laugier's Comet are not thought worth publishing. The nucleus of the Great Comet of 1843 was searched for, but was not seen.

The Double-image Micrometer attached to the South Equatoreal has been used for measuring the double stars γ Virginis and 36 Ophiuchi; and for measuring the diameters of the planets Venus, Mars, and Jupiter, together with the breadth of their illuminated parts.

IV. *Explanation of the Printed Observations.*

§ 1. *Transits as observed, and calculation of Apparent Right Ascensions*, page [2] to [115].

The *first* column on each left-hand page contains the day, which is always supposed to commence with the transit of the Sun.

The *second* column contains the numbers for convenience of reference.

The *third* column contains the name of the object observed. With respect to the Sun, Moon, and Planets, the limb whose transit is observed is always mentioned. If no limb is mentioned, it is to be understood that the estimated center was observed: this, however, is generally stated unequivocally, except where omitted from inadvertence. The center is observed only when the planet's disc is so small and so round as to make it easier to estimate the center than to determine with accuracy the place of the limb. With regard to the stars, it is to be remarked, that the proper names which have commonly been used in the Greenwich Observations and the Nautical Almanac are adopted in preference to other names. For other stars, the names have been taken in the following order of preference.

1. The Greek or Italic letter of Bayer, as adopted in Baily's Flamsteed, with the name of the constellation.
2. Flamsteed's number, with the name of the constellation.
3. The number in the Astronomical Society's Catalogue.
4. Piazzi's hour and number.
5. The number in Groombridge's Catalogue.
6. The number in Bessel's Bradley.
7. The number in Baily's edition of Flamsteed's British Catalogue.
8. The North Polar Distance; which may be a few minutes in error.

The *next seven* columns contain the seconds and decimals of seconds of time (and, for several stars near the pole, the minutes) at which the object was observed to pass each of the wires: the hour and minute also being given in the *tenth* column. When the object is not observed at the 7th wire, the hour and minute are those which correspond to the last wire at which an observation was made.

With regard to the general method of observing, it may be sufficient to remark, that it is the practice to take a second from the clock-face before the transit over the first wire, and to preserve the counting by listening to the beats, and not to look again at the clock-face till the transit is finished. In observing the planets, this rule is not always adhered to; the observer looking at the clock between the transits over the different wires. The fraction of the second is noted by remarking the place at which the object is seen at the successive beats of the clock. Errors in the hours and minutes are seldom alluded to in the notes of the printed observations: but every alteration of the seconds is carefully recorded.

The clocks are wound up every Monday.

In observing the Sun, a light shade is placed upon the telescope-tube, which completely screens the axis from the Sun's rays.

In observing a double star, the brighter star (if it is not otherwise expressed) is always observed.

The *eleventh* column contains the correction which is to be applied to the mean of the wires actually observed, in order to give the result which would have been obtained if observations had been made on all the wires, or the transit across a line corresponding to the mean of all the wires (supposing the observation perfect).

The last determination of the values of the intervals between the wires of the transit-instrument was made in 1840. For this purpose, sixteen complete transits of Polaris, ending with August 6, were discussed in the following manner:—For each transit the difference between each wire and the mean of all the wires was taken; then the mean of all those determinations relating to the same wire in the different transits was taken, and was supposed to apply to the mean of all the polar distances of the star. The equatoreal distance of each wire from the mean was then computed by the formula:

$$\text{Equatoreal distance in seconds of time} = \frac{\text{sin. star's N. P. D.} \times \text{sin. dist. in time for star}}{15 \text{ sin. } 1''}:$$

and, by a reverse operation, the distances in time for a star at N. P. D. 1°. 31′ and 1°. 32′, and for a star at N.P.D. 3°. 24′ and 3°. 25′, were found. The results of these operations are contained in the following table:—

INTERVALS OF EACH WIRE FROM THE MEAN.

For an equatoreal star.

	s
A	+38·566
B	+25·674
C	+12·917
D	+ 0·048
E	−12·863
F	−25·739
G	−38·603

For Polaris, declination = 88°.28′ + n″.

A	$+24^{m}.\ 3^{s}\cdot 91 + n \times 0^{s}\cdot 265$
B	$+16.\ 0\cdot 25 + n \times 0\cdot 176$
C	$+\ 8.\ 2\cdot 83 + n \times 0\cdot 088$
D	$+\ 1\cdot 79$
E	$-\ 8.\ 0\cdot 82 - n \times 0\cdot 088$
F	$-16.\ 2\cdot 70 - n \times 0\cdot 177$
G	$-24.\ 5\cdot 31 - n \times 0\cdot 266$

For δ Ursæ Minoris, declination = 86°.35′ + n″.

A	$+10^{m}.\ 47^{s}\cdot 35 + n \times 0^{s}\cdot 053$
B	$+\ 7.\ 10\cdot 87 + n \times 0\cdot 035$
C	$+\ 3.\ 36\cdot 75 + n \times 0\cdot 018$
D	$+\ 0\cdot 81$
E	$-\ 3.\ 35\cdot 85 - n \times 0\cdot 018$
F	$-\ 7.\ 11\cdot 96 - n \times 0\cdot 035$
G	$-10.\ 47\cdot 98 - n \times 0\cdot 053$

The signs must be changed when the illuminated end is East and the star below the pole, or when the illuminated end is West and the star above the pole.

The correction to the imperfect transit of a star is found, by adding together the equatoreal numbers from the table above for the wires observed, dividing by the number of the wires, and multiplying by the secant of the star's declination.

For a planet, the number thus obtained is multiplied by

$$1 + \frac{\text{daily increase of R.A. in seconds of time}}{24 \times 60 \times 60}; \text{ or } 1 + \frac{\text{hourly increase of R.A. in seconds of time}}{60 \times 60}$$

the computation being facilitated by the following small table, of which the argument is the hourly increase of Right Ascension of the planet, taken from the Nautical Almanac.

I = Var. in R.A. in 1ʰ.	$\frac{3600 + I}{3600}$ Nat. N°.	$\frac{3600 + I}{3600}$ Log.	I = Var. in R.A. in 1ʰ.	$\frac{3600 + I}{3600}$ Nat. N°.	$\frac{3600 + I}{3600}$ Log.
+ 1ˢ	1·00028	0·00012	− 1ˢ	0·99972	9·99988
2	·00056	·00024	2	·99944	·99976
3	·00083	·00036	3	·99917	·99964
4	·00111	·00048	4	·99889	·99952
5	·00139	·00060	5	·99861	·99940
6	·00167	·00072	6	·99833	·99927
7	·00194	·00084	7	·99806	·99916
8	·00222	·00096	8	·99778	·99903
+ 9	1·00250	0·00108	− 9	0·99750	9·99891

I = Var. in R.A. in 1h.	$\frac{3600 + I}{3600}$ Nat. N°.	$\frac{3600 + I}{3600}$ Log.	I = Var. in R.A. in 1h.	$\frac{3600 + I}{3600}$ Nat. N°.	$\frac{3600 + I}{3600}$ Log.
s			s		
+ 10	1·00278	0·00120	− 10	0·99722	9·99879
11	·00306	·00132	11	·99694	·99867
12	·00333	·00144	12	·99667	·99855
13	·00361	·00156	13	·99638	·99842
14	·00389	·00169	14	·99611	·99831
15	·00417	·00181	15	·99583	·99819
16	·00444	·00192	16	·99556	·99807
17	·00472	·00204	17	·99528	·99795
18	·00500	·00216	18	·99500	·99782
19	·00528	·00229	19	·99472	·99770
20	·00555	·00240	20	·99445	·99758
21	·00583	·00252	21	·99417	·99746
22	·00611	·00265	22	·99389	·99734
23	·00639	·00277	23	·99361	·99722
24	·00667	·00289	24	·99333	·99709
25	·00694	·00300	25	·99306	·99698
26	·00722	·00312	26	·99278	·99685
27	·00750	·00324	27	·99250	·99673
28	·00778	·00337	28	·99222	·99661
29	·00806	·00349	29	·99194	·99649
+ 30	1·00833	0·00361	− 30	0·99167	9·99637

For the Moon, the whole factor is computed by the formula

$$\frac{3600 + I'}{3600} \times \frac{\text{sin. Moon's geocentric } Z.D.}{\text{sin. Moon's apparent } Z.D.} \times \text{secant Moon's geocentric declination},$$

where I is the increase (in seconds of time) of the Moon's R.A., for the transit over a meridian upon the Earth distant by 1^h of terrestrial longitude, as given in the section *Moon-culminating Stars* in the Nautical Almanac.

For the easy computation of this formula, the following small table (including the limits of the values of I) of the natural numbers and logarithms of $\frac{3600 + I}{3600}$, is used:—

I = Var. in R.A. for 1h of Longitude.	$\frac{3600 + I}{3600}$ Nat. No.	$\frac{3600 + I}{3600}$ Log.	I = Var. in R.A. for 1h of Longitude.	$\frac{3600 + I}{3600}$ Nat. No.	$\frac{3600 + I}{3600}$ Log.
s			s		
100	1·02778	0·01190	107	1·02972	0·01272
101	·02806	·01202	108	·03000	·01284
102	·02834	·01213	109	·03028	·01296
103	·02861	·01225	110	·03055	·01307
104	·02889	·01237	111	·03084	·01319
105	·02917	·01249	112	·03111	·01330
106	·02945	·01260	113	·03139	·01342
107	1·02972	0·01272	114	1·03167	0·01354

I = Var. in R.A. for 1^h of Longitude.	$\frac{3600 + I}{3600}$ Nat. No.	$\frac{3600 + I}{3600}$ Log.	I = Var. in R.A. for 1^h of Longitude.	$\frac{3600 + I}{3600}$ Nat. No.	$\frac{3600 + I}{3600}$ Log.
s 114	1·03167	0·01354	s 152	1·04222	0·01796
115	·03195	·01366	153	·04250	·01808
116	·03222	·01377	154	·04278	·01819
117	·03250	·01389	155	·04306	·01831
118	·03278	·01401	156	·04333	·01842
119	·03306	·01413	157	·04361	·01854
120	·03333	·01424	158	·04389	·01866
121	·03361	·01436	159	·04417	·01877
122	·03389	·01447	160	·04444	·01888
123	·03417	·01459	161	·04472	·01900
124	·03444	·01471	162	·04500	·01912
125	·03472	·01482	163	·04528	·01923
126	·03500	·01494	164	·04556	·01935
127	·03528	·01506	165	·04583	·01946
128	·03556	·01518	166	·04611	·01958
129	·03583	·01529	167	·04639	·01969
130	·03611	·01541	168	·04667	·01981
131	·03639	·01552	169	·04694	·01992
132	·03667	·01564	170	·04722	·02004
133	·03694	·01575	171	·04750	·02015
134	·03722	·01587	172	·04778	·02027
135	·03750	·01599	173	·04806	·02039
136	·03778	·01611	174	·04833	·02050
137	·03806	·01622	175	·04861	·02061
138	·03833	·01634	176	·04889	·02073
139	·03861	·01645	177	·04916	·02084
140	·03889	·01657	178	·04944	·02096
141	·03917	·01669	179	·04972	·02107
142	·03945	·01680	180	·05000	·02119
143	·03972	·01692	181	·05028	·02130
144	·04000	·01703	182	·05056	·02142
145	·04028	·01715	183	·05083	·02153
146	·04056	·01727	184	·05111	·02165
147	·04083	·01738	185	·05139	·02176
148	·04111	·01750	186	·05167	·02188
149	·04139	·01761	187	·05194	·02199
150	·04166	·01773	188	·05222	·02211
151	·04195	·01784	189	·05250	·02222
152	1·04222	0·01796	190	1·05278	0·02234

The *twelfth* column contains the mean of the seven wires; or the mean of the wires observed, corrected by the quantity in the eleventh column. It is therefore the time of transit over an imaginary line near to the wire D.

The *thirteenth* contains the initials of the observer's name.

The *second* column on the *right-hand* page contains the value, in seconds of arc, of the error of collimation, supposed positive when it implies an additive correction to the transits of stars above the pole. For the measurement of the error of collimation, the following method has been used.

A collimator of 63 inches focal length and 3·9 inches aperture, mounted like a transit in the north opening of the transit room, is used as a fixed mark for observing with the transit in reversed positions. The wires in the field of the collimator are arranged in the form of an acute cross, or X, which admits of being observed with great accuracy, by means of the micrometer-wire of the transit eye-piece. A metallic reflector is attached to the eye-piece of the collimator, for the purpose of throwing the light of the sky upon its wires.

In the year 1842 seven observations were made of the time of passage of Polaris across the interval between the two wires moved by the micrometer on the eye-piece of the transit-instrument. The mean of the times of passage was found to be $3^{m}. 0^{s}·86$. The corresponding mean of the polar distances of the star was $1°. 31'. 32''·3$. Also, by bringing each micrometer-wire successively into coincidence with D, it was found that the interval between them was $4^{r}·355$ (mean of 10 measures). From the above data, the value of one revolution of the micrometer-head was found to be $16''·585$.

The following are the details of the observations for the error of collimation in 1843:—

1843, Feb. 7, 21^{h}. Observer, Mr. Henry. The morning was calm and the sky cloudy; the temperature was about 35° within the room and without it.

Illuminated end East.	r
Micrometer reading on coincidence with collimator (6 measures)...........	9·103
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)...........	10·619
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	9·116
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)...........	10·616
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	9·140
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)...........	10·617
Hence reading for true line of collimation by 1st and 2nd Sets	9·861
,, ,, by 3rd and 4th Sets	9·866
,, ,, by 5th and 6th Sets	9·879
Reading for true line of collimation..................................	9·869
Micrometer reading on coincidence with *D*............................	9·915
Hence apparent error of collimation for *D*............................	0·046

The illuminated end of the axis was left West, which was also the position of the micrometer-head; and, as the readings of the micrometer increase as the wire moves apparently from the head, D was therefore East of the line of collimation, and stars pass it too late, or the correction is $-0^{r}\cdot046 = -0''\cdot763$. Also, Polaris passes the mean of wires sooner than it passes D by $1^{s}\cdot72$, which, in arc, is $0''\cdot72$; and the correction for diurnal aberration is $-0''\cdot19$. Hence, finally, the correction for collimation of the mean of wires is $-0''\cdot763 + 0''\cdot72 - 0''\cdot19 = -0''\cdot23$.

1843, April 27, 21^{h}. Observer, Mr. Henry. The morning was cloudy, with a temperature of about 50°, but a strong wind blew from the South, causing a very slight tremor of the collimator.

Illuminated end West.	**r**
Micrometer reading on coincidence with collimator (6 measures)..........	**8·101**
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)..........	**11·654**
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)..........	**8·141**
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)..........	**11·623**
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)..........	**8·169**
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)..........	**11·618**
Hence reading for true line of collimation by 1st and 2nd Sets................	**9·878**
,, ,, by 3rd and 4th Sets................	**9·882**
,, ,, by 5th and 6th Sets................	**9·894**
Reading for true line of collimation..................................	**9·885**
Micrometer reading on coincidence with *D*..........................	**9·912**
Hence apparent error of collimation for *D*..........................	**0·027**

Hence, the illuminated end being West, stars pass D too late, and the correction is $-0^{r}\cdot027$, or $-0''\cdot45$. Farther correcting this, as before, by $+0''\cdot53$, for reduction to mean of wires and for diurnal aberration, the final correction for error of collimation is $-0''\cdot45 + 0''\cdot53 = +0''\cdot08$.

1843, August 29, 21^{h}. Observers, Mr. Main and Mr. Henry. The morning was gloomy and calm, with an external temperature of 66°.

Illuminated end West.	**r**
Micrometer reading on coincidence with collimator (6 measures)..........	**7·747**
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)..........	**11·608**

	r
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)..........	7·712
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)..........	11·938
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)..........	8·136
Illuminated end East.	
Micrometer reading on coincidence with collimator (2 measures)..........	11·590

The above observations shewing that the collimator was not steady, a new set was taken after a short interval of time, by which it appears that at some time during the summer a considerable change of collimation had taken place. The observations are as follow :

	r
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)..........	11·629
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)..........	7·744
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)..........	11·629
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)..........	7·740
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)..........	11·589
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)..........	7·759
Hence reading for true line of collimation by 1st and 2nd Sets................	9·687
,, ,, by 3rd and 4th Sets................	9·685
,, ,, by 5th and 6th Sets................	9·674
Reading for true line of collimation................................	9·682
Micrometer reading on coincidence with *D*...........................	9·906
Hence apparent error of collimation for *D*...........................	0·224

Hence, with illuminated end West, stars pass D too late by $0^{r}\cdot224$, and the correction is $-0^{r}\cdot224 = -3''\cdot73$. Correcting this by $+0''\cdot53$ for reduction to mean of wires and diurnal aberration, the final correction for collimation is $-3''\cdot20$.

On account of the startling change of collimation exhibited by the preceding observations, the following additional set was made at noon on the same day:—

	r
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)..........	8·312
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)..........	10·851

Illuminated end West.	r
Micrometer reading on coincidence with collimator (6 measures)...........	8·335
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	10·810
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)...........	8·304
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	10·798
Hence reading for true line of collimation by 1st and 2nd Sets.................	9·582
,, ,, by 3rd and 4th Sets.................	9·573
,, ,, by 5th and 6th Sets.................	9·551
Reading for true line of collimation....................................	9·569
Micrometer reading on coincidence with *D*.............................	9·906
Hence apparent error of collimation for *D*	0·337

Hence, as before, stars pass D too late by $0^r{\cdot}337$, and the correction is $-0^r{\cdot}337 = -5''{\cdot}59$. Farther correcting this by $+0''{\cdot}53$ as before, the final correction for collimation is $-5''{\cdot}06$.

1843, August 30, 21^h. On account of the unsatisfactory results obtained on the preceding morning, the following observations were made. The morning was cloudy and calm, and the cross of the collimator appeared better defined than usual.

Illuminated end West.	r
Micrometer reading on coincidence with collimator (6 measures)...........	8·349
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	11·140
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)...........	8·365
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	11·111
Hence reading for true line of collimation by 1st and 2nd Sets.................	9·744
,, ,, by 3rd and 4th Sets.................	9·738
Reading for true line of collimation	9·741
Micrometer reading on coincidence with *D*.............................	9·906
Hence apparent error of collimation for *D*	0·165

Hence, the correction is $-0^r{\cdot}165$, or $-2''{\cdot}74$; and, correcting this as before by $+0''{\cdot}53$, the final correction for collimation is $-2''{\cdot}21$.

Combining this with the two preceding results, and giving weights, 3, 3, 2, to the first, second, and third results respectively, we obtain finally $-3''{\cdot}65$, which quantity has been used as a correction from August 29, 21^h to September 5.

1843, September 11, 0^h. Observer, Mr. Henry. The morning was cloudy and calm.

Illuminated end West.	r
Micrometer reading on coincidence with collimator (6 measures)..........	8·775
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)..........	11·156
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)..........	8·744
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)..........	11·165
Hence reading for true line of collimation by 1st and 2nd Sets................	9·966
,, ,, by 3rd and 4th Sets................	9·954
Reading for true line of collimation..................................	9·960
Micrometer reading on coincidence with *D*............................	9·899
Hence apparent error of collimation for *D*............................	0·061

Hence, with illuminated end West, stars pass D too soon by $0^r·061$, and the correction is + $1''·01$. Correcting this as before, the final correction for collimation is + $1''·54$.

1843, September 25, 0^h. Observer, Mr. Henry. The object-glass having been taken out and re-fixed by Mr. Simms on Sept. 20, on account of the unsteadiness of the collimation, the following observations were made. The morning was cloudy and calm, with a temperature of 60° within and without the room.

Illuminated end West.	r
Micrometer reading on coincidence with collimator (6 measures)..........	8·546
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)..........	11·146
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)..........	8·549
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)..........	11·151
Hence reading for true line of collimation by 1st and 2nd Sets................	9·846
,, ,, by 3rd and 4th Sets................	9·850
Reading for true line of collimation..................................	9·848
Micrometer reading on coincidence with *D*............................	9·881
Hence apparent error of collimation for *D*............................	0·033

Hence, with illuminated end West, stars pass D too late by $0^r·033$, and the correction is − $0''·55$. Farther correcting this by + $0''·53$ for correction to mean of wires and diurnal aberration, the final correction for collimation is − $0''·02$.

1843, October 19, 23^h. Observer, Mr. Henry. The morning was calm, with a temperature of 43° both within and without.

Illuminated end West.	r
Micrometer reading on coincidence with collimator (6 measures)...........	8·846
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	10·815
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)...........	8·847
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	10·807
Hence reading for true line of collimation by 1st and 2nd Sets.................	9·831
,, ,, by 3rd and 4th Sets.................	9·827
Reading for true line of collimation....................................	9·829
Micrometer reading on coincidence with *D*............................	9·868
Hence apparent error of collimation for *D*............................	0·039

Hence, stars pass D too late by $0^{r}\cdot039$, or the correction is $-0''\cdot65$. Correcting this by $+0''\cdot53$, as usual, the final correction for collimation is $-0''\cdot12$.

The mean of this correction and that $(-0''\cdot02)$ obtained on Sept. 25, viz. $-0''\cdot07$, is adopted for use.

1843, Nov. $10^{d}.21^{h}$. Observer, Mr. Henry. The morning was calm and cloudy, with an external temperature of 37°, and an internal temperature of 40°.

Illuminated end West.	r
Micrometer reading on coincidence with collimator (6 measures)...........	8·639
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	10·993
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)...........	8·648
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	10·985
Hence reading for true line of collimation by 1st and 2nd Sets.................	9·816
,, ,, by 3rd and 4th Sets.................	9·817
Reading for true line of collimation....................................	9·817
Micrometer reading on coincidence with *D*............................	9·862
Hence apparent error of collimation for *D*............................	0·045

Hence, stars pass D too late by $0^{r}\cdot045$, and the correction for collimation of D is $-0^{r}\cdot045$, or $-0''\cdot75$. Correcting this by $+0''\cdot53$, as usual, the final correction is $-0''\cdot22$.

1843, Dec. 1, 21^{h}. Observer, Mr. Henry. The morning was cloudy and calm, with an external temperature of 30°.

Illuminated end West.	r
Micrometer reading on coincidence with collimator (6 measures)...........	8·796
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	10·806

Illuminated end West.	r
Micrometer reading on coincidence with collimator (6 measures)...........	8·715
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	10·844
Hence reading for true line of collimation by 1st and 2nd Sets.................	9·801
,, ,, by 3rd and 4th Sets.................	9·779
Reading for true line of collimation..................................	9·790
Micrometer reading on coincidence with *D*............................	9·860
Hence apparent error of collimation for *D*............................	0·070

Hence, stars pass D too late by $0^{r}\cdot070$, and the correction for collimation of D is $-1''\cdot16$. Correcting this as usual, the final correction is $-0''\cdot63$.

The mean of this correction, and that ($-0''\cdot22$) obtained on November 10, viz. $-0''\cdot42$, is adopted for use.

The numerical correction, in seconds of time, to the observed transit, is,

$$\text{error of collimation} \times \frac{1}{15 \text{ sin. N. P. D.}}$$

The *third* column on the right-hand page contains the level-error: considered positive when the western pivot is too high. This is ascertained by the application of a large spirit-level, which is placed upon the pivots. In the year 1842 the level was twice fastened by strong copper wire to the Mural Circle, for the purpose of ascertaining the value of a division of its scale. The mean of two results obtained on January 7 by measuring upwards of 60 divisions of the scale was $1''\cdot329$. The mean of three results, obtained on November 23 from upwards of 80 divisions of the scale, gave, for the value of one division, $1''\cdot170$. The value used is $1''\cdot2$.

On January 2 of the same year the level was applied 6 times in reversed positions of the pivots of the transit instrument, to determine the value of the inequality of the pivots. The mean of the three results when the illuminated end of the axis was East, shewed that the Western pivot was too high by $+1^{d}\cdot44$; and the mean of the other three results when the illuminated end of the axis was West, shewed that the Western pivot was too high by $+1^{d}\cdot38$. The correction for this inequality has been considered too insignificant and uncertain to be applied.

The error of level is determined by applying the spirit-level 12 times (6 times in one position and 6 times in the reversed position). The level is usually applied every Saturday; the time is, however, always mentioned in the notes.

The numerical correction of the transits is,

$$\text{error of level} \times \frac{\text{cos. zenith distance south}}{15 \text{ sin. N. P. D.}}$$

On the morning of January 2 the level was applied to the pivots, and the readings of the ends of the bubble were taken, while the instrument was turned slowly as far as the construction of the level would permit. The following are the readings:—

Position of Object-glass.	Elevation of Object-glass.	Reading of East Scale.	Reading of West Scale.	Position of Object-glass.	Elevation of Object-glass.	Reading of East Scale.	Reading of West Scale.
	°	d	d		°	d	d
S	0	127·0	123·4	N	0	126·3	123·2
	10	127·0	123·3		10	126·0	123·2
	20	126·9	123·2		20	126·0	123·3
	30	126·9	123·1		30	126·0	123·3
	40	126·8	123·1		40	126·0	123·3
	50	126·9	123·2		50	125·9	123·3
	60	126·8	123·2		60	125·8	123·2
	0	126·5	123·0		0	125·5	123·3
	− 10	126·3	123·0		− 10	125·2	123·4
	− 20	126·5	123·1		− 20	125·3	123·5
	− 30	126·5	123·0		− 30	125·8	123·2
	− 40	126·3	123·1		− 40	125·9	123·3
	− 50	126·3	123·2		− 50	125·8	123·2
	− 60	126·2	123·3		− 60	125·8	123·3

The above observations shew that there is no appreciable irregularity of an anomalous character in the form of the pivots, and no irregularity which affects, by an appreciable quantity, the relative elevation of the pivots. This remark does not exclude the possibility of an oval form, which would cause horizontal disturbance of the pivots; but it renders it extremely improbable.

Shortly after the above observations, Mr. Henry and Mr. Ellis examined the general condition of the pivots, and found them to be in excellent order. They appear never to have been in better condition. Though examined with a magnifying glass, no defects or scratches of any importance are visible, and they are perfectly smooth to the touch.

The *fourth* column contains the transits corrected for the error of collimation and the level-error. These are set down only for those stars which are used for deducing the azimuthal error.

The *fifth* column contains the azimuthal error, considered positive when the eastern pivot is too far north. This is generally determined from observations of Polaris, at consecutive passages above and below the pole, or from one observation of Polaris, combined with one observation of another star. The stars used for this purpose are mentioned in the notes: the method of using them is as follows:

If two consecutive passages of Polaris have been observed, the first transit (as corrected for the error of collimation and level-error) is altered by the change of the star's R.A., and the estimated clock-rate for 12^h; and the difference, in seconds of time, between the altered first transit and the second transit (rejecting 12^h) is divided by 3·125 to obtain the azimuthal error in seconds of space.

If three transits have been observed, the difference between the first and second is taken (rejecting 12^h), and the difference between the second and third in like manner: and the mean between these is supposed to be independent of the change of R.A. and the clock's rate, and is then divided by 3·125.

If several transits have been observed, the same process is used for every successive set of three, and the results are used separately, or the mean of the results is taken, according as there appears reason to think that the position of the instrument has or has not undergone a change.

When a single observation only can be obtained: the letter z being put for the azimuthal error, the clock-error is found by comparing the R.A. of the Nautical Almanac (with a small alteration hereafter mentioned) with the time of transit including a term multiplied by z. The clock-error, therefore, from Polaris, contains a term depending on z. In like manner the clock-error from some other star not near the pole contains a term depending on z. Equating these (with the proper allowance for rate of the clock), z is found.

The error is positive when the transit of Polaris above the pole is too late.

In a few instances, δ Ursæ Minoris has been used instead of Polaris. The division used with it is 1·396.

The numerical correction in seconds of time to each transit is,

$$\text{azimuthal error} \times \frac{\text{sin. zenith distance south.}}{15 \times \text{sin. N.P.D.}}$$

On September 9, the sky being clear, some observations were made of the position of the Chingford mark, by which it appeared that the center of the mark was apparently West, or really East of D by 0″·464. Now, by observations made on September 11, for determining the error of collimation, D was found to lie apparently West, or really East of the line of collimation by 1″·01. Therefore the mark was really East of the line of collimation by 1″·47. The azimuthal error, by consecutive observations of Polaris, extending from Sep. 6, 2^h, to Sep. 8, 2^h, was + 2″·90, and by three consecutive observations on Sep. 12 and 13, it was + 2″·89. Using, therefore, + 2″·90, by which the telescope pointed to the West of the North meridian, the mark appears to be West of the North meridian by 1″·43.

Taking as correct the result obtained at page xiii of the Introduction to the volume for 1842, it would appear that the error of collimation applied at this time was sensibly in error.

The numerical values of the above-mentioned three factors, for error of collimation, for error of level, and for azimuthal error, are obtained at sight from the following tables; of which the first is constructed for the stars of the Nautical Almanac, and the second is general, having for its argument the polar distance of the object observed:

Star.	Collimation. $\frac{1}{15 \text{Sin.N.P.D.}}$	Level. $\frac{\text{Cos. Z.D.}}{15 \text{Sin.N.P.D.}}$	Azimuth. $\frac{\text{Sin. Z.D.}}{15 \text{Sin.N.P.D.}}$
α Andromedæ	+0·076	+0·069	+0·030
γ Pegasi	+0·069	+0·055	+0·042
α Cassiopeiæ	+0·118	+0·118	−0·009
β Ceti	+0·070	+0·024	+0·066
Polaris	+2·510	+2·004	−1·510
θ Ceti	+0·067	+0·033	+0·059
η Ursæ Majoris S.P.	−0·104	−0·021	+0·102
α Arietis	+0·072	+0·063	+0·035
γ Ceti	+0·067	+0·044	+0·050
β Ursæ Minoris S.P.	−0·254	−0·151	+0·205
α Ceti	+0·067	+0·045	+0·050
α Persei	+0·102	+0·102	+0·004
η Tauri	+0·073	+0·064	+0·034
γ Eridani	+0·069	+0·028	+0·062
ζ Ursæ Minoris S.P.	−0·329	−0·210	+0·253
η Draconis S.P.	−0·141	−0·056	+0·130
Aldebaran	+0·070	+0·057	+0·040
ε Ursæ Minoris S.P.	−0·497	−0·344	+0·359
Capella	+0·095	+0·095	+0·009
Rigel	+0·067	+0·034	+0·058
β Tauri	+0·076	+0·070	+0·030
δ Orionis	+0·067	+0·041	+0·052
α Leporis	+0·070	+0·025	+0·066
β Draconis S.P.	−0·109	−0·026	+0·106
ε Orionis	+0·067	+0·040	+0·053
α Columbæ	+0·080	+0·006	+0·080
α Orionis	+0·067	+0·048	+0·047
γ Draconis S.P.	−0·107	−0·024	+0·104
μ Geminorum	+0·072	+0·063	+0·035
Cephei 51 (Hev.)	+1·394	+1·131	−0·815
δ Ursæ Minoris S.P.	−1·120	−0·834	+0·750
Sirius	+0·070	+0·026	+0·065
ε Canis Majoris	+0·076	+0·013	+0·075
δ Geminorum	+0·072	+0·063	+0·035
Castor	+0·079	+0·074	+0·026
Procyon	+0·067	+0·047	+0·048
Pollux	+0·075	+0·070	+0·030
15 Argûs	+0·073	+0·018	+0·070
λ Ursæ Minoris S.P.	−3·300	−2·539	+2·106
α Cygni S.P.	−0·094	−0·010	+0·093
ε Hydræ	+0·067	+0·048	+0·047
ι Ursæ Majoris	+0·101	+0·101	+0·005
α Cephei S.P.	−0·141	−0·056	+0·130
α Hydræ	+0·067	+0·034	+0·058
θ Ursæ Majoris	+0·109	+0·109	−0·002
β Cephei S.P.	−0·193	−0·101	+0·165
ε Leonis	+0·073	+0·065	+0·033
Regulus	+0·068	+0·053	+0·043
α Ursæ Majoris	+0·145	+0·142	−0·028
δ Leonis	+0·072	+0·062	+0·036
δ Crateris	+0·069	+0·029	+0·062
γ Cephei S.P.	−0·290	−0·179	+0·228
β Leonis	+0·069	+0·056	+0·041
γ Ursæ Majoris	+0·115	+0·115	−0·006
β Corvi	+0·072	+0·020	+0·069
α Cassiopeiæ S.P.	−0·118	−0·035	+0·113
12 Canum Venaticûm	+0·086	+0·084	+0·018
Polaris S.P.	−2·510	−1·921	+1·615
Spica	+0·068	+0·032	+0·060
η Ursæ Majoris	+0·104	+0·104	+0·002
η Bootis	+0·070	+0·060	+0·038
Arcturus	+0·071	+0·061	+0·037
ε Bootis	+0·075	+0·069	+0·030
α Libræ	+0·069	+0·027	+0·064
β Ursæ Minoris	+0·254	+0·234	−0·101
β Libræ	+0·067	+0·033	+0·058
α Persei S.P.	−0·102	−0·019	+0·100
α Coronæ Borealis	+0·075	+0·069	+0·031
α Serpentis	+0·067	+0·048	+0·047
ζ Ursæ Minoris	+0·329	+0·293	−0·148
β^1 Scorpii	+0·071	+0·023	+0·067
δ Ophiuchi	+0·067	+0·038	+0·054
Antares	+0·074	+0·016	+0·072
η Draconis	+0·141	+0·139	−0·026
ε Ursæ Minoris	+0·497	+0·427	−0·255
Capella S.P.	−0·095	−0·012	+0·095
α Herculis	+0·069	+0·055	+0·041
β Draconis	+0·109	+0·109	−0·002
α Ophiuchi	+0·068	+0·053	+0·043
γ Draconis	+0·107	+0·107	0·000
μ Sagittarii	+0·071	+0·021	+0·068
Cephei 51 (Hev.) S.P.	−1·394	−1·048	+0·920
δ Ursæ Minoris	+0·122	+0·918	+0·646
α Lyræ	+0·086	+0·083	+0·019
β Lyræ	+0·080	+0·076	+0·025
ζ Aquilæ	+0·068	+0·054	+0·042
δ Aquilæ	+0·067	+0·044	+0·050
γ Aquilæ	+0·068	+0·051	+0·045
α Aquilæ	+0·067	+0·049	+0·046
β Aquilæ	+0·067	+0·047	+0·048
α^2 Capricorni	+0·068	+0·029	+0·062
λ Ursæ Minoris	+3·300	+2·622	−2·002
α Cygni	+0·094	+0·093	+0·011
ι Ursæ Majoris S.P.	−0·101	−0·018	+0·099
61 Cygni	+0·085	+0·082	+0·020
ζ Cygni	+0·077	+0·071	+0·029
α Cephei	+0·141	+0·139	−0·026
θ Ursæ Majoris S.P.	−0·109	−0·028	+0·106
β Aquarii	+0·067	+0·036	+0·057
β Cephei	+0·193	+0·184	−0·061
ε Pegasi	+0·067	+0·050	+0·045
α Aquarii	+0·067	+0·040	+0·053
ζ Pegasi	+0·068	+0·051	+0·045
Fomalhaut	+0·077	+0·011	+0·077
α Ursæ Majoris S.P.	−0·145	−0·059	+0·132
α Pegasi	+0·069	+0·055	+0·041
ι Piscium	+0·067	+0·046	+0·049
γ Cephei	+0·290	+0·262	−0·124
γ Ursæ Majoris S.P.	−0·115	−0·032	+0·111

N. P. D.	Collimation. $\frac{1}{15\ \text{Sin. N.P.D.}}$	Level. $\frac{\text{Cos. Z. D.}}{15\ \text{Sin. N.P.D.}}$	Azimuth. $\frac{\text{Sin. Z. D.}}{15\ \text{Sin. N.P.D.}}$	N. P. D.	Collimation. $\frac{1}{15\ \text{Sin. N.P.D.}}$	Level. $\frac{\text{Cos. Z. D.}}{15\ \text{Sin. N.P.D.}}$	Azimuth. $\frac{\text{Sin. Z. D.}}{15\ \text{Sin. N.P.D.}}$
° ′				° ′			
−45. 0	−0·094	−0·011	+0·094	− 7. 0	−0·547	−0·383	+0·390
−44. 0	−0·096	−0·013	+0·095	− 6. 30	−0·589	−0·416	+0·417
−43. 0	−0·098	−0·014	+0·096	− 6. 0	−0·638	−0·455	+0·447
−42. 0	−0·100	−0·016	+0·098				
−41. 0	−0·102	−0·018	+0·100	6. 0	+0·638	+0·538	−0·343
−40. 0	−0·104	−0·021	+0·102	6. 30	+0·589	+0·499	−0·312
−39. 0	−0·106	−0·023	+0·104	7. 0	+0·547	+0·466	−0·286
−38. 0	−0·108	−0·025	+0·105	7. 30	+0·511	+0·438	−0·263
−37. 0	−0·111	−0·027	+0·107	8. 0	+0·479	+0·413	−0·243
−36. 0	−0·113	−0·030	+0·109	8. 30	+0·451	+0·391	−0·226
−35. 0	−0·116	−0·033	+0·111	9. 0	+0·426	+0·371	−0·210
−34. 0	−0·119	−0·036	+0·114	9. 30	+0·404	+0·353	−0·196
−33. 0	−0·122	−0·039	+0·116	10. 0	+0·384	+0·337	−0·183
−32. 0	−0·126	−0·042	+0·119	10. 30	+0·366	+0·323	−0·172
−31. 0	−0·129	−0·045	+0·121	11. 0	+0·349	+0·310	−0·161
−30. 0	−0·133	−0·049	+0·124	11. 30	+0·334	+0·298	−0·152
−29. 0	−0·138	−0·053	+0·127	12. 0	+0·321	+0·287	−0·143
−28. 0	−0·142	−0·057	+0·130	12. 30	+0·308	+0·277	−0·135
−27. 0	−0·147	−0·061	+0·133	13. 0	+0·296	+0·267	−0·128
−26. 0	−0·152	−0·065	+0·137	13. 30	+0·288	+0·259	−0·122
−25. 0	−0·158	−0·070	+0·141	14. 0	+0·276	+0·251	−0·116
−24. 0	−0·164	−0·076	+0·145	14. 30	+0·266	+0·244	−0·111
−23. 0	−0·171	−0·082	+0·150	15. 0	+0·257	+0·236	−0·105
−22. 0	−0·178	−0·088	+0·155	15. 30	+0·249	+0·230	−0·099
−21. 0	−0·186	−0·094	+0·160	16. 0	+0·242	+0·224	−0·093
−20. 0	−0·195	−0·102	+0·166	16. 30	+0·235	+0·218	−0·088
−19. 30	−0·200	−0·106	+0·170	17. 0	+0·228	+0·212	−0·084
−19. 0	−0·205	−0·110	+0·173	17. 30	+0·222	+0·207	−0·080
−18. 30	−0·210	−0·114	+0·176	18. 0	+0·216	+0·202	−0·076
−18. 0	−0·216	−0·119	+0·180	18. 30	+0·210	+0·197	−0·072
−17. 30	−0·222	−0·124	+0·184	19. 0	+0·205	+0·193	−0·068
−17. 0	−0·228	−0·129	+0·188	19. 30	+0·200	+0·189	−0·065
−16. 30	−0·235	−0·134	+0·192	20. 0	+0·195	+0·185	−0·062
−16. 0	−0·242	−0·140	+0·197	21. 0	+0·186	+0·177	−0·056
−15. 30	−0·249	−0·146	+0·202	22. 0	+0·178	+0·171	−0·051
−15. 0	−0·257	−0·153	+0·207	23. 0	+0·171	+0·164	−0·046
−14. 30	−0·266	−0·160	+0·213	24. 0	+0·164	+0·159	−0·041
−14. 0	−0·276	−0·168	+0·219	25. 0	+0·158	+0·153	−0·037
−13. 30	−0·286	−0·176	+0·225	26. 0	+0·152	+0·148	−0·033
−13. 0	−0·296	−0·184	+0·232	27. 0	+0·147	+0·144	−0·029
−12. 30	−0·308	−0·194	+0·240	28. 0	+0·142	+0·140	−0·026
−12. 0	−0·321	−0·204	+0·248	29. 0	+0·138	+0·136	−0·023
−11. 30	−0·334	−0·214	+0·256	30. 0	+0·133	+0·131	−0·020
−11. 0	−0·349	−0·227	+0·266	31. 0	+0·129	+0·128	−0·017
−10. 30	−0·366	−0·240	+0·276	32. 0	+0·126	+0·125	−0·014
−10. 0	−0·384	−0·254	+0·288	33. 0	+0·122	+0·122	−0·012
− 9. 30	−0·404	−0·270	+0·300	34. 0	+0·119	+0·119	−0·009
− 9. 0	−0·426	−0·288	+0·314	35. 0	+0·116	+0·116	−0·007
− 8. 30	−0·451	−0·308	+0·330	36. 0	+0. 113	+0·113	−0·005
− 8. 0	−0·479	−0·330	+0·348	37. 0	+0·111	+0·111	−0·003
− 7. 30	−0·511	−0·355	+0·368	38. 0	+0·108	+0·108	−0·001
− 7. 0	−0·547	−0·383	+0·390	39. 0	+0·106	+0·106	+0·001
				40. 0	+0·104	+0·104	+0·003

N. P. D.	Collimation. $\frac{1}{15 \text{ Sin. N. P. D.}}$	Level. $\frac{\text{Cos. Z. D.}}{15 \text{ Sin. N. P. D.}}$	Azimuth. $\frac{\text{Sin. Z. D.}}{15 \text{ Sin. N. P. D.}}$	N. P. D.	Collimation. $\frac{1}{15 \text{ Sin. N. P. D.}}$	Level. $\frac{\text{Cos. Z. D.}}{15 \text{ Sin. N. P. D.}}$	Azimuth. $\frac{\text{Sin. Z. D.}}{15 \text{ Sin. N. P. D.}}$
° ′				° ′			
40. 0	+0·104	+0·104	+0·003	83. 0	+0·067	+0·048	+0·047
41. 0	+0·102	+0·101	+0·004	84. 0	+0·067	+0·047	+0·048
42. 0	+0·100	+0·099	+0·006	85. 0	+0·067	+0·046	+0·048
43. 0	+0·098	+0·097	+0·007	86. 0	+0·067	+0·045	+0·049
44. 0	+0·096	+0·096	+0·009	87. 0	+0·067	+0·044	+0·050
45. 0	+0·094	+0·094	+0·011	88. 0	+0·067	+0·043	+0·051
46. 0	+0·093	+0·092	+0·012	89. 0	+0·067	+0·042	+0·052
47. 0	+0·091	+0·090	+0·013	90. 0	+0·067	+0·041	+0·052
48. 0	+0·090	+0·088	+0·015	91. 0	+0·067	+0·040	+0·053
49. 0	+0·088	+0·087	+0·016	92. 0	+0·067	+0·040	+0·054
50. 0	+0·087	+0·085	+0·017	93. 0	+0·067	+0·039	+0·054
51. 0	+0·086	+0·084	+0·018	94. 0	+0·067	+0·038	+0·055
52. 0	+0·085	+0·082	+0·020	95. 0	+0·067	+0·037	+0·056
53. 0	+0·083	+0·081	+0·021	96. 0	+0·067	+0·036	+0·057
54. 0	+0·082	+0·080	+0·022	97. 0	+0·067	+0·035	+0·057
55. 0	+0·081	+0·078	+0·023	98. 0	+0·067	+0·034	+0·058
56. 0	+0·080	+0·077	+0·024	99. 0	+0·067	+0·033	+0·059
57. 0	+0·080	+0·075	+0·025	100. 0	+0·068	+0·032	+0·060
58. 0	+0·079	+0·074	+0·026	101. 0	+0·068	+0·031	+0·060
59. 0	+0·078	+0·073	+0·027	102. 0	+0·068	+0·030	+0·061
60. 0	+0·077	+0·072	+0·028	103. 0	+0·068	+0·029	+0·062
61. 0	+0·076	+0·070	+0·029	104. 0	+0·069	+0·028	+0·063
62. 0	+0·076	+0·069	+0·030	105. 0	+0·069	+0·027	+0·063
63. 0	+0·075	+0·068	+0·031	106. 0	+0·069	+0·027	+0·064
64. 0	+0·074	+0·067	+0·032	107. 0	+0·070	+0·026	+0·065
65. 0	+0·073	+0·066	+0·033	108. 0	+0·070	+0·025	+0·066
66. 0	+0·073	+0·065	+0·034	109. 0	+0·071	+0·024	+0·066
67. 0	+0·072	+0·064	+0·035	110. 0	+0·071	+0·023	+0·067
68. 0	+0·072	+0·063	+0·035	111. 0	+0·072	+0·022	+0·068
69. 0	+0·071	+0·061	+0·036	112. 0	+0·072	+0·021	+0·069
70. 0	+0·071	+0·060	+0·037	113. 0	+0·073	+0·020	+0·070
71. 0	+0·071	+0·059	+0·038	114. 0	+0·073	+0·018	+0·071
72. 0	+0·070	+0·058	+0·039	115. 0	+0·074	+0·017	+0·072
73. 0	+0·070	+0·057	+0·039	116. 0	+0·075	+0·016	+0·072
74. 0	+0·069	+0·056	+0·040	117. 0	+0·075	+0·015	+0·073
75. 0	+0·069	+0·055	+0·041	118. 0	+0·076	+0·014	+0·074
76. 0	+0·069	+0·054	+0·042	119. 0	+0·076	+0·013	+0·075
77. 0	+0·068	+0·053	+0·043	120. 0	+0·077	+0·012	+0·076
78. 0	+0·068	+0·053	+0·043	121. 0	+0·078	+0·011	+0·077
79. 0	+0·068	+0·052	+0·044	122. 0	+0·079	+0·009	+0·078
80. 0	+0·068	+0·051	+0·045	123. 0	+0·080	+0·008	+0·079
81. 0	+0·067	+0·050	+0·045	124. 0	+0·080	+0·007	+0·080
82. 0	+0·067	+0·049	+0·046	125. 0	+0·081	+0·005	+0·081
83. 0	+0·067	+0·048	+0·047	126. 0	+0·082	+0·004	+0·082

The *sixth* column contains the seconds of every transit as affected with the three preceding corrections: and is conceived to represent the time at which each body passed the true astronomical meridian of Greenwich. The numbers to which a bracket is annexed are those resulting from the mean of two limbs.

The *seventh* column contains the seconds of the tabular R. A. of the stars which are

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used for determining the clock-error. The stars are taken from the list of the Nautical Almanac, those only being used whose N.P.D. exceeds 50°. The tabular R.A. of Polaris also is set down, to enable the reader to judge of the general state of adjustment of the instrument. The tabular R.A. are computed by adding to the place given in the Nautical Almanac a constant for each star, representing the excess of the Mean R.A. for 1843, Jan. 1, brought up from the Greenwich Catalogue of 1439 stars (Appendix to Greenwich Observations, 1842), above the Mean R.A. for 1843, Jan. 1, in the Nautical Almanac. Thus the corrections of the Nautical Almanac are employed, while the mean places adopted are those of the Greenwich Catalogue. For Polaris, the additional correction depending on the place of the Moon is also taken into account. The following table gives the mean R.A. for 1843, Jan. 1, which in fact are used in these computations, and the constant alterations to the places of the Nautical Almanac.

Star's Name.	Assumed Mean R. A. Jan. 1, 1843.	Correction to N. A.	Star's Name.	Assumed Mean R. A. Jan. 1, 1843.	Correction to N. A.
	h m s	s		h m s	s
α Andromedæ	0. 0. 16·91	+ 0·07	β Corvi	12. 26. 8·97	+ 0·09
γ Pegasi	0. 5. 9·37	+ 0·09	Spica	13. 16. 55·70	+ 0·10
β Ceti	0. 35. 42·23	+ 0·09	η Bootis	13. 47. 12·49	+ 0·12
Polaris	1. 3. 0·34	+ 0·83	Arcturus	14. 8. 30·07	+ 0·08
θ Ceti	1. 16. 10·56	+ 0·10	ε Bootis	14. 38. 7·76	+ 0·10
α Arietis	1. 58. 20·00	+ 0·06	α Libræ	14. 42. 12·14	+ 0·07
γ Ceti	2. 35. 10·23	+ 0·09	β Libræ	15. 8. 33·87	+ 0·10
α Ceti	2. 54. 4·70	− 0·02	α Coronæ Borealis	15. 28. 2·41	+ 0·07
η Tauri	3. 38. 9·68	+ 0·08	α Serpentis	15. 36. 32·19	+ 0·05
γ Eridani	3. 50. 42·31	+ 0·08	β^1 Scorpii	15. 56. 18·92	+ 0·12
Aldebaran	4. 26. 55·03	+ 0·10	δ Ophiuchi	16. 6. 7·31	+ 0·08
Rigel	5. 6. 59·65	+ 0·08	Antares	16. 19. 47·37	+ 0·09
β Tauri	5. 16. 22·23	+ 0·09	α Herculis	17. 7. 29·37	+ 0·07
δ Orionis	5. 23. 59·18	+ 0·11	α Ophiuchi	17. 27. 38·83	+ 0·07
α Leporis	5. 25. 48·39	+ 0·10	μ Sagittarii	18. 4. 22·41	+ 0·08
ε Orionis	5. 28. 14·87	+ 0·07	δ Ursæ Minoris	18. 22. 58·52	+ 0·07
α Columbæ	5. 33. 57·91	+ 0·11	α Lyræ	18. 31. 37·25	+ 0·06
α Orionis	5. 46. 40·37	+ 0·09	β Lyræ	18. 44. 16·98	+ 0·08
μ Geminorum	6. 13. 27·62	+ 0·06	ζ Aquilæ	18. 58. 11·60	+ 0·09
Sirius	6. 38. 13·83	+ 0·08	δ Aquilæ	19. 17. 34·78	+ 0·06
ε Canis Majoris	6. 52. 27·33	+ 0·12	γ Aquilæ	19. 38. 47·63	+ 0·09
δ Geminorum	7. 10. 44·45	+ 0·10	α Aquilæ	19. 43. 7·28	+ 0·06
Castor	7. 24. 34·43	+ 0·11	β Aquilæ	19. 47. 35·96	+ 0·07
Procyon	7. 31. 4·71	+ 0·11	α^2 Capricorni	20. 9. 20·24	+ 0·08
Pollux	7. 35. 42·01	+ 0·08	ζ Cygni	21. 6. 15·35	+ 0·07
15 Argûs	8. 0. 51·50	+ 0·17	β Aquarii	21. 23. 17·30	+ 0·12
ε Hydræ	8. 38. 27·46	+ 0·13	ε Pegasi	21. 36. 28·43	+ 0·06
α Hydræ	9. 19. 52·25	+ 0·08	α Aquarii	21. 57. 43·01	+ 0·06
ε Leonis	9. 36. 55·70	+ 0·06	ζ Pegasi	22. 33. 37·92	+ 0·10
Regulus	10. 0. 0·34	+ 0·08	Fomalhaut	22. 48. 57·55	+ 0·09
δ Leonis	11. 5. 44·93	+ 0·09	α Pegasi	22. 56. 56·57	+ 0·07
δ Crateris	11. 11. 29·55	+ 0·28	ι Piscium	23. 31. 52·45	+ 0·02
β Leonis	11. 41. 2·79	+ 0·08			

The *eighth* column contains the error of the clock, found by subtracting the numbers in the sixth column from those in the seventh. It is therefore positive when the clock is slow.

The *ninth* and *tenth* columns contain the adopted losing rate, and the adopted error of the clock at 0^h sidereal, as found by the following process. The observations are divided into groups, marked by bars across these columns (in far the greater number of instances the same as the limits of each individual's observations). On two or three occasions, the observations of clock-stars by one observer have been combined with those by another; but in those cases it is believed that personal equation does not exist to any amount worth consideration. The mean of the clock-errors given by all the clock-stars in the same group is then taken, and this is held to be the clock-error corresponding to the mean of all the times of transit of the same stars. The next step is to allow for personal equation. It will be seen in one of the following tables in this Introduction (page xxx), that the clock-error given by Mr. Ellis's observations is greater than that given by Mr. Henry's observations by $0^s{\cdot}25$, as deduced from the mean of the observations suitable for its determination in this year 1843; but, this quantity not having been determined before the complete reduction of the observations of 1843, the quantity $0^s{\cdot}36$, which has been used in former years, is subtracted from each of the mean clock-errors determined by Mr. Ellis, and it is then considered that we have a set of clock-errors justly comparable among themselves. Each mean clock-error is now compared with that which precedes and with that which follows; a preceding rate and a following rate are thus found, and by this the computer is guided in adopting the clock-rate to be used through the group of observations: this adopted clock-rate is set down in the ninth column. For facility of calculation, the proportional part of this rate, corresponding to the mean sidereal time or mean of all the times of transit for the group, is applied with changed sign to the mean clock-error (unaltered for personal equation), and thus the clock-error at 0^h sidereal is found. If it happen that any observations included in the same group are made in the sidereal day preceding or following that for which the mean error has been found, the whole adopted daily rate is subtracted from or added to the error found for 0^h, and thus the error for 0^h of the preceding or following sidereal day is obtained. These errors at 0^h are set down in the tenth column. It is to be remarked that, in the application of these errors, if the observations of small stars and planets have been made by the same person as the observations of the clock-stars (whether it be Mr. Henry or Mr. Ellis), no further computation is necessary for obtaining the right ascension of these objects than the application to the time of transit of the clock-error at 0^h, and a proportional part of the clock-rate corresponding to the right ascension of the object: but, if the clock-stars are observed by Mr. Ellis and the other object by Mr. Henry, a farther correction of $-\,0^s{\cdot}25$ must be applied; if the clock-stars are observed by Mr. Henry and the object by Mr. Ellis, $+\,0^s{\cdot}25$ must be applied. These quantities are *not* applied in the column of *Apparent Right Ascension from the Observations* in this Section.

In the years preceding, from 1838 to 1842, observations were exhibited which give the relative personal equations of the different observers with the transit, as far as means existed for determining them.

In the year 1843, the following sets of observations have been found available for determining personal equations. They have been treated in the same manner as in former years, by comparing the clock-error at the same sidereal noon given by two different groups of stars observed by different persons.

OBSERVATIONS for the PERSONAL EQUATION between MR. MAIN and MR. HENRY.

Day, 1843.	Interval of nearest Stars.	Order of Observations.	Clock Slow at 0^h by M.	Clock Slow at 0^h by H.	M — H.
	h		s	s	s
July 14	7	H M	23·74	23·57	+ 0·17
16 to 17	10	H M	26·90	26·78	+ 0·12
19	4	H M	28·23	28·11	+ 0·12

The mean of these values is + 0^s·14. For an observation of the Sun on April 17, + 0^s·10 has been used as a correction.

OBSERVATIONS for the PERSONAL EQUATION between MR. MAIN and MR. RICHARDSON.

Day, 1843.	Interval of nearest Stars.	Order of Observations.	Clock Slow at 0^h by M.	Clock Slow at 0^h by WR.	M — WR
	h		s	s	s
July 25	1	M WR	31·36	31·43	— 0·07

OBSERVATIONS for the PERSONAL EQUATION between MR. MAIN and MR. ELLIS.

Day, 1843.	Interval of nearest Stars.	Order of Observations.	Clock Slow at 0^h by M.	Clock Slow at 0^h by E.	E — M.
	h		s	s	s
March 16	12	E M	3·04	3·38	+ 0·34
April 17 to 18	5	M E	19·21	19·61	+ 0·40
July 31 to Aug. 1	8	M E	35·92	36·08	+ 0·16
August 2	10	M E	36·87	37·19	+ 0·32
October 12 to 13	4	M E	23·83	24·06	+ 0·23
November 11	7	M E	48·97	49·44	+ 0·47

The mean of these values is + 0^s·32. For an observation of Venus on May 15, and of the Sun on May 16, the correction + 0^s·30 has been used.

OBSERVATIONS for the PERSONAL EQUATION between MR. MAIN and MR. ROGERSON.

Day, 1843.		Interval of nearest Stars.	Order of Observations.	Clock Slow at 0^h by M.	Clock Slow at 0^h by R.	M — R.
March	16 to 17	h 11	M R	s 3·86	s 4·04	s — 0·18
August	10 to 11	9	R M	42·90	43·10	— 0·20

The mean of these values is — $0^s·19$.

OBSERVATIONS for the PERSONAL EQUATION between MR. MAIN and MR. HIND.

Day, 1843.		Interval of nearest Stars.	Order of Observations.	Clock Slow at 0^h by M.	Clock Slow at 0^h by J H.	M — J H.
August	11	h 2	M J H	s 43·65	s 43·54	s + 0·11
	18 to 19	4	J H M	49·51	49·38	+ 0·13

The mean of these values is + $0^s·12$, which correction is used for an observation of Uranus on August 22.

OBSERVATIONS for the PERSONAL EQUATION between MR. MAIN and MR. DUNKIN.

Day, 1843.		Interval of nearest Stars.	Order of Observations.	Clock Slow at 0^h by M.	Clock Slow at 0^h by D.	M — D
August	17	h 3	M D	s 48·67	s 48·68	s — 0·01

OBSERVATIONS for the PERSONAL EQUATION between MR. MAIN and MR. PAUL.

Day, 1843.		Interval of nearest Stars.	Order of Observations.	Clock Slow at 0^h by M.	Clock Slow at 0^h by P.	M — P.
August	16 to 17	h 13	P M	s 47·72	s 47·86	s — 0·14

OBSERVATIONS for the PERSONAL EQUATION between MR. HENRY and MR. RICHARDSON.

Day. 1843.		Interval of nearest Stars.	Order of Observations.	Clock Slow at 0^h by H.	Clock Slow at 0^h by W R.	W R — H
June	22 to 23	h 12	H WR	s 63·07	s 63·32	s + 0·25
	26 to 27	9	H WR	7·33	7·68	+ 0·35

The mean of these values is + $0^s·30$. This value was used for an observation of Mars on September 20.

OBSERVATIONS for the PERSONAL EQUATION between MR. HENRY and MR. ELLIS.

Day, 1843.		Interval of nearest Stars.	Order of Observations.	Clock Slow at 0^h by H.	Clock Slow at 0^h by E.	E — H.
		h		s	s	s
January	4 to 5	9	H E	32·04	32·24	+ 0·20
	5	10	E H	32·18	32·44	+ 0·26
	10 to 11	11	H E	33·44	33·60	+ 0·16
	13	12	E H	34·10	34·31	+ 0·21
	30	7	H E	44·12	44·48	+ 0·36
February	16	7	E H	50·35	50·59	+ 0·24
Feb. 28 to	March 1	12	H E	54·66	54·84	+ 0·18
March	2 to 3	7	E H	55·16	55·41	+ 0·25
	24 to 25	10	H E	7·95	8·13	+ 0·18
	28 to 29	7	H E	10·09	10·39	+ 0·30
May	1 to 2	11	E H	26·15	26·37	+ 0·22
	24 to 25	11	E H	38·78	39·11	+ 0·33
	29	8	E H	42·78	43·16	+ 0·38
June	16 to 17	6	H E	56·79	57·09	+ 0·30
September	12 to 13	10	H E	6·86	7·17	+ 0·31
	15 to 16	12	E H	9·02	9·17	+ 0·15
	16	9	H E	9·92	10·21	+ 0·29
	19 to 20	10	E H	12·88	13·12	+ 0·24
	27 to 28	9	H E	17·88	18·08	+ 0·20
October	4 to 5	12	E H	21·09	21·30	+ 0·21
	14	8	H E	24·32	24·57	+ 0·25
	26 to 27	11	E H	35·87	36·08	+ 0·21
November	7 to 8	12	E H	45·07	45·39	+ 0·32

The mean of these values is $+ 0^s{\cdot}25$: this quantity has been used throughout the year 1843, wherever it was needed.

OBSERVATIONS for the PERSONAL EQUATION between MR. HENRY and MR. ROGERSON.

Day, 1843.		Interval of nearest Stars.	Order of Observations.	Clock Slow at 0^h by H.	Clock Slow at 0^h by R.	H — R.
		h		s	s	s
January	16	6	H R	34·89	35·04	— 0·15

This quantity was used in the cases of Saturn and the Moon, observed by Mr. Rogerson on June 22 and July 21 respectively.

OBSERVATIONS for the PERSONAL EQUATION between MR. ELLIS and MR. GLAISHER.

Day, 1843.		Interval of nearest Stars.	Order of Observations.	Clock Slow at 0^h by E.	Clock Slow at 0^h by G.	E — G.
September	13	h 5	E G	s 7·81	s 7·41	s + 0·40

OBSERVATIONS for the PERSONAL EQUATION between MR. ELLIS and MR. HIND.

Day, 1843.		Interval of nearest Stars.	Order of Observations.	Clock Slow at 0^h by E.	Clock Slow at 0^h by J H.	E — J H.
August	11 to 12	h 7	J H E	s 43·89	s 43·54	s + 0·35

OBSERVATIONS for the PERSONAL EQUATION between MR. ELLIS and MR. DUNKIN.

Day, 1843.		Interval of nearest Stars.	Order of Observations.	Clock Slow at 0^h by E.	Clock Slow at 0^h by D.	E — D.
August	24	h 3	E D	s 52·96	s 52·78	s + 0·18

OBSERVATIONS for the PERSONAL EQUATION between MR. ELLIS and MR. PAUL.

Day, 1843.		Interval of nearest Stars.	Order of Observations.	Clock Slow at 0^h by E.	Clock Slow at 0^h by P.	E — P.
March	17 to 18	h 7	P E	s 4·81	s 4·62	s + 0·19
August	16	5	E P	48·09	47·86	+ 0·23

The mean of these values is + 0^s·21.

OBSERVATIONS for the PERSONAL EQUATION between MR. ROGERSON and MR. HIND.

Day, 1843.		Interval of nearest Stars.	Order of Observations.	Clock Slow at 0^h by R.	Clock Slow at 0^h by J H.	R — J H
August	18	h 6	R J H	s 48·84	s 48·38	s + 0·46

OBSERVATIONS of the PERSONAL EQUATION between MR. ROGERSON and MR. DUNKIN.

Day, 1843.	Interval of nearest Stars.	Order of Observations.	Clock Slow at 0^h by R.	Clock Slow at 0^h by D.	R — D
August 17 to 18	7^h	D R	$48^s \cdot 84$	$48^s \cdot 68$	$+ 0^s \cdot 16$

OBSERVATIONS of the PERSONAL EQUATION between MR. ROGERSON and MR. PAUL.

Day, 1843.	Interval of nearest Stars.	Order of Observations.	Clock Slow at 0^h by R.	Clock Slow at 0^h by P.	R — P.
March 17	2^h	R P	$4^s \cdot 04$	$3^s \cdot 90$	$+ 0^s \cdot 14$

In other cases requiring the application of Personal Equation during the year, the following corrections have been applied :—

Between MR. ELLIS and MR. ROGERSON.

For an Observation of the Moon on January 17th, it is assumed that E — R = + $0^s \cdot 16$
For Observations of the Sun on May 19th and 20th, it is assumed that E — R = + $0^s \cdot 12$

For Observations of Stars on January 17th, by MR. HENRY and MR. GLAISHER, it is assumed that no Personal Equation exists.

For an Observation of the Moon on September 10th, by MR. RICHARDSON, Clock-stars by MR. ELLIS, it is assumed that W R — E = — $0^s \cdot 05$.

For an Observation of Mars on September 20th, by MR. RICHARDSON, Clock-stars by MR. HENRY, it is assumed that W R — H = + $0^s \cdot 30$.

The *eleventh* column contains the duration of passage of the semidiameter of a planet, &c., when both limbs have not been observed. For the Sun, this quantity is taken from the Nautical Almanac: for the Moon, from the section of Moon-culminating stars in that work: and for the Planets, from the Meridian Ephemeris in the same work. No corrections are made in this section to the semidiameters: these are noticed in a subsequent section.

The *twelfth* column contains the right ascension of the center of the body observed: it is formed by adding the time from the sixth column, the clock-error at 0^h next preceding from the tenth column, the proportional part of the rate in the ninth column corresponding to the right ascension, and the duration of semidiameter's passage from the eleventh column.

No result is set down for a clock-star, unless four clock-stars, excluding Polaris, have been observed; and no result is set down for Polaris, unless Polaris or δ Ursæ Minoris has been observed at opposite passages.

The *fourteenth* column contains the correction with its proper sign, as it is to be applied for reducing the apparent right ascension at the time of observation to the mean right ascension on the 1st of January, 1843. It is computed in the following way:

For the stars in the list of the Nautical Almanac, the mean R. A. of the Nautical Almanac is subtracted from the apparent R. A. of the Nautical Almanac (corrected, in the case of Polaris and δ Ursæ Minoris, for the Moon's longitude), and the sign of the quantity so found is changed.

For other stars, the corrections are computed by the formula

$$\text{A a} + \text{B b} + \text{C c} + \text{D d}$$

or

$$\frac{\text{A}}{15}\cos.\ \text{R.A. cosec. N.P.D.} + \frac{\text{B}}{15}\sin.\ \text{R.A. cosec. N.P.D.} + \text{C. sin. R.A. cotan. N.P.D.} \times$$

$$\text{n}^{\circ}.\ \log.\ 0\cdot1259 + \frac{\text{D}}{15}\cos.\ \text{R.A. cotan. N.P.D.} + \text{C.} \times \text{n}^{\circ}.\ \log.\ 0\cdot4869,$$

acccording as the star is or is not included in the Astronomical Society's Catalogue. The logarithms of A, B, C, D, are taken from the Nautical Almanac. The sign of the quantity thus computed is then changed.

§ 2. *Apparent Right Ascensions of Polaris and δ Ursæ Minoris, and Mean Right Ascensions of Stars observed in the Year* 1843, page [117] to [129].

The apparent right ascensions of Polaris and δ Ursæ Minoris are extracted without alteration from the *twelfth* column of the right-hand page of the *Transits as observed*, &c.

The mean right ascensions of the stars are found by applying to the apparent right ascensions in the *twelfth* column, the corrections in the *fourteenth* column.

The resulting mean right ascensions have been increased by $0^{s}\cdot25$ when the star whose right ascension is determined was observed by Mr. Ellis, and the clock-stars by Mr. Henry. The corrections applied for personal equation in the case of other observers have been already mentioned.

The rules for the nomenclature of the stars are the same as those for the names in the section of *Transits as observed*, detailed in page ix.

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§ 3. *Observations with Troughton's Mural Circle*, page (2) to (136).

The observations throughout the year 1843 were made with Troughton's Circle, though Jones's Circle was perfectly ready for use if it had been required.

Before describing the method of observing with it, and explaining the printed observations in detail, I shall give those observations from which the approximate position of the instrument with regard to the meridian is inferred.

For this purpose the transits of different stars have been observed with the clock which is near the Circle. This clock is immediately compared with the transit clock, and the sidereal time of transit is, therefore, readily found, and admits of comparison with the right ascension, or the correct time of transit over the astronomical meridian. The following table contains the principal steps, the parts omitted having been carefully verified :—

TRANSITS FOR THE POSITION OF TROUGHTON'S CIRCLE,
Throughout the Year 1843.

Day, 1843.		Object.	Transit by Graham 2.	Transit by Hardy.	Sidereal Time.	Sec. of R. A.	Error.
			h m s	h m s	h m s	s	s
January	30	α Leporis........	5. 25. 3· 0	5. 25. 4·50	5. 25. 48·77	50·51	− 1·74
	,,	α Orionis........	5. 45. 56·20	5. 45. 57·70	5. 46. 41·98	42·79	− 0·81
February	17	α Pegasi........	22. 56. 25·60	22. 56. 5·60	22. 56. 55·95	56·75	− 0·80
March	16	Venus, 2 L.	20. 50. 44·20	20. 49. 27·80	20. 49. 31·46	33·04	− 1·58
	,,	α Aquarii	21. 58. 55·00	21. 57. 38·80	21. 57. 42·50	43·59	− 1·09
	17	Castor..........	7. 25. 47·00	7. 24. 33·80	7. 24. 38·06	37·19	+ 0·87
	28	ε Hydræ........	8. 38. 22·80	8. 38. 19·20	8. 38. 29·03	29·95	− 0·92
April	21	α Persei........	3. 12. 30·20	3. 12. 50·70	3. 13. 11·73	9·35	+ 2·38
	,,	15 Argûs........	8. 0. 7·60	8. 0. 29·40	8. 0. 50·53	52·54	− 2·01
	22	α Persei R.	3. 12. 19·20	3. 12. 47·20	3. 13. 8·98	9·35	− 0·37
May	20	α Pegasi........	22. 57. 50·20	22. 56. 22·00	22. 56. 58·19	58·36	− 0·17
	24	α Arietis........	1. 58. 50·60	1. 57. 42·60	1. 58. 21·65	21·22	+ 0·43
	29	α Arietis........	1. 58. 14·20	1. 57. 38·70	1. 58. 21·70	21·34	+ 0·36
June	23	Pollux..........	7. 35. 25·22	7. 34. 40·22	7. 35. 44·50	43·61	+ 0·89
	26	Sirius	6. 37. 30·48	6. 38. 6·08	6. 38. 13·45	14·62	− 1·17
	,,	Antares.........	16. 19. 3·78	16. 19. 41·98	16. 19. 49·75	51·72	− 1·97
	27	Procyon........	7. 30. 15·00	7. 30. 56·93	7. 31. 5·38	6·05	− 0·67
July	2	Sirius..........	6. 36. 40·04	6. 37. 59·04	6. 38. 13·36	14·67	− 1·31
	16	β Tauri.........	5. 15. 6·30	5. 15. 58·80	5. 16. 25·22	24·37	+ 0·85
	31	α Orionis	5. 46. 42·20	5. 46. 5·60	5. 46. 42·03	42·42	− 0·39

TRANSITS FOR THE POSITION OF TROUGHTON'S CIRCLE—*continued.*

Day, 1843.		Object.	Transit by Graham 2.	Transit by Hardy.	Sidereal Time.	Sec. of R.A.	Error.
			h m s	h m s	h m s	s	s
July	31	Sirius	6. 38. 13·38	6. 37. 37·08	6. 38. 13·50	15·12	− 1·62
	,,	Procyon	7. 31. 5·30	7. 30. 29·30	7. 31. 5·68	6·43	− 0·75
August	2	Sirius	6. 37. 56·28	6. 37. 36·28	6. 38. 13·69	15·16	− 1·47
	..	Pollux..........	7. 35. 27·00	7. 35. 7·40	7. 35. 45·10	44·10	+ 1·00
	11	Procyon	7. 29. 29·50	7. 30. 21·70	7. 31. 5·96	6·62	− 0·66
September	19	Regulus	10. 0. 9·90	9. 59. 49·30	10. 0. 2·90	2·63	+ 0·27
	22	η Ursæ Majoris ..	13. 42. 13·98	13. 41. 10·48	13. 41. 25·22	21·58	+ 3·64
October	13	η Ursæ Majoris ..	13. 42. 7·00	13. 41. 0·00	13. 41. 24·24	21·44	+ 2·80
	,,	Arcturus........	14. 9. 14·50	14. 8. 7·50	14. 8. 31·87	31·80	+ 0·07
	,,	α Aquarii	21. 58. 30·00	21. 57. 22·50	21. 57. 46·83	47·19	− 0·36
	26	β Leonis	11. 41. 13·77	11. 40. 29·07	11. 41. 5·32	5·27	+ 0·05
	27	ε Bootis.........	14. 38. 18·50	14. 37. 33·50	14. 38. 9·87	9·29	+ 0·58
November	10	ε Bootis.........	14. 38. 22·13	14. 37. 21·63	14. 38. 10·17	9·38	+ 0·79
	15	η Bootis.........	13. 47. 39·20	13. 46. 20·20	13. 47. 14·92	14·66	+ 0·26
	,,	Arcturus........	14. 8. 56·80	14. 7. 37·80	14. 8. 32·54	32·04	+ 0·50
	16	β Ceti	0. 36. 11·20	0. 34. 50·70	0. 35. 45·90	46·74	− 0·84
	,,	θ Ceti...........	1. 16. 40·00	1. 15. 19·50	1. 16. 14·72	15·19	− 0·47
	18	Fomalhaut	22. 49. 30·36	22. 48. 2·86	22. 49. 0·19	1·85	− 1·66
	23	☉ 2 L.	15. 55. 30·73	15. 53. 37·14	15. 53. 39·30	40·45	− 1·15
	,,	ι Piscium	23. 32. 39·13	23. 31. 54·13	23. 31. 56·64	56·62	+ 0·02
	29	Arcturus........	14. 9. 30·80	14. 8. 22·30	14. 8. 32·16	32·31	− 0·15
December	1	η Draconis	16. 22. 55·60	16. 21. 39·10	16. 21. 51·50	50·79	+ 0·71
	2	α Ophiuchi......	17. 29. 44·37	17. 28. 28·07	17. 28. 40·53	40·92	− 0·39
	,,	Venus 1 L.	17. 39. 5·04	17. 37. 48·74	17. 38. 1·58	2·57	− 0·99
	,,	γ Draconis	17. 54. 1·60	17. 52. 45·30	17. 52. 57·78	57·41	+ 0·37
	,,	α Lyræ ..... R. *	18. 32. 40·67	18. 31. 24·17	18. 31. 36·68	38·22	− 1·54
	,,	α Lyræ ..... D. *	18. 32. 42·25	18. 31. 25·75	18. 31. 38·26	38·22	+ 0·04

I now proceed with the explanation of the columns of the printed Observations.

The *first* column on the left-hand page contains the day, always beginning with the Sun's transit: the *second* contains numbers of reference: the *third* contains the name of the object observed (the nomenclature of the stars following the same general rules as in the section of *Transits observed*, &c., except that, as a last resource, the place of the star is defined by its right ascension, which may sometimes be in error 10^s or more). The letters N. L. and S. L. denote the north and south limbs of planets. The letter M denotes that the object is observed, not on the fixed horizontal wire, but on the wire carried by a micrometer-screw. The letter R denotes that the object is observed by reflexion from a trough

* The transits over the first three wires in the reflexion-position, and over the last two in the direct-position were observed: to reduce to the center wire, the mean of the observed intervals in the two positions was adopted.

of mercury. The troughs used for this purpose are about eighteen inches long and four inches broad: they are placed either on a ledge of the circle-pier, about thirty inches below the lower limb of the circle, or upon a bracket, which admits of being placed at different elevations on a carriage travelling with wheels on the ledge of the pier.

The *fourth* column contains the pointer-reading. The pointer is merely an index fixed to the pier, and pointing to the division whose reading is greater than that of microscope A by 5°. The pointer is nearer to the floor than the microscope by this quantity.

The columns from the *fifth* to the *tenth* contain the readings of the six microscopes. The application of the letters is the same as in the Observations of preceding years from 1836: the observer beginning with the northern horizontal microscope, and passing the upper microscopes, the southern horizontal, and the lower ones, in the direction of the circle's circumference, reads them in the order A, C, E, B, D, F. These readings, in the observing books, are placed in the order $\begin{matrix} A, C, E \\ B, D, F \end{matrix}$: from which form they are easily changed into the order of printing. Each pair of adjacent readings, therefore, is the pair of readings at the opposite ends of a diameter. The minutes are given in the fifth column only.

During the observations of September 15, the microscope D suffered some derangement, and the necessity of having it repaired, was considered to afford a favourable opportunity for the inspection of the remaining microscopes Microscopes A, D, and E were consequently first removed and repaired (leaving for use three equidistant microscopes), and, on their replacement, the remaining microscopes were taken away and repaired.

It was thought desirable also at the same time to discontinue the use of a fixed wire in the eye-piece of the telescope, and, for the future, to make all observations with the moveable wire carried by the micrometer. The fixed wire was accordingly removed, and a new wire was also substituted in the place of the micrometer-wire in use up to this time, the latter having become fretted.

In order to determine the mean reading of the microscopes, the mean of the seconds in the readings of the six microscopes (or of the three microscopes when only three are used) must be taken. This is correct, on the supposition that the micrometer in each microscope makes exactly five revolutions in carrying its wire from the image of one division on the limb to the image of the next division. This however seldom holds. It is necessary to take into account the error, not only because it is sensible, but also because it is periodic, varying considerably with the general temperature of the season.

It is the practice now, on every Monday, to examine three intervals on the limb with each microscope, and thus to ascertain the excess of reading of the micrometer in the position commonly used (namely when the micrometer is turned in the direction increasing its readings, from its zero till the wire coincides with the next image of a division) above its reading for the image of a division on the other side of the zero. The quantity by which this exceeds 5′ being taken for each microscope, the sum of these excesses with sign changed is given as a correction, in the *eleventh* column, called "Correction for Runs." This number is the correction when the micrometer-reading amounts to 5′: a proportional part is to be taken for any other reading: and it is to be applied to the sum of the microscope-readings before that sum is divided by 6 (or by 3 when three microscopes are used). Occasionally, when the image of a division is very near the zero of the micrometer, the micrometer is turned in the opposite direction to coincide with that image: this is indicated by the mark †, denoting "the micrometers placed on the next divisions." The amount of correction then necessary is, the correction which would have been applied if the observations had been made in the usual way, diminished by the whole correction for 5′.

The following table contains the amount of error in each microscope for a reading of 5′, as ascertained in various positions of the Circle in each week.

ERRORS OF EACH MICROSCOPE OF TROUGHTON's CIRCLE FOR A READING OF 5′,
Throughout the Year 1843.

Day, 1843.	Pointer Reading.	MICROSCOPES. A	B	C	D	E	F	Sum.
	°	″	″	″	″	″	″	″
January..... 4	170	+ 1·8	+ 1·1	+ 1·1	− 0·5	+ 0·5	− 0·6	+ 3·4
,,	305	+ 1·6	0·0	+ 1·4	− 0·2	− 1·3	− 0·2	+ 1·3
,,	100	+ 0·6	+ 1·6	+ 0·5	− 1·7	+ 0·2	+ 0·4	+ 1·6
9	5	− 0·6	− 1·2	+ 0·8	+ 1·7	+ 0·6	− 0·1	+ 1·2
,,	128	+ 2·0	+ 0·7	+ 0·8	− 1·4	+ 0·2	− 1·3	+ 1·0
,,	249	+ 0·4	+ 0·2	− 0·2	− 1·3	+ 1·4	+ 1·2	+ 1·7
16	7	+ 1·0	+ 1·2	+ 1·2	− 1·2	− 0·4	+ 0·2	+ 2·0
,,	129	+ 2·2	+ 1·8	+ 0·8	− 1·4	− 1·1	− 0·4	+ 1·9
,,	248	+ 0·2	− 0·6	− 1·6	+ 1·2	+ 1·1	+ 0·6	+ 0·9
23	18	+ 1·7	+ 0·1	+ 0·8	+ 0·2	+ 0·6	+ 0·8	+ 4·2
,,	139	+ 0·2	+ 1·9	+ 0·4	+ 1·2	+ 2·2	+ 1·5	+ 7·4
,,	257	+ 1·2	+ 1·8	+ 2·2	+ 0·8	+ 0·6	+ 0·7	+ 7·3
30	154	+ 2·4	+ 2·7	+ 0·1	− 1·4	+ 0·3	+ 0·8	+ 4·9
,,	58	+ 1·4	+ 2·0	+ 0·1	− 0·8	+ 0·4	0·0	+ 3·1
,,	276	+ 0·6	+ 1·6	− 0·8	− 1·5	− 1·3	− 0·6	− 2·0
February.... 6	45	+ 0·4	+ 0·8	− 0·5	− 2·5	− 1·0	+ 0·8	− 2·0
,,	164	+ 1·6	− 0·9	+ 0·3	− 1·5	+ 0·3	+ 0·4	+ 0·2
,,	283	+ 0·9	+ 0·8	+ 0·2	− 2·2	+ 0·2	+ 0·6	+ 0·5
13	70	+ 3·2	+ 1·0	+ 0·3	− 0·4	+ 0·2	− 0·6	+ 3·7
,,	191	+ 0·4	− 0·1	+ 0·2	− 0·4	+ 0·5	− 0·6	0·0
,,	309	+ 2·1	+ 1·8	0·0	− 1·2	+ 0·1	− 0·9	+ 1·9

ERRORS OF EACH MICROSCOPE OF TROUGHTON'S CIRCLE—*continued.*

Day, 1843.	Pointer Reading.	MICROSCOPES. A	B	C	D	E	F	Sum.
	°	″	″	″	″	″	″	″
February.....20	55	+ 1·2	+ 0·4	+ 0·5	− 1·3	+ 1·6	+ 0·2	+ 2·6
,,	283	+ 2·2	+ 1·5	+ 0·2	− 1·4	− 0·6	+ 0·6	+ 2·5
,,	159	+ 2·0	+ 0·6	0·0	− 1·6	+ 0·4	+ 1·1	+ 2·5
27	170	+ 1·9	+ 1·5	+ 1·2	− 1·7	− 0·4	+ 0·2	+ 2·7
,,	290	− 0·1	+ 1·3	+ 0·8	− 1·5	+ 1·5	+ 1·4	+ 3·4
,,	50	+ 0·3	+ 0·1	+ 0·4	− 0·2	− 0·6	− 1·1	− 1·1
March...... 6	16	+ 1·4	+ 1·3	0·0	0·0	+ 1·5	− 0·4	+ 3·8
,,	136	+ 2·1	+ 0·9	− 0·5	− 1·2	0·0	+ 0·1	+ 1·4
,,	257	+ 1·4	+ 0·8	− 0·4	− 0·4	− 1·2	+ 0·7	+ 0·9
15	152	+ 0·2	+ 2·0	+ 1·6	− 1·8	+ 1·5	+ 0·2	+ 3·7
,,	273	+ 1·6	+ 1·2	+ 0·8	− 1·2	+ 0·6	− 0·2	+ 2·8
,,	35	+ 1·2	+ 1·1	− 0·4	− 2·2	− 1·4	0·0	− 1·7
20	163	+ 3·1	+ 0·2	+ 0·2	− 2·4	+ 1·4	− 0·8	+ 1·7
,,	274	+ 2·2	+ 1·4	+ 1·7	− 2·0	+ 1·9	+ 1·6	+ 6·8
,,	41	− 0·1	− 0·4	+ 0·4	− 1·1	+ 0·2	− 0·6	− 1·6
27	51	− 1·2	+ 2·4	− 2·0	− 0·9	− 2·0	+ 0·4	− 3·3
,,	170	+ 1·0	+ 1·0	+ 0·7	− 2·3	+ 0·2	+ 0·6	+ 1·2
,,	292	− 0·4	+ 1·2	+ 0·8	− 2·0	− 0·4	+ 0·3	− 0·5
April....... 3	40	+ 1·3	+ 1·0	− 1·0	− 1·1	− 0·4	+ 0·7	+ 0·5
,,	162	+ 0·7	− 1·0	+ 0·6	− 0·2	+ 0·7	+ 1·8	+ 2·6
,,	281	+ 0·4	+ 1·6	+ 1·0	− 2·5	+ 1·4	+ 0·2	+ 2·1
10	164	+ 2·2	+ 0·1	+ 0·7	− 1·4	− 0·5	− 0·4	+ 0·7
,,	285	− 0·1	− 0·7	+ 0·1	− 0·8	− 0·2	− 0·6	− 2·3
,,	43	+ 0·4	− 0·2	+ 1·1	− 1·4	+ 0·6	0·0	+ 0·5
17	160	+ 1·8	+ 1·4	+ 0·5	+ 0·7	+ 0·6	− 0·6	+ 4·4
,,	22	+ 1·3	+ 0·8	+ 0·4	− 1·2	+ 0·9	+ 0·6	+ 2·8
,,	243	+ 0·9	+ 0·8	+ 1·0	0·0	− 0·3	+ 1·4	+ 3·8
24	45	+ 1·9	+ 1·0	− 1·3	− 1·8	+ 2·0	+ 1·6	+ 3·4
,,	164	− 1·3	− 0·6	− 0·9	− 0·9	+ 1·4	+ 0·2	− 2·1
,,	286	+ 1.2	− 0·1	+ 0·2	− 2·7	− 0·7	+ 0·1	− 2·0
30	47	+ 1·4	+ 1·6	− 0·4	+ 0·8	+ 1·3	+ 1·2	+ 5·9
,,	166	+ 1·4	+ 0·2	+ 0·5	0·0	+ 0·7	+ 1·0	+ 3·8
,,	285	+ 1·5	+ 1·5	+ 1·0	− 0·3	+ 1·5	+ 1·9	+ 7·1
May........ 8	25	+ 0·8	+ 0·7	+ 0·1	− 1·4	+ 1·3	− 0·2	+ 1·3
,,	146	+ 2·4	+ 1·5	+ 1·5	− 0·5	+ 1·6	+ 1·0	+ 7·5
,,	263	− 1·2	+ 1·3	+ 2·6	− 0·4	+ 1·2	+ 0·3	+ 3·8

ERRORS OF EACH MICROSCOPE OF TROUGHTON'S CIRCLE—*continued.*

Day, 1843.	Pointer Reading.	MICROSCOPES. A	B	C	D	E	F	Sum.
	°	"	"	"	"	"	"	"
May........15	16	+ 1·4	+ 0·3	+ 1·9	0·0	+ 2·6	+ 1·5	+ 7·7
,,	135	+ 1·9	+ 0·5	+ 2·4	− 0·1	+ 1·8	− 0·4	+ 6·1
,,	254	+ 0·9	+ 0·4	+ 1·4	− 0·3	0·0	+ 0·2	+ 2·6
22	42	+ 0·8	+ 1·8	+ 1·4	+ 4·0	+ 2·2	− 0·4	+ 9·8
,,	160	+ 1·0	+ 2·1	+ 2·4	+ 0·2	+ 1·1	+ 1·5	+ 8·3
,,	281	+ 0·6	+ 1·2	+ 2·4	− 0·9	+ 1·4	0·0	+ 4·7
29	131	+ 1·5	+ 2·0	+ 2·0	+ 0·3	+ 2·0	+ 1·0	+ 8·8
,,	250	+ 1·8	+ 2·0	+ 1·4	− 1·2	+ 0·5	+ 1·8	+ 6·3
,,	12	+ 2·6	+ 2·6	+ 1·2	− 0·6	+ 1·5	+ 0·8	+ 8·1
June........ 5	170	+ 1·4	+ 0·3	+ 1·2	− 2·1	+ 1·2	+ 0·8	+ 2·8
,,	30	+ 0·6	+ 1·7	+ 1·2	− 1·6	+ 2·4	+ 0·8	+ 5·1
,,	280	+ 1·6	+ 1·6	+ 0·2	− 0·2	− 0·4	− 0·7	+ 2·1
12	30	+ 0·8	+ 2·4	+ 1·0	− 1·0	+ 0·7	0·0	+ 3·9
,,	151	+ 2·0	− 0·3	+ 1·4	− 1·3	+ 2·0	− 0·2	+ 3·6
,,	272	+ 0·6	− 0·7	+ 1·0	− 1·0	+ 0·5	+ 1·8	+ 2·2
19	32	− 0·6	+ 1·0	+ 2·2	− 1·0	− 0·5	+ 2·6	+ 3·7
,,	151	+ 0·2	+ 2·7	+ 2·0	− 0·1	+ 2·0	+ 0·8	+ 7·6
,,	273	+ 2·0	+ 1·5	+ 1·3	− 1·6	+ 0·6	− 0·3	+ 3·5
26	48	+ 2·4	+ 3·1	0·0	− 1·1	+ 0·2	+ 1·3	+ 5·9
,,	169	+ 2·4	+ 1·5	+ 1·1	− 0·7	+ 2·1	+ 1·7	+ 8·1
,,	292	+ 2·5	+ 1·1	+ 1·6	− 1·7	+ 0·9	− 0·3	+ 4·1
July........ 3	7	+ 2·6	+ 2·2	+ 2·6	− 2·2	+ 2·7	+ 1·5	+ 9·4
,,	126	+ 1·5	0·0	+ 3·0	− 0·6	+ 1·6	+ 2·6	+ 8·1
,,	248	+ 2·0	+ 1·4	+ 0·9	+ 0·8	+ 1·5	+ 1·2	+ 7·8
10	49	+ 0·3	+ 1·4	+ 3·2	− 1·4	+ 1·7	− 0·8	+ 4·4
,,	171	+ 3·3	+ 0·4	+ 2·4	− 1·8	+ 1·6	− 0·2	+ 5·7
,,	289	+ 2·8	+ 2·3	+ 2·4	− 0·4	+ 1·8	+ 1·0	+ 9·9
17	35	+ 1·6	+ 2·9	+ 0·5	− 1·1	− 1·1	− 1·3	+ 1·5
,,	155	+ 1·1	− 1·0	+ 0·9	+ 0·3	+ 0·8	+ 0·3	+ 2·4
,,	276	− 0·6	+ 1·6	− 0·4	− 1·2	+ 0·7	+ 1·6	+ 1·7
24	141	+ 2·6	+ 1·4	+ 2·1	− 1·7	+ 1·2	+ 0·2	+ 5·8
,,	262	+ 0·6	− 0·4	+ 2·5	− 1·5	+ 0·8	+ 0·3	+ 2·5
,,	24	+ 2·8	+ 0·6	0·0	− 2·0	− 0·6	− 1·6	− 0·8
31	131	+ 1·7	+ 3·0	+ 0·8	− 1·7	− 0·3	− 1·3	+ 2·2
,,	252	+ 3·2	+ 1·1	+ 0·9	− 1·2	+ 1·0	− 2·5	+ 2·5
,,	14	+ 0·8	+ 0·6	+ 0·9	− 1·1	+ 0·6	− 0·3	+ 1·5

ERRORS OF EACH MICROSCOPE OF TROUGHTON's CIRCLE—*continued.*

Day, 1843.	Pointer Reading.	MICROSCOPES. A	B	C	D	E	F	Sum.
	°	″	″	″	″	″	″	″
August 7	19	+ 3·2	+ 3·1	− 0·2	− 1·1	− 0·4	+ 2·2	+ 6·8
,,	141	+ 1·8	+ 2·1	+ 3·4	− 3·0	+ 0·8	+ 0·7	+ 5·8
,,	259	+ 2·1	+ 3·2	+ 1·4	− 0·5	+ 1·2	+ 1·2	+ 8·6
14	126	+ 3·2	+ 3·6	+ 2·3	+ 0·4	+ 2·6	− 0·6	+11·5
,,	106	0·0	+ 0·8	+ 1·6	− 1·2	+ 0·7	+ 0·4	+ 2·3
,,	245	+ 1·7	+ 1·4	+ 0·2	+ 0·2	+ 0·3	+ 0·8	+ 4·6
21	160	+ 2·2	− 1·8	− 0·4	+ 0·4	+ 0·5	+ 0·8	+ 1·7
,,	40	+ 1·6	+ 2·5	+ 0·7	− 0·2	+ 0·2	+ 0·6	+ 5·4
,,	280	+ 2·0	+ 0·2	− 0·2	+ 0·4	+ 2·6	+ 0·3	+ 5·3
28	174	+ 2·4	+ 1·1	+ 2·5	− 1·5	+ 0·6	+ 2·8	+ 7·9
,,	52	+ 1·5	+ 1·9	+ 2·4	+ 2·0	+ 1·6	+ 2·7	+12·1
,,	273	+ 2·8	+ 1·8	+ 3·1	− 1·3	+ 1·0	+ 0·6	+ 8·0
September .. 4	40	+ 1·5	+ 4·0	+ 2·1	− 0·4	+ 2·5	+ 0·4	+10·1
,,	161	+ 2·6	+ 3·6	+ 1·8	− 0·4	+ 0·4	+ 0·8	+ 8·8
,,	282	+ 1·9	+ 1·7	+ 3·9	− 1·6	+ 1·0	− 0·2	+ 6·7
11	20	+ 1·0	+ 1.7	0·0	+ 1·0	+ 1·4	+ 0·7	+ 5·8
,,	141	+ 2·0	+ 1·8	+ 1·6	− 3·6	+ 3·0	− 0·3	+ 4·5
,,	262	+ 1·1	+ 1·0	+ 4·8	− 1·4	+ 1·5	− 0·4	+ 6·6
18	44	+ 2·4	+ 0·4	+ 2·2	+ 0·5	+ 1·7	+ 0·7	+ 7·9
,,	165	+ 3·0	− 0·5	+ 0·9	− 0·6	+ 1·2	+ 1·6	+ 5·6
,,	283	+ 2·6	+ 3·0	+ 2·6	+ 0·9	+ 1·9	+ 1·0	+12·0
19	140		+ 3·6	− 0·8			+ 3·6	+ 6·4
,,	261		+ 4·8	+ 2·0			+ 2·8	+ 9·6
,,	22		+ 4·7	+ 1·4			+ 2·2	+ 8·3
20	80	+ 2·9			+ 3·2	+ 0·8		+ 6·9
,,	201	+ 1·9			+ 0·6	+ 3·2		+ 5·7
,,	322	+ 1·9			+ 0·9	+ 1·8		+ 4·6
25	150	+ 2·3			+ 1·7	− 0·5		+ 3·5
,,	271	+ 2·8			+ 1·1	+ 1·1		+ 5·0
,,	22	+ 1·3			+ 0·5	+ 0·8		+ 2·6
28	10	+ 2·0			+ 1·7	+ 0·4		+ 4·1
,,	130	+ 2·2			− 0·4	+ 0·7		+ 2·5
,,	250	+ 2·1			− 0·8	+ 1·2		+ 2·5
October..... 2	15	+ 1·2			+ 0·8	− 0·6		+ 1·4
,,	135	+ 0·6			+ 0·2	+ 0·1		+ 0·9
,,	255	− 0·4			+ 0·2	+ 0·8		+ 0·6

ERRORS OF EACH MICROSCOPE OF TROUGHTON'S CIRCLE—*continued.*

Day, 1843.	Pointer Reading.	MICROSCOPES. A	B	C	D	E	F	Sum.
	°	"	"	"	"	"	"	"
October..... 5	130	+ 2·1			+ 1·0	− 0·8		+ 2·3
,,	251	+ 1·0			+ 1·5	+ 1·8		+ 4·3
,,	12	+ 0·5			+ 0·5	+ 1·8		+ 2·8
9	8	+ 3·2			+ 1·2	+ 0·4		+ 4·8
,,	129	+ 3·7			+ 0·8	− 1·0		+ 3·5
,,	251	+ 2·4			+ 0·1	+ 1·4		+ 3·9
12	118	+ 1·0			− 1·2	+ 2·0		+ 1·8
,,	239	+ 1·0			+ 1·8	− 0·5		+ 2·3
,,	0	+ 0·1			− 0·5	− 0·6		− 1·0
16	120	+ 0·7			+ 0·8	+ 2·5		+ 4·0
,,	241	+ 1·0			− 0·9	+ 1·0		+ 1·1
,,	2	+ 0·5			− 0·9	− 0·1		− 0·5
19	41	+ 2·3			− 0·2	− 0·5		+ 1·6
,,	163	− 0·1			− 1·1	− 0·8		− 2·0
,,	282	+ 0·7			− 0·8	− 0·5		− 0·6
23	8	+ 1·8			− 0·5	+ 1·4		+ 2·7
,,	127	+ 0·2			+ 0·2	+ 0·9		+ 1·3
,,	249	+ 1·4			− 0·8	+ 1·2		+ 1·8
26	27	+ 1·2			− 0·3	− 1·6		− 0·7
,,	149	+ 1·4			− 0·6	+ 0·3		+ 1·1
,,	271	+ 1·2			− 0·7	− 1·4		− 0·9
30	158	+ 1·2			− 2·0	− 1·1		− 1·9
,,	279	+ 2·6			+ 3·0	+ 2·0		+ 7·6
,,	40	− 0·2			+ 1·9	+ 2·0		+ 3·7
November... 1	101	+ 2·0			− 0·2	− 0·9		+ 0·9
,,	222	+ 2·2			− 1·4	+ 1·2		+ 2·0
,,	341	+ 1·6			+ 0·9	− 1·2		+ 1·3
7	120	+ 2·4			+ 0·1	− 0·5		+ 2·0
,,	241	+ 3·0			− 2·1	+ 1·6		+ 2·5
,,	2	+ 2·6			− 0·5	− 0·1		+ 2·0
10	7	+ 0·6			− 1·4	+ 1·2		+ 0·4
,,	126	+ 2·1			+ 0·9	+ 0·5		+ 3·5
,,	249	+ 1·7			+ 0·2	+ 0·7		+ 2·6
13	100	− 1·6			+ 0·1	+ 0·5		− 1·0
,,	221	+ 1·9			+ 1·1	+ 1·9		+ 4·9
,,	342	+ 1·3			− 0·1	+ 0·1		+ 1·3

ERRORS OF EACH MICROSCOPE OF TROUGHTON'S CIRCLE—*concluded.*

Day, 1843.	Pointer Reading.	MICROSCOPES. A	B	C	D	E	F	Sum.
	°	"			"	"		"
November .. 16	17	+ 1·2			+ 2·2	+ 0·1		+ 3·5
,,	136	+ 0·9			+ 0·9	− 0·8		+ 1·0
,,	259	+ 2·8			− 0·7	− 0·3		+ 1·8
20	150	− 0·3			+ 0·5	0·0		+ 0·2
,,	271	+ 1·5			+ 1·4	+ 0·4		+ 3·3
,,	32	+ 2·6			− 0·1	+ 0·5		+ 3·0
23	23	+ 2·6			− 0·4	+ 0·5		+ 2·7
,,	142	+ 1·6			+ 0·2	+ 1·2		+ 3·0
,,	266	+ 0·9			0·0	+ 1·3		+ 2·2
27	49	+ 0·9			+ 0·6	+ 0·1		+ 1·6
,,	170	− 0·7			− 0·9	− 0·2		− 1·8
,,	291	+ 2·1			+ 0·6	+ 0·8		+ 3·5
December... 1	42	+ 2·0			+ 0·1	+ 0·2		+ 2·3
,,	160	+ 0·8			− 0·1	+ 1·2		+ 1·9
,,	284	+ 0·6			+ 0·1	− 0·3		+ 0·4
4	20	− 0·4			+ 1·6	+ 0·4		+ 1·6
,,	139	+ 2·8			+ 3·4	− 1·0		+ 5·2
,,	261	+ 1·5			+ 0·8	+ 1·8		+ 4·1
7	50	+ 1·2			− 0·2	− 1·2		− 0·2
,,	173	+ 0·8			+ 0·1	+ 0·9		+ 1·8
,,	291	+ 1·4			+ 0·8	+ 1·6		+ 3·8
11	15	− 0·3			− 0·8	+ 2·2		+ 1·1
,,	134	− 0·7			− 0·4	+ 1·5		+ 0·4
,,	256	+ 0·5			+ 0·6	+ 0·6		+ 1·7
14	4	+ 1·1			+ 0·3	+ 1·0		+ 2·4
,,	127	− 0·5			+ 0·7	+ 1·6		+ 1·8
,,	251	+ 1·2			− 0·5	+ 2·4		+ 3·1
18	25	+ 1·8			+ 0·5	+ 0·1		+ 2·4
,,	144	+ 1·8			− 0·3	+ 1·2		+ 2·7
,,	266	− 0·2			+ 1·6	+ 0·9		+ 2·3
23	9	− 0·2			+ 0·2	+ 0·8		+ 0·8
,,	135	+ 2·6			+ 1·6	+ 1·8		+ 6·0
,,	259	+ 1·6			+ 1·4	− 1·4		+ 1·6

The *eleventh* column contains the value of the correction for runs; determined, for the most part, by taking the mean of the preceding and following sums from the table above.

The *twelfth* column contains the reading of the micrometer in the eye-piece of the circle-telescope. Before September 18 it was used, either when an object was observed by reflexion and directly at the same transit (the circle being clamped and the microscopes read before the object is seen by reflexion; and the observation, when it was near the center wire, being made with the micrometer-wire); or when two objects passed in rapid succession in the same field; or for the observation of one limb of a planet when the other limb was observed on the fixed wire; or for the Moon when observed several times in passing the field. The reading of the micrometer at coincidence with the fixed wire was ascertained at least once every week, and this reading is given at the bottom of the page. The wires not being perfectly parallel, it was thought desirable to ascertain the coincidence-reading at each of the points where the horizontal wire is intersected by the five vertical wires. From September 18, when the micrometer-wire was used alone, $5^{r}\cdot000$ was assumed as the zero to which the readings should be referred in the computation of their equivalents; and when no reading of the micrometer is given, it is understood that the reading was $5^{r}\cdot000$. This is stated in the foot-notes to the Observations.

The *thirteenth* column contains the value, in minutes and seconds, of the arc measured with the micrometer. The value of one revolution which is used throughout the year is $53''\cdot24$, and the details of the observations from which this value is determined are fully given in the Introduction to the Observations for 1840.

The *fourteenth* column contains the number of the vertical wire at which the object was seen when the observation with the horizontal wire was made. The telescope of the circle contains five vertical wires: the intervals between the wires have been ascertained by transits of stars, which (being entirely free from any sensible doubt) it is not necessary to detail here. The equatoreal interval of the wires is considered to be 20^{s}.

The *fifteenth* column contains the correction to be applied to the circle-reading in consequence of the object not having been observed when passing the middle wire. It consists of two parts, one due to the body's change of N.P.D. (if it be the Sun, the Moon, a planet, or a comet), the other due to the difference between the small circle described by the body and the great circle of which the horizontal wire forms a part. Of the former of these no explanation is required, except that for the Moon the change is computed by the formula, change of declination for 1 hour of terrestrial longitude (from the section of Moon-culminating Stars in the Nautical Almanac) × sec. declination × n°. (log. = $7\cdot745$) × number of intervals of wires. The latter is calculated by this formula: tan. declination × n°. (log. = $9\cdot350$) × (number of intervals of wires).^{2} (A table has been formed of the values of this latter correction for convenient intervals of N. P. D., and the correction itself for one or for two intervals can always be taken out at sight.) The two numbers are combined together to form the number in the *fifteenth* column.

The *sixteenth* column contains the circle-reading, as found by adding the mean of the microscopes (corrected for runs) to the pointer-reading, and applying the corrections from columns 13 and 15.

The *seventeenth* column contains the initials of the Observers' names. M. is Mr. Main's signature, W. R. Mr. Richardson's, R. Mr. Rogerson's, H. Mr. Henry's, E. Mr. Ellis's, G. Mr. Glaisher's, R. H. Mr. Harris's, J. H. Mr. Hind's, D. Mr. Dunkin's, P. Mr. Paul's, and H. B. that of Mr. Hugh Breen, jun.

The *first* column on the right-hand page contains numbers for reference, corresponding to those in the second column of the left-hand page.

The *second* column contains the sums of the circle-readings when the same object has been observed by reflexion and directly at the same transit. These are necessary for the determination of the Zenith Point, or the circle-reading corresponding to a vertical position of the telescope. The observations being divided into groups (seldom exceeding four days), and each of these groups being subdivided into two parcels, one containing the stars which passed north of the zenith, and the other containing the stars which passed south of the zenith, the mean value of D + R for each parcel is ascertained : the mean between the two values of D + R for the two parcels is found, and is considered to be the value of D + R applicable to the whole group : this quantity is increased or diminished by 180° and divided by 2, and the result is adopted as the Zenith Point. It will be seen from this description, that the result as to the Zenith Distance of the objects comprehended in one group is entirely independent of the operations of any kind in any other group. It will also be seen that the system of taking the means of the results from the north parcel and the south parcel, without respect to the number of stars in each parcel, supposing the zenith distance of the stars to be not very unequal, entirely eliminates the effect of any drop of the eye-end or object-end, or of any other cause which acts symmetrically on both sides of the zenith to increase or to diminish the telescope's angle with the vertical. In the daily observations however of 1843, care has also been taken to balance the number of stars observed by reflexion on the north side and on the south side.

In the division of the groups, the general rule has been to divide if possible where a considerable interval occurs between the observations; except in cases where there is an evident change of Zenith Point between two parts of one of the selected groups; or where any recorded accident during the observations renders it necessary to make a division.

The *third* column contains the Adopted Zenith Point, determined by the rules just described.

The *fourth* column contains the Apparent Zenith Distance, which is found by subtracting the Zenith Point in the preceding column from the circle-reading: the negative sign denotes that the object is north of the zenith. When the Moon has been observed at several wires, the mean of all the concluded circle-readings is used to form the zenith distance.

When both limbs of the Moon are observed, it usually happens that one of them is slightly defective, from the failure of illumination by the Sun. The necessary correction (which is not applied in this column, but which must be applied with others in order to form the numbers in the column of *Geocentric N.P.D of Center*) is ascertained by computation in the following manner:—When the Moon is horned, let θ be the angle which the circle joining the cusps makes with the meridian; δ_s the Sun's declination, and δ_m the Moon's declination as seen at Greenwich; P the Sun's hour-angle at the Moon's transit: then,

$$\text{Tan}\ \theta = \text{Cosec.}\ P.\ \text{Cos.}\ \delta_m.\ \text{Tan}\ \delta_s - \text{Cot.}\ P.\ \text{Sin.}\ \delta_m$$

and the correction required will be

$$\text{Moon's semidiameter} \times \text{vers.}\ \theta.$$

If the Moon be gibbous, as is the case in the greater number of instances, draw a great circle through the center of the Moon, at right angles to the meridian, and let it meet the declination-circle of the Sun; then the intersection of these two circles will determine the place of a fictitious Sun, which would equally illuminate both limbs of the Moon when on the meridian; and the elevation or depression of the true Sun above or below the great circle joining the Moon and fictitious Sun, measured in a plane at right angles to that circle, will represent the angle by which the lowest or highest part of the illuminated hemisphere is distant from the limb, and therefore the angle whose versed sine multiplied into the Moon's semidiameter is the correction required.

Let then P be the North Pole of the heavens, M the Moon on the meridian, and S and S_1 the true and fictitious Suns, and imagine the triangles formed by great circles joining these. Let also δ_1 be the declination of the fictitious Sun, θ_1 the arc joining the true and fictitious Suns, and θ the perpendicular arc before mentioned.

Then $$\text{Tan}\ \delta_1 = \text{Tan}\ \delta_m\ \text{Cos.}\ MPS_1$$

And $$\theta_1 = \delta_s - \delta_1$$

Also $$\begin{aligned}\text{Sin.}\ \theta &= \text{Sin.}\ \theta_1\ \text{Sin.}\ MS_1P \\ &= \text{Sin.}\ \theta_1 \frac{\text{Sin.}\ MP}{\text{Sin.}\ S_1P} \\ &= \text{Sin.}\ \theta_1 \frac{\text{Cos.}\ \delta_m}{\text{Cos.}\ \delta_1}\end{aligned}$$

Whence θ is formed, and the correction required is

$$\text{Moon's semidiameter} \times \text{vers.}\ \theta.$$

In either case the North limb is fully illuminated if θ is positive, and the South limb if θ is negative.

The *fifth* column contains the reading of the barometer. This instrument is by Newman: the raising of the index by which the upper surface of the mercury is read, depresses a plunger in the cistern of mercury, for the purpose of making the elevation of its surface invariable. This barometer is not fit for any delicate purpose : but it is sufficiently accurate for computation of refraction.

The *sixth* column contains the reading of the exterior thermometer. This is by Troughton and Simms: it is mounted on the outside of the Observatory, at the distance of four feet nearly from the north wall, in a tinned case, with its bulb quite free to the current of air, but protected from radiation.

The *seventh* column contains the reading of the interior thermometer: it is a small thermometer suspended between the two circle-piers.

The *eighth* column contains the refraction computed by Bessel's tables in the *Tabulæ Regiomontanæ*. These tables, altered in form (but so as to give in all cases the same result) and expanded, are given in the Appendix to the volume for 1836. The exterior thermometer only is used in the computation.

The *ninth* column contains the parallax. This is computed on the supposition that the earth's ellipticity is $\frac{1}{300}$. For the planets the formula is, log. parallax = log. sin. (zen. dist. − 11′.12″) + ar. co. log. distance + 0·9325. For the Moon, the horizontal equatoreal parallax, as interpolated with second differences from the Nautical Almanac, is affected with a number from the following table: which is peculiar to the Moon's limb. These numbers may be inferred from the investigation given in a subsequent part of this Introduction, for the Moon's parallax in Occultations, by supposing V (the angle on the Moon's limb from the vertical) = 0° or 180°.

Correction to Moon's Horizontal Parallax, to be used when Parallax is to be applied to the Observation of a Limb.

Z. D.	South Limb.	Z. D.	South Limb.	Z. D.	North Limb.	Z. D.	North Limb.
°	″	°	″	°	″	°	″
30	+ 0·10	60	+ 0·15	30	− 0·03	60	− 0·08
35	+ 0·11	65	+ 0·15	35	− 0·04	65	− 0·08
40	+ 0·12	70	+ 0·16	40	− 0·05	70	− 0·09
45	+ 0·12	75	+ 0·16	45	− 0·06	75	− 0·09
50	+ 0·13	80	+ 0·16	50	− 0·06	80	− 0·09
55	+ 0·14			55	− 0·07		

The parallax is then computed by the formula: log. seconds of parallax = log. seconds of corrected horizontal equatoreal parallax + log. sin. (zen. dist. − 11′. 12″) + 9·9991136 + log. $\frac{\text{sin.}}{\text{arc}}$ (for hor. par.) + log. $\frac{\text{arc}}{\text{sin.}}$ (for parallax).

The logarithms of the last two factors for the computation of the parallax are taken from the following tables :—

Arc.	Log. $\left(\frac{\text{Sin.}}{\text{Arc.}}\right)$	Arc.	Log. $\left(\frac{\text{Sin.}}{\text{Arc.}}\right)$
′		′	
50	9·9999846	58	9·9999794
51	·9999841	59	·9999786
52	·9999834	60	·9999779
53	·9999828	61	·9999772
54	·9999821	62	·9999765
55	·9999815	63	·9999757
56	·9999807	64	·9999749
57	·9999801	65	·9999741
58	9·9999794	66	9·9999733

Approx. Log.	Approx. Arc.	Log $\left(\frac{\text{Arc.}}{\text{Sin.}}\right)$
	′ ″	
3·00	16. 40	0·0000017
3·05	18. 42	·0000022
3·10	20. 59	·0000027
3·15	23. 32	·0000034
3·20	26. 25	·0000043
3·25	29. 38	·0000055
3·30	33. 15	·0000068
3·35	37. 18	·0000086
3·40	41. 52	·0000107
3·45	46. 58	·0000136
3·50	52. 52	·0000171
3·55	59. 8	·0000214
3·60	66. 21	0·0000270

The *tenth* column contains the reading of the micrometer for that limb or cusp of a planet which was not observed on the fixed wire of the telescope.

The *eleventh* column contains the semidiameter used in the reduction of the observations. That of the Sun is taken from the Nautical Almanac: that of the Moon is interpolated with second differences from the Nautical Almanac: that of Mars, Jupiter, and Saturn, is half of the micrometrical measure of the diameter in the preceding section: that of Mercury and Venus is found by dividing the micrometrical measure by 1 + cos. θ, where θ is found by the following process. If the planet is horned, the planet's geocentric place is brought to the zenith of a celestial globe, and the quadrant of altitude being made to pass over the Sun's place, the deviation from the E. or W. point is the measure of θ. If the planet is gibbous, the planet's geocentric place is brought to the intersection of the meridian and horizon, and the point opposite to the planet's heliocentric place being marked, its elevation above or depression below the horizon is taken for θ. If the full limb has been observed with the fixed wire of the circle, the semidiameter thus obtained is to be applied: but if the imperfect limb has been observed with the fixed wire, the difference betweed this semidiameter and the whole micrometrical measure is to be applied.

The *twelfth* column contains the geocentric N. P. D. of the center of each object from every observation: found by combining the Apparent Zenith Distance with the Refraction, Parallax, Semidiameter, and assumed Co-latitude 38°. 31′. 21″.

The *thirteenth* column contains the name of the object observed; it is described in the same manner as in the third column on the left-hand page, with the omission only of the letters indicating observation with the micrometer and observation of a limb.

The *fourteenth* column contains the corrections which are to be applied to the apparent N. P. D. of the stars in order to obtain the mean N. P. D. 1843, Jan. 1. For the stars in the list of the Nautical Almanac, the correction is found by subtracting the mean declination of the Nautical Almanac from the apparent declination of the same. For stars in the Astronomical Society's Catalogue, the correction is computed by the formula $A\,a' + B\,b' + C\,c' + D\,d'$. For other stars the correction is computed by the formula A. sin. N. P. D. × (n°. log. = 9·6375) − A. sin. R. A. cos. N. P. D. + B. cos. R. A. cos. N. P. D. + C. cos. R. A. × n°. (log. = 1·3020) ∓ D. sin. R. A.

§ 4. *Mean North Polar Distances of Stars deduced from each day's observations,* page (137) to (155).

The Mean North Polar Distances are found by applying to the North Polar Distances in section 3, the corrections opposite to them in that section.

The results of direct and reflexion-observations are kept separate, with a view of ascertaining whether there is discordance between them, as has been observed in the results of this and other circles: and the results above and below the pole are kept separate, in order to ascertain whether there is any sensible error in the assumed co-latitude.

With regard to the first of these points, the means of the groups of Direct-results and Reflexion-results have been taken for all the stars observed: and the algebraical excess of the Reflexion-result over the Direct-result (the results for stars below the pole being considered negative) is given in the subjoined tables.

EXCESS OF REFLEXION-RESULTS ABOVE DIRECT-RESULTS, WITH TROUGHTON's CIRCLE, 1843.

Name of Star.	Approx. N. P. D.	Sec. of R.	Sec. of D.	R — D.	No. of Obs. R	No. of Obs. D
	° ′	″	″	″		
β Cassiopeiæ S. P. ..	−31. 43	−58 ·18	−61 ·05	+ 2·87	1	2
ν Cephei S. P.......	−29. 36	− 9·60	− 9·00	− 0·60	1	1
7 Camelopardali S.P.	−27. 4	−25·36	−26·17	+ 0·81	1	3
Piazzi I. 159 S. P...	−26. 55	−34·21	−32·36	− 1·85	1	1

EXCESS OF REFLEXION-RESULTS ABOVE DIRECT-RESULTS, WITH TROUGHTON'S CIRCLE, 1843—*continued.*

Name of Star.	Approx. N. P. D.	Sec. of R.	Sec. of D.	R — D.	No. of Obs. R	No. of Obs. D
	° ′	″	″	″		
γ Cephei S. P.	—13. 15	—38 ·81	—37 ·24	— 1 ·57	3	6
δ Ursæ Minoris S. P.	— 3. 24	—23 ·36	—24 ·39	+ 1 ·03	1	1
Cephei 51 (Hev.) S. P.	— 2. 44	—21 ·64	—22 ·05	+ 0 ·41	2	5
Polaris S. P.	— 1. 32	—40 ·45	—40 ·05	— 0 ·40	21	22
λ Ursæ Minoris	1. 10	40 ·54	39 ·60	+ 0 ·94	9	11
Polaris	1. 32	38 ·61	40 ·00	— 1 ·39	8	10
δ Ursæ Minoris	3. 24	23 ·76	22 ·70	+ 1 ·06	7	7
ε Ursæ Minoris	7. 43	52 ·70	52 ·14	+ 0 ·56	11	11
ζ Ursæ Minoris	11. 44	31 ·43	31 ·29	+ 0 ·14	4	4
5 Ursæ Minoris	13. 36	20 ·49	21 ·83	— 1 ·34	1	1
β Ursæ Minoris	15. 12	9 ·79	9 ·91	— 0 ·12	17	17
β Cephei	20. 8	38 ·17	38 ·01	+ 0 ·16	10	10
σ Draconis	20. 36	18 ·67	19 ·43	— 0 ·76	2	2
Groombridge 628	20. 51	4 ·77	4 ·63	+ 0 ·14	1	1
ω Draconis	21. 10	10 ·75	11 ·45	— 0 ·70	2	2
f Draconis	21. 46	56 ·07	53 ·27	+ 2 ·80	1	1
σ¹ Ursæ Majoris	22. 30	10 ·08	9 ·69	+ 0 ·39	1	1
A. S. C. 552	23. 56	1 ·64	1 ·85	— 0 ·21	2	2
ζ Draconis	24. 5	28 ·90	29 ·68	— 0 ·78	8	10
π Draconis	24. 35	14 ·30	13 ·76	+ 0 ·54	1	1
α Draconis	24. 52	18 ·19	19 ·46	— 1 ·27	3	3
19 Camelopardali	25. 57	26 ·80	27 ·50	— 0 ·70	1	1
Groombridge 1853	26. 11	22 ·16	22 ·61	— 0 ·45	2	3
Piazzi XV. 198	26. 55	48 ·37	47 ·99	+ 0 ·38	4	4
ε Cassiopeiæ	27. 6	24 ·73	24 ·59	+ 0 ·14	1	1
Groombridge 3993	27. 13	51 ·36	54 ·24	— 2 ·88	1	1
30 Cephei	27. 14	49 ·48	48 ·01	+ 1 ·47	3	4
Piazzi XI. 74	27. 22	4 ·80	4 ·90	— 0 ·10	3	3
α Ursæ Majoris	27. 24	10 ·38	9 ·44	+ 0 ·94	14	14
κ Cassiopeiæ	27. 56	7 ·02	7 ·46	— 0 ·44	1	4
Groombridge 2345	27. 57	41 ·70	40 ·47	+ 1 ·23	3	3
25 Cephei	27. 59	52 ·25	52 ·22	+ 0 ·03	2	4
α Cephei	28. 5	40 ·14	40 ·23	— 0 ·09	18	18
η Draconis	28. 8	43 ·79	44 ·23	— 0 ·44	11	12
71 Draconis	28. 14	23 ·78	23 ·15	+ 0 ·63	1	1
8 Lyncis	28. 23	24 ·66	24 ·87	— 0 ·21	2	3
66 Draconis	28. 28	30 ·66	31 ·14	— 0 ·48	3	3
9 Cephei	28. 37	28 ·01	28 ·46	— 0 ·45	2	3
η Cephei	28. 46	10 ·57	10 ·68	— 0 ·11	1	1
12 Cassiopeiæ	29. 2	21 ·76	22 ·09	— 0 ·33	1	4
Piazzi XIII. 110	29. 14	29 ·94	29 ·61	+ 0 ·33	3	4
Piazzi 0. 25	29. 20	22 ·04	21 ·43	+ 0 ·61	2	2
ν Cephei	29. 36	6 ·92	6 ·51	+ 0 ·41	3	3
Groombridge 4198	29. 39	3 ·92	4 ·18	— 0 ·26	2	3
10 Camelopardali	29. 48	46 ·49	47 ·45	— 0 ·96	1	1
47 Camelopardali	29. 49	58 ·15	56 ·26	+ 1 ·89	1	3
29 Lyncis	29. 57	17 ·68	17 ·37	+ 0 ·31	1	3
40 Camelopardali	29. 58	1 ·05	1 ·61	— 0 ·56	1	1
γ Cassiopeiæ	30. 8	4 ·79	5 ·30	— 0 ·51	1	5

EXCESS OF REFLEXION-RESULTS ABOVE DIRECT-RESULTS, WITH TROUGHTON'S CIRCLE, 1843—*continued.*

Name of Star.	Approx. N. P. D.	Sec. of R.	Sec. of D.	R — D.	No. of Obs. R	No. of Obs. D
	° ′	″	″	″		
14 Lyncis	30. 22	27 ·90	27 ·99	— 0 ·09	2	2
ι Draconis..........	30. 29	54 ·61	54 ·81	— 0 ·20	7	7
δ Cassiopeiæ........	30. 35	59 ·05	57 ·02	+ 2 ·03	1	1
A. S. C. 371	30. 37	48 ·07	47 ·32	+ 0 ·75	3	3
Piazzi XXI. 51.....	30. 39	26 ·37	25 ·46	+ 0 ·91	4	5
ο Draconis..........	30. 48	7 ·12	6 ·26	+ 0 ·86	4	4
2 Lyncis	30. 56	29 ·85	29 ·67	+ 0 ·18	2	4
θ Draconis	31. 1	48 ·74	49 ·51	— 0 ·77	4	4
37 Camelopardali....	31. 3	11 ·21	12 ·33	— 1 ·12	2	3
70 Ursæ Majoris....	31. 16	38 ·39	38 ·54	— 0 ·15	2	3
Piazzi III. 208	31. 17	16 ·72	17 ·74	— 1 ·02	1	2
b Draconis	31. 17	17 ·52	18 ·05	— 0 ·53	2	2
1 Cassiopeiæ........	31. 26	39 ·76	39 ·45	+ 0 ·31	2	3
2 Cassiopeiæ........	31. 31	4 ·12	3 ·83	+ 0 ·29	2	3
Piazzi XIX. 371....	31. 34	17 ·73	17 ·23	+ 0 ·50	2	3
A. S. C. 373	31. 40	21 ·24	20 ·09	+ 1 ·15	1	1
41 Ursæ Majoris	31. 48	29 ·16	28 ·52	+ 0 ·64	2	3
δ Ursæ Majoris......	32. 6	40 ·62	40 ·30	+ 0 ·32	2	3
τ Cassiopeiæ........	32. 13	19 ·99	20 ·02	— 0 ·03	1	1
54 Camelopardali....	32. 18	56 ·40	55 ·39	+ 1 ·01	2	3
A. S. C. 2807	32. 19	56 ·58	58 ·12	— 1 ·54	1	1
δ² Cephei...........	32. 23	13 ·79	12 ·15	+ 1 ·64	2	6
23 Lyncis	32. 34	1 ·01	0 ·37	+ 0 ·64	2	5
ζ Cephei	32. 34	15 ·23	16 ·20	— 0 ·97	1	1
η Cassiopeiæ........	33. 1	8 ·06	7 ·65	+ 0 ·41	1	3
Piazzi XVI. 291....	33. 5	44 ·29	44 ·46	— 0 ·17	5	6
ξ Draconis	33. 6	1 ·68	1 63	+ 0 ·05	2	2
29 Camelopardali....	33. 8	31 ·04	31 ·13	— 0 ·09	1	4
ε Ursæ Majoris	33. 11	12 ·36	12 ·44	— 0 ·08	4	4
36 Ursæ Majoris	33. 13	0 ·42	0 ·12	+ 0 ·30	2	4
ρ Cassiopeiæ	33. 22	26 ·17	25 ·94	+ 0 ·23	2	3
73 Ursæ Majoris	33. 25	1 ·84	1 ·29	+ 0 ·55	2	4
33 Cygni...........	33. 55	36 ·92	36 ·33	+ 0 ·59	1	1
Groombridge 3041...	34. 7	38 ·41	38 ·42	— 0 ·01	5	8
ζ¹ Ursæ Majoris.....	34. 15	10 ·11	10 ·27	— 0 ·16	8	7
α Cassiopeiæ........	34. 19	27 ·81	27 ·60	+ 0 ·21	7	7
6 Camelopardali	34. 26	10 ·31	9 ·88	+ 0 ·43	2	2
83 Ursæ Majoris	34. 31	17 ·88	18 ·93	— 1 ·05	3	3
σ Cassiopeiæ........	35. 7	7 ·01	7 ·78	— 0 ·77	2	4
e Ursæ Majoris	35. 20	5 ·42	4 ·86	+ 0 ·56	1	1
Piazzi IX. 229......	35. 21	6 ·96	7 ·01	— 0 ·05	2	5
γ Ursæ Majoris	35. 26	55 ·77	56 ·81	— 1 ·04	6	5
Groombridge 2822...	35. 55	50 ·62	49 ·80	+ 0 ·82	2	3
θ Cygni............	40. 8	24 ·88	22 ·36	+ 2 ·52	1	2
α Persei	40. 42	11 ·79	10 ·78	+ 1 ·01	2	7
ι Persei............	41. 0	30 ·32	30 ·99	— 0 ·67	1	1
ω¹ Cygni............	41. 8	5 ·29	4 ·81	+ 0 ·48	2	4
ι Ursæ Majoris......	41. 21	46 ·70	47 ·55	— 0 ·85	2	5
π² Cygni	41. 25	53 ·37	52 ·77	+ 0 ·60	1	4

EXCESS OF REFLEXION-RESULTS ABOVE DIRECT-RESULTS, WITH TROUGHTON's CIRCLE, 1843—*continued.*

Name of Star.	N. P. D.	Sec. of R.	Sec. of D.	R — D.	No. of Obs. R	D
	° ′	″	″	″		
θ Persei	41. 26	24 ·70	24 ·35	+ 0 ·35	1	1
8 Andromedæ	41. 50	29 ·14	30 ·63	— 1 ·49	1	1
μ Persei	42. 0	47 ·15	46 ·82	+ 0 ·33	1	3
Groombridge 3933	42. 9	11 ·25	10 ·97	+ 0 ·28	1	3
25 Lyncis	42. 13	50 ·62	51 ·19	— 0 ·57	2	4
ψ Persei	42. 20	7 ·91	7 ·86	+ 0 ·05	1	1
δ Persei	42. 43	13 ·84	13 ·44	+ 0 ·40	4	4
Groombridge 3692	42. 50	57 ·87	57 ·89	— 0 ·02	2	5
Groombridge 3699	42. 51	23 ·95	23 ·15	+ 0 ·80	2	3
f^2 Cygni	42. 59	48 ·84	48 ·01	+ 0 ·83	1	5
f^1 Cygni	43. 5	21 ·93	22 ·03	— 0 ·10	1	5
15 Leonis Minoris	43. 15	2 ·97	3 ·56	— 0 ·59	1	5
φ Andromedæ	43. 36	47 ·43	48 ·23	— 0 ·80	1	1
o^2 Cygni	43. 44	56 ·04	53 ·63	+ 2 ·41	1	1
d Persei	43. 53	58 ·89	57 ·85	+ 1 ·04	1	1
ι Herculis	43. 54	25 ·10	24 ·89	+ 0 ·21	6	7
Capella	44. 10	9 ·00	9 ·33	— 0 ·33	14	14
2 Lacertæ	44. 15	8 ·02	6 ·92	+ 1 ·10	2	2
λ Andromedæ	44. 23	29 ·55	31 ·26	— 1 ·71	1	2
ψ Andromedæ	44. 27	3 ·25	3 ·80	— 0 ·55	2	4
4 Andromedæ	44. 28	34 ·73	35 ·32	— 0 ·59	1	1
16 Lyncis	44. 43	34 ·67	34 ·15	+ 0 ·52	3	4
Groombridge 1919	45. 2	10 ·33	11 ·11	— 0 ·78	3	3
β Aurigæ	45. 5	33 ·79	34 ·10	— 0 ·31	1	1
ρ Cygni	45. 6	58 ·66	59 ·15	— 0 ·49	1	2
α Cygni	45. 17	40 ·03	40 ·49	— 0 ·46	14	14
55 Aurigæ	45. 20	56 ·16	54 ·37	+ 1 ·79	1	1
35 Lyncis	45. 42	37 ·17	39 ·67	— 2 ·50	1	4
ω Ursæ Majoris	45. 58	30 ·97	33 ·01	— 2 ·04	2	2
36 Lyncis	46. 8	22 ·74	21 ·06	+ 1 ·68	2	4
13 Lyræ	46. 15	25 ·62	25 ·90	— 0 ·28	2	3
Groombridge 3882	46. 17	47 ·75	47 ·53	+ 0 ·22	1	4
λ Ursæ Majoris	46. 18	15 ·03	14 ·56	+ 0 ·47	2	2
30 Persei	46. 33	26 ·51	25 ·00	+ 1 ·51	1	1
26 Andromedæ	47. 5	52 ·19	51 ·21	+ 0 ·98	1	4
σ Herculis	47. 14	9 ·22	8 ·41	+ 0 ·81	2	2
ι Andromedæ	47. 36	3 ·00	1 ·07	+ 1 ·93	1	4
μ Ursæ Majoris	47. 43	47 ·01	47 ·13	— 0 ·12	1	1
g Herculis	47. 46	10 ·14	9 ·87	+ 0 ·27	2	2
8 Canum Venaticûm	47. 47	17 ·90	17 ·66	+ 0 ·24	1	1
13 Andromedæ	47. 57	5 ·57	4 ·28	+ 1 ·29	2	3
19 Leonis Minoris	48. 12	59 ·15	58 ·76	+ 0 ·39	1	5
9 Canum Venaticûm	48. 16	37 ·52	36 ·94	+ 0 ·58	2	5
γ^1 Andromedæ	48. 25	19 ·77	19 ·67	+ 0 ·10	1	1
14 Lacertæ	48. 53	35 ·56	33 ·59	+ 1 ·97	1	4
Groombridge 2538	49. 7	17 ·61	18 ·33	— 0 ·72	1	2
15 Andromedæ	50. 38	43 ·76	42 ·72	+ 1 ·04	2	4
η Herculis	50. 47	32 ·56	32 ·16	+ 0 ·40	5	6
12 Can. Venat. (2nd star)	50. 50	57 ·55	56 ·34	+ 1 ·21	1	1

EXCESS OF REFLEXION-RESULTS ABOVE DIRECT-RESULTS, WITH TROUGHTON's CIRCLE, 1843—*continued*.

Name of Star.	N. P. D.	Sec. of R.	Sec. of D.	R — D.	No. of Obs. R	No. of Obs. D
	° ′	″	″	″		
γ Bootis	51. 0	6 ·85	8 ·10	− 1 ·25	3	3
Groombridge 1830	51. 9	20 ·96	20 ·23	+ 0 ·73	1	4
Piazzi XVIII. 137	51. 14	45 ·73	45 ·29	+ 0 ·44	2	3
38 Leonis Minoris	51. 16	23 ·68	24 ·41	− 0 ·73	2	4
α Lyræ	51. 22	31 ·11	31 ·78	− 0 ·67	15	15
Groombridge 1931	51. 38	39 ·23	38 ·31	+ 0 ·92	1	4
Groombridge 1961	51. 44	18 ·28	18 ·26	+ 0 ·02	3	4
β¹ Lyræ	56. 49	56 ·33	56 ·35	− 0 ·02	2	3
ζ Cygni	60. 25	50 ·37	49 ·74	+ 0 ·63	4	9
η Pegasi	60. 36	54 ·58	52 ·83	+ 1 ·75	1	4
β Tauri	61. 31	53 ·84	54 ·13	− 0 ·29	4	7
Pollux	61. 36	0 ·92	0 ·80	+ 0 ·12	6	11
α Andromedæ	61. 47	35 ·73	34 ·90	+ 0 ·83	4	7
ε Bootis	62. 16	39 ·03	38 ·16	+ 0 ·87	3	9
α Coronæ Borealis	62. 45	12 ·02	10 ·95	+ 1 ·17	6	13
β Pegasi	62. 46	2 ·17	2 ·16	+ 0 ·01	1	4
ε Leonis	65. 30	21 ·32	21 ·18	+ 0 ·14	9	11
η Tauri	66. 23	9 ·05	7 ·22	+ 1 ·83	3	6
α Arietis	67. 17	58 ·13	58 ·26	− 0 ·13	2	6
μ Geminorum	67. 25	44 ·88	43 ·12	+ 1 ·76	2	5
υ Pegasi	67. 27	33 ·61	32 ·81	+ 0 ·80	2	3
δ Geminorum	67. 44	4 ·29	3 ·81	+ 0 ·48	5	7
71 Pegasi	68. 22	1 ·33	0 ·35	+ 0 ·98	1	4
ϑ Leonis	68. 37	1 ·46	0 ·81	+ 0 ·65	4	6
A. S. C. 318	69. 1	51 ·88	51 ·76	+ 0 ·12	1	1
β Arietis	69. 58	43 ·00	42 ·19	+ 0 ·81	1	1
Arcturus	70. 0	50 ·29	49 ·66	+ 0 ·63	22	22
η Bootis	70. 49	46 ·55	45 ·48	+ 1 ·07	2	5
ε Tauri	71. 10	22 ·78	24 ·16	− 1 ·38	1	1
θ Cancri	71. 23	45 ·48	45 ·46	+ 0 ·02	1	1
ζ¹ Cancri	71. 53	1 ·31	2 ·19	− 0 ·88	1	3
d² Cancri	72. 26	27 ·93	28 ·33	− 0 ·40	2	3
Aldebaran	73. 49	42 ·07	42 ·63	− 0 ·56	4	9
o² Cancri	73. 49	12 ·34	10 ·92	+ 1 ·42	2	3
o¹ Cancri	74. 5	44 ·29	43 ·38	+ 0 ·91	1	2
β Leonis	74. 33	1 ·26	0 ·39	+ 0 ·87	3	8
α Herculis	75. 26	30 ·20	32 ·23	− 2 ·03	1	6
η Piscium	75. 28	55 ·37	54 ·79	+ 0 ·58	1	1
α Pegasi	75. 38	16 ·60	17 ·92	− 1 ·32	1	5
γ Pegasi	75. 41	20 ·73	21 ·22	− 0 ·49	3	5
ζ Aquilæ	76. 22	53 ·85	54 ·51	− 0 ·66	9	13
Regulus	77. 16	3 ·53	4 ·46	− 0 ·93	2	8
α Ophiuchi	77. 19	13 ·59	14 ·38	− 0 ·79	10	15
α Cancri	77. 32	17 ·19	19 ·59	− 2 ·40	1	1
γ Aquilæ	79. 46	53 ·00	52 ·99	+ 0 ·01	13	13
ζ Pegasi	79. 59	10 ·20	10 ·21	− 0 ·01	2	4
κ Ophiuchi	80. 22	32 ·88	33 ·62	− 0 ·74	7	7
ε Pegasi	80. 50	29 ·74	30 ·02	− 0 ·28	8	16
α Aquilæ	81. 32	28 ·94	29 ·51	− 0 ·57	13	17

EXCESS OF REFLEXION-RESULTS ABOVE DIRECT-RESULTS, WITH TROUGHTON's CIRCLE, 1843—*concluded.*

Name of Star.	N. P. D.	Sec. of R.	Sec. of D.	R — D.	No of Obs. R	No of Obs. D
	° ′	″	″	″		
α Orionis...........	82. 38	38 ·95	40 ·40	— 1 ·45	2	6
ε Hydræ...........	83. 0	31 ·44	32 ·79	— 1 ·35	3	5
α Serpentis.........	83. 5	32 ·78	32 ·81	— 0 ·03	1	3
β Aquilæ...........	83. 59	49 ·98	50 ·47	— 0 ·49	17	17
Procyon...........	84. 22	35 ·23	37 ·73	— 2 ·50	1	8
ι Piscium..........	85. 13	25 ·76	25 ·63	+ 0 ·13	2	9
α Ceti..............	86. 32	45 ·60	47 ·92	— 2 ·32	1	3
δ Aquilæ...........	87. 12	35 ·68	34 ·30	+ 1 ·38	2	7
δ Orionis...........	90. 25	14 ·22	14 ·21	+ 0 ·01	1	3
α Aquarii..........	91. 5	45 ·88	47 ·25	— 1 ·37	4	11
δ Ophiuchi.........	93. 17	6 ·85	6 ·26	+ 0 ·59	2	5
α Hydræ...........	97. 59	52 ·52	51 ·87	+ 0 ·65	3	8
Sirius..............	106. 30	18 ·24	17 ·19	+ 1 ·05	2	11
15 Argûs...........	113. 51	19 ·35	19 ·33	+ 0 ·02	1	5

The above table of the values of R—D rendering it pretty evident that no error exists following a law of continuity for which a correction could be safely applied, the values have not been grouped, and no correction has been applied.

The results for thirty circumpolar stars were then used for examination of the assumed colatitude, but the result has not a very great weight, on account of the general want of equality in the number of observations above the pole and below the pole respectively.

The computations are contained in the subjoined table: of which no explanation appears necessary, except that the weight is approximately determined by multiplying $\frac{a\,b}{a+b}$ (where a is the number of observations above the pole, and b the number below) by the number 60 for the first star, 59 for the second, 58 for the third, and so on.

CORRECTION OF ASSUMED LATITUDE.

Star's Name, Position, and Mode of Observation.	No. of Obs.	N. P. D. from each Group.	No. of Obs.	Concluded N. P. D. in each Position on assumed Latitude.	No. of Obs.	Algebraic Sum of Determinations.	Weight.	Product.
		° ′ ″		″		″		″
Polaris.............. D.	10	1. 31. 40·00	18	39 ·38	61	—0 ·87	48	— 41 ·76
R.	8	38·61						
S. P... D.	22	— 1. 31. 40·05	43	—40 ·25				
R.	21	40·45						

Star's Name, Position, and Mode of Observation.	No. of Obs.	N. P. D. from each Group.	No. of Obs.	Concluded N. P. D. in each Position on assumed Latitude.	No. of Obs.	Algebraic Sum of Determinations.	Weight.	Product.
		° ′ ″		″		″		″
δ Ursæ Minoris....... D.	7	3. 24. 22·70	14	23·23	16	−0·65	6	− 3·90
R.	7	23·76						
S. P... D.	1	− 3. 24. 24·39	2	−23·88				
R.	1	23·36						
γ Cephei............ D.	1	13. 14. 38·41	1	38·41	10	+0·65	3	+ 1·95
R.	..	.....						
S. P... D.	6	−13. 14. 37·24	9	−37·76				
R.	3	38·81						
β Ursæ Minoris...... D.	17	15. 12. 9·91	34	9·85	36	+0·26	7	+ 1·82
R.	17	9·79						
S. P... D.	2	−15. 12. 9·59	2	− 9·59				
R.	..	.....						
19 Camelopardali..... D.	1	25. 57. 27·50	2	27·15	4	−0·52	4	− 2·08
R.	1	26·80						
S. P... D.	2	−25. 57. 27·67	2	−27·67				
R.	..	.....						
Piazzi I. 159......... D.	1	26. 55. 32·89	1	32·89	3	−0·40	2	− 0·80
R.	..	.....						
S. P... D.	1	−26. 55. 32·36	2	−33·29				
R.	1	34·21						
Piazzi 0. 25.......... D.	2	29. 20. 21·43	4	21·74	6	−0·91	5	− 4·55
R.	2	22·04						
S. P... D.	2	−29. 20. 22·65	2	−22·65				
R.	..	.....						
Groombridge 4222.... D.	2	29. 33. 37·17	2	37·17	4	−1·51	3	− 4·53
R.	..	.....						
S. P... D.	2	−29. 33. 38·68	2	−38·68				
R.	..	.....						
ν Cephei............. D.	3	29. 36. 6·51	6	6·72	8	−2·58	5	−12·90
R.	3	6·92						
S. P... D.	1	−29. 36. 9·00	2	− 9·30				
R.	1	9·60						
47 Camelopardali..... D.	3	29. 48. 56·26	4	56·73	6	−3·73	4	−14·92
R.	1	58·15						
S. P... D.	2	−29. 48. 60·46	2	−60·46				
R.	..	.....						

Star's Name, Position, and Mode of Observation.	No. of Obs.	N. P. D. from each Group.	No. of Obs.	Concluded N. P. D. in each Position on assumed Latitude.	No. of Obs.	Algebraic Sum of Determinations.	Weight.	Product.
		° ′ ″		″		″		″
29 Lyncis............ D.	3	29. 57. 17·37	4	17·43	5	− 0·97	3	− 2·91
R.	1	17·60						
S. P... D.	1	−29. 57. 18·40	1	−18·40				
R.	..	.....						
ι Draconis........... D.	7	30. 28. 54·81	14	54·71	15	− 0·96	3	− 2·88
R.	7	54·61						
S. P... D.	1	−30. 28. 55·67	1	−55·67				
R.	..	.....						
24 Lyncis............ D.	1	30. 55. 48·59	1	48·59	3	− 1·96	2	− 3·92
R.	..	.....						
S. P... D.	2	−30. 55. 50·55	2	−50·55				
R.	..	.....						
2 Lyncis............. D.	4	30. 56. 29·67	6	29·73	7	− 2·52	3	− 7·56
R.	2	29·85						
S. P... D.	1	−30. 56. 32·25	1	−32·25				
R.	..	.....						
Piazzi III. 208....... D.	2	31. 17. 17·74	3	17·40	4	− 2·42	2	− 4·84
R.	1	16·72						
S. P... D.	1	−31. 17. 19·82	1	−19·82				
R.	..	.....						
Piazzi XXII. 4...... D.	3	31. 55. 26·03	3	26·03	6	− 1·69	4	− 6·76
R.	..	.....						
S. P... D.	3	−31. 55. 27·72	3	−27·72				
R.	..	.....						
54 Camelopardali..... D.	3	32. 17. 55·39	5	55·79	6	− 1·69	2	− 3·38
R.	2	56·40						
S. P... D.	1	−32. 17. 57·48	1	−57·48				
R.	..	.....						
A. S. C. 2807......... D.	1	32. 18. 58·12	2	57·35	4	− 1·10	3	− 3·30
R.	1	56·58						
S. P... D.	2	−32. 18. 58·45	2	−58·45				
R.	..	.....						
23 Lyncis............ D.	5	32. 34. 0·37	7	0·55	8	− 2·17	2	− 4·34
R.	2	1·01						
S. P... D.	1	−32. 34. 2·72	1	− 2·72				
R.	..	.....						

Star's Name, Position, and Mode of Observation.	No. of Obs.	N. P. D. from each Group.	No. of Obs.	Concluded N. P. D. in each Position on assumed Latitude.	No. of Obs.	Algebraic Sum of Determinations.	Weight.	Product.
		° ′ ″		″		″		″
29 Camelopardali..... D.	4	33. 8. 31·13	5	31·11	7	− 2·42	4	− 9·68
R.	1	31·04						
S. P... D.	2	−33. 8. 33·53	2	−33·53				
R.	..	.....						
ρ Cassiopeiæ .... D.	3	33. 22. 25·94	5	26·03	7	− 1·42	4	− 5·68
R.	2	26·17						
S. P... D.	2	−33. 22. 27·45	2	−27·45				
R.	..	.....						
24 Camelopardali..... D.	1	33. 30. 35·24	1	35·24	3	+ 0·07	2	+ 0·14
R.	..	.....						
S. P... D.	2	−33. 30. 35·17	2	−35·17				
R.	..	.....						
α Cassiopeiæ......... D.	7	34. 19. 27·60	14	27·71	16	− 1·71	4	− 6·84
R.	7	27·81						
S. P... D.	2	−34. 19. 29·42	2	−29·42				
R.	..	.....						
σ Cassiopeiæ......... D.	4	35. 7. 7·78	6	7·52	7	+ 0·18	2	+ 0·36
R.	2	7·01						
S. P... D.	1	−35. 7. 7·34	1	− 7·34				
R.	..	.....						
e Ursæ Majoris....... D.	1	35. 20. 4·86	2	5·14	3	+ 0·70	1	+ 0·70
R.	1	5·42						
S. P... D.	1	−35. 20. 4·44	1	− 4·44				
R.	..	.....						
γ Ursæ Majoris ...... D.	5	35. 25. 56·81	11	56·24	12	− 1·00	2	− 2·00
R.	6	55·77						
S. P... D.	1	−35. 25. 57·24	1	−57·24				
R.	..	.....						
θ Ursæ Majoris ...... D.	8	37. 36. 39·39	8	39. 39	14	− 3·09	7	−21·63
R.	..	.....						
S. P... D.	6	− 37. 36. 42·48	6	−42·48				
R.	..	.....						
Piazzi XXI. 383. .... D.	4	37. 52. 22·82	4	22·82	6	+ 1·11	3	+ 3·33
R.	..	.....						
S. P... D.	2	−37. 52. 21·71	2	−21·71				
R.	..	.....						

Star's Name, Position, and Mode of Observations.	No. of Obs.	N.P.D. from each Group.	No. of Obs.	Concluded N.P.D. in each Position on assumed Latitude.	No. of Obs.	Algebraic Sum of Determinations.	Weight.	Product.
27 Lyncis .... D.	1	° ′ ″ 38. 2. 51·23	1	″ 51·23	2	″ — 1·35	1	″ — 1·35
R.	..	.....						
S. P... D.	1	—38. 2. 52·58	1	—52·58				
R.	..	.....						
ι^2 Cygni .... D.	3	38. 36. 6·78	3	6·78	4	— 4·08	1	— 4·08
R.	..	.....						
S. P... D.	1	—38. 36. 10·86	1	—10·86				
R.	..	.....						

If z be the correction to be applied to the colatitude, $2z$ + the algebraic sum of each determination ought to be = 0. Combining the whole with the weights above attached to them, $2z = +1''\cdot 19$, or $z = +0''\cdot 60$; and the true co-latitude is $38°. 31'. 21''\cdot 60$.

The colatitude adopted for the results of the year 1843 is the same as that used in 1842, viz. $38°. 31'. 21''\cdot 80$.

§ 5. *Catalogue of the Mean Places of Stars observed in the Year* 1843, *page* 2 *to* 11.

The right ascensions in the catalogue are the means of all the separate determinations of the mean right ascension of each star, excluding only those which are contained in brackets. The annual variations for the Nautical Almanac Stars are taken from the Nautical Almanac (those in which proper motion is included being marked with an asterisk). The others are computed independently, with the elements given in the Nautical Almanac, 1834, 2nd edition, page xiii; which were taken from the *Tabulæ Regiomontanæ*, and which have been used for all the later volumes of the Nautical Almanac.

The north polar distances in the catalogue are the means of the daily results affected with the correction $+0''\cdot 80$. The adopted seconds of N. P. D. are found by taking the mean of the groups of direct and reflexion-observations, giving to each a weight proportional to its number of observations. With regard to circumpolar stars, the following rules have been followed. For stars whose N. P. D. does not exceed 15°, the observations above and below the pole are considered equally good: from N. P. D. 15° to N. P. D. 36°, those below have the weight $\frac{2}{3}$ for each observation: from N. P. D. 36° to N. P. D. 41°,

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those below have the weight $\frac{1}{2}$: beyond 41° N. P D., the observations are not combined. The annual variations are taken from the Nautical Almanac, as far as its list extends: for other stars they are computed with the elements given in the Nautical Almanac, 1834, 2nd edition, page xiii.

§ 6. *Horizontal and Vertical Diameters, Right Ascensions, and North Polar Distances, of the Sun, Moon, and Planets; deduced from the Observations, and compared with the tables, &c.*, page 14 to 36.

The duration of the passage of the Sun's diameter is found by subtracting the clock time of transit of the first limb from that of the second limb in the *Transits observed, &c.*, without any further correction. The tabular duration is found by doubling the time of passage of the semidiameter given in the Nautical Almanac. The excess of the latter over the former is set down as the Apparent Error of the Nautical Almanac. The mean of all the values of this error is $-0^{s}\cdot 14$.

The Sun's vertical diameter is found by subtracting the zenith-distance of the north limb corrected for refraction and parallax, from that of the south limb similarly corrected. The tabular diameter is found by doubling the semidiameter of the Nautical Almanac. The excess of the latter above the former is set down as the apparent error of the Nautical Almanac, and the mean of all the values of this error is $-1''\cdot 84$

For the correction of the passage of the Moon's diameter, a correction is applied (negative to the time of passage of the first limb, or positive to that of the second limb, according as the Moon had passed or had not passed the opposition in right ascension), thus investigated. The excess or defect of the difference of R.A. of the Sun and Moon from 12^{h}, at the time of the Moon's transit, being found, and expressed in arc, this quantity is multiplied by the cosine of the Sun's declination, and thus an arc θ is obtained which represents the angle upon the Moon's surface, of the unenlightened part of the disc (with respect to right ascension); the correction required is, semidiameter × versine θ.

The Moon's vertical diameter is found in the same manner as the Sun's (the correction for defective illumination having been already applied, see page xlv). The mean of the twenty-one values of the errors is $-5''\cdot 05$.

The vertical diameters of Mercury and Venus are found by doubling the semidiameters given in the section of *Observations made with Troughton's Mural Circle.* These diameters, therefore, are not imperfect diameters, as observed in the first instance. The vertical diameters of the other planets are merely the measures corresponding to the micrometer readings in the 10th column of the right-hand page of the same section, or are the doubles of the semidiameters in the 11th column. The duration of passages of the planets' diameters is formed as for the Sun.

The Mean Solar Time is found, in all cases, from the Right Ascension or Sidereal Time, by adding together the Mean Solar Time at the transit of the first point of Aries next preceding, and the equivalents in Mean Solar Time for the hours, minutes, and seconds of the Sidereal Time: the whole of these numbers being taken from the Nautical Almanac. In practice this operation is made a little easier, by putting the addition in the following form:

1. Sidereal Time.
2. Mean Solar Time of Transit of first point of Aries, diminished by 4^{m}.
3. $3^{m}.47^{s}\cdot00$—hours of Sid. Time + solar equiv. for hours.
4. $10^{s}\cdot00$—minutes of Sid. Time + solar equiv. for minutes.
5. $3^{s}.00$—seconds of Sid. Time + solar equiv. for seconds.

Small tables of the 3rd, 4th, and 5th quantities are prepared (See Appendix to Observations, 1837, Table No. IV.), and the operation is then very simple, consisting entirely of addition, with few figures and no interpolation.

When any object is observed in N. P. D. and not in Right Ascension, the Right Ascension at Transit (for the calculation of the Mean Solar Time) is taken from the Nautical Almanac.

The Right Ascensions of the Sun are transcribed from those in the *Transits, &c.*, with no alteration, except that, when necessary, the personal equation $\pm\ 0^{s}\cdot25$ is applied as mentioned in a former part of this introduction; and that when the first limb only has been observed, the correction $+0^{s}\cdot07$ has been applied; and when the second limb only has been observed, the correction $-0^{s}\cdot07$. The North Polar Distances of the Sun are the means of those deduced from the two limbs, in the 12th column of the right-hand page in the section *Observations with the Mural Circle:* the correction $+0''\cdot80$ for alteration of latitude being applied, and the correction $+0''\cdot92$ when the N. limb only was observed, and $-0''\cdot92$ when the S. limb only was observed. The tabular places are taken from the Nautical Almanac.

The Right Ascensions of the Moon are taken from the *Transits, &c.*, corrected, if necessary, for personal equation: the correction $+0^{s}\cdot20$ being applied when the first limb was observed, and $-0^{s}\cdot20$ when the second limb was observed. This is the same correction which was used in all preceding years since 1836: it is fully supported by all the observations hitherto made, as appears from the following collection. The equatoreal observations for 1843 will be found in a subsequent part of this volume. With regard to these and the other equatoreal observations, it is to be noted that, on account of the greater unsteadiness of the instrument, and the smaller number of wires, one set of equatoreal observations is considered equivalent only to one transit observation.

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Error of Moon's Tabular Horizontal Diameter.

Year.	Tabular Error.	Number of Observations in Results.	Error × Number.	
	s		s	
1836	— 0·41	3	— 1·23	Transit observations.
1837	— 0·38	1	— 0·38	
1838	— 0·48	2	— 0·96	
1839	— 0·56	3	— 1·68	
1840	— 0·20	2	— 0·40	
1842	— 0·17	3	— 0·51	
1843	— 0·33	3	— 0·99	
1837	— 0·37	2	— 0·74	Equatoreal observations.
1838	— 0·31	2	— 0·62	
1839	— 0·33	4	— 1·32	
1840	— 0·33	3	— 0·99	
1841	— 0·40	1	— 0·40	
1842	— 0·42	3	— 1·26	
1843	— 0·71	2	— 1·42	
		34	— 12·90	
		Mean Tabular Error =	— 0·38	

When both limbs are observed, the correction for defective illumination mentioned (page lviii) is first applied to the proper limb, and the mean of the two is then taken without further correction.

The North Polar Distances are taken from those of the twelfth column on the right-hand page in the section of *Observations with the Mural Circle*, with the following alterations. The correction $+0''\cdot80$ for change of latitude is applied throughout, and the correction $+2''\cdot35$ when the N. limb only is observed, and $-2''\cdot35$ when the S. limb only is observed. This correction is deduced, with a trifling alteration owing to an error subsequently discovered, from the following collection of observations of the Moon's vertical diameter:—

Error of Moon's Tabular Vertical Diameter.

Year.	Tabular Error.	Number of Observations.	Error × Number.
	"		"
1836	— 6·23	8	— 49·84
1837	— 5·94	7	— 41·58
1838	— 5·51	11	— 60·61
1839	— 6·02	6	— 36·12
1840	— 3·56	10	— 35·60
1841	— 4·07	10	— 40·70
1842	— 3·83	26	— 99·58
1843	— 5·05	21	— 106·05
		99	— 470·08
		Mean Tabular Error =	— 4·75

When both limbs are observed, the mean is taken. There is then applied $-\frac{1}{2600}$ of the lunar parallax actually employed, for the augmentation of lunar parallax deduced by Professor Henderson, from the observations made at the Cape of Good Hope, and compared with those in Europe (Mem. Ast. Society, vol. x.). The tabular N. P. D. are taken from the 7th column in the section *Moon-culminating Stars* of the Nautical Almanac.

For the Right Ascensions of Venus, a correction for the error of semidiameter has been applied. From an investigation in the Introduction to the Observations, 1838, it appears that the error of the semidiameters in right ascension may be represented by the following formula:—

$$-0^{s}\cdot05 - 0^{s}\cdot03 \times \text{tabular semidiameter in R. A.}$$

The corrections applied in consequence are as follows:—

January 8 to 10	$-\overset{s}{0}\cdot11$	March 6 to April 23	$-\overset{s}{0}\cdot07$
February 2	$-0\cdot09$	April 30 to September 14	$-0\cdot06$
February 12 to 20	$-0\cdot08$	November 9 to December 8	$+0\cdot06$

For all the other planets, the Right Ascensions are extracted from the twelfth column on the right-hand page of *Transits observed, &c.*, with no alteration, except for personal equation when necessary: for all the planets, the North Polar Distances are taken from the twelfth column on the right-hand page of the *Observations with the Mural Circle*, with the addition of $+ 0''\cdot80$ for correction of colatitude. The tabular places are taken entirely from the Nautical Almanac, excepting certain places of Vesta and Juno, which Lieutenant Stratford (Superintendant of the Nautical Almanac) obligingly computed, at my request, from the same elements as those used for the places of those planets in the Nautical Almanac. The following are the days for which the above-mentioned tabular places were furnished:—For Vesta, January 4 and 5, March 16, 17, 18, 23, 24, 25, and April 5; for Juno, September 15 and 19.

The result of an observation of Faye's Comet made with the Mural Circle, was inadvertently omitted at its proper place after the results of planetary observations: it is as follows:—

North Polar Distance of Faye's Comet.

Mean Solar Time of Observation.	N. P. D. from Observation.	Seconds of Tabular N.P.D.	Apparent Error of Tables in N.P.D.
1843. d h m s	° ′ ″	″	″
Nov. 29. 11. 17. 56	84. 25. 32 ·13	24·10	− 7·03

The Seconds of Tabular N. P. D. were computed from an Ephemeris furnished by Mr. Hind, to which allusion will be made in the Section of Equatoreal Observations.

The investigation of the position of the Ecliptic is conducted in the same manner as the investigations from observations at the Cambridge Observatory, given in the Astronomical Society's Memoirs, vols. 8, 9, and 10. The mean of all the errors in each month, for R. A. and for N. P. D., is supposed to be the error for the day which is nearest to the mean of all the days of observation. When the same day was not found for R.A. and for N. P. D., an alteration of a unit or more has sometimes been made. From these, the error in Ecliptic Polar Distance is obtained by means of the factors R and S in the Tables forming the second part of the Appendix to the Greenwich Observations, 1836. Supposing these errors to arise from an erroneous position of the ecliptic assumed in the Nautical Almanac, they may be expressed by the formula $x \times$ cos. ⊙ longitude + $y \times$ sin. ⊙ longitude + z. For convenience, the weight attributed to each monthly equation is so altered, that the sums of those in opposite quarters are equal. The rest of the process needs no explanation.

In former years the correction + $0^{s}\cdot03$ was applied to the Errors in the Tabular Geocentric Right Ascensions of the Sun, Moon, and Planets, to make the assumed Equinox correspond with that used in the reduction of the Cambridge Planetary Observations, contained in a memoir in the 10th volume of the Royal Astronomical Society's Memoirs. In the observations of the year 1843, the clock-error has in all cases been obtained by means of the places of stars in the Greenwich Catalogue of 1439 stars without alteration, and the determinations of R. A. are therefore always referred to the same equinox as the place of that Catalogue. The Apparent Errors of R. A. are found by comparing these R. A. without any alteration, with the Tabular R. A. The investigation of the corrections to the Greenwich Right Ascensions formerly adopted, and to the R. A. of the Nautical Almanac, will be found in the Introduction to the Greenwich Catalogue of 1439 stars, which forms the Appendix to the Volume of the Astronomical Observations for 1842. The errors in longitude and E. P. D. are formed by the use of the numbers P, Q, R, S, in the Appendix to the Greenwich Observations, 1836. For Juno and Ceres, whose latitude exceeded the limits of those tables, the longitude and E. P. D. were computed, 1st, from the R. A. and N. P. D. of the Nautical Almanac; 2nd, from these quantities affected with the errors in R. A. and N. P. D.; and the differences between these results gave the errors in longitude and E. P. D.

For the *Errors in the Tabular Helicocentric Places of the Planets*, the following formulæ are used:—

For the four small planets,

Let R = radius vector of planet, L = planet's heliocentric longitude,
Δ = planet's distance from earth, λ = planet's geocentric longitude,
r = earth's radius vector, l = earth's heliocentric longitude.

Then

$$\text{Error of geoc. long.} = \frac{R \times \cos.\ \text{hel. lat.} \times \cos.\ (\lambda - L)}{\Delta \times \cos.\ \text{geoc. lat.}} \times \text{error of hel. long.}$$

$$- \frac{\sin.\ (\lambda - L)}{\Delta \times \cos.\ \text{geoc. lat.} \times \sin.\ 1''} \times \text{error of projection of radius vector.}$$

$$\text{Error of Hel. E. P. D.} = \frac{\Delta \times \cos.\ \text{hel. lat.}}{R \times \cos.\ \text{geoc. lat.}} \times \text{error of geocen. E. P. D.}$$

$$- \sin.\ \text{hel. lat.} \times \cos.\ \text{hel. lat.} \times \tan.\ (\lambda - L) \times \text{error of geocen. long.}$$

$$- \frac{r \times \tan.\ \text{geoc. lat.} \times \cos.\ (L - l)}{R^2 \times \cos.\ (\lambda - L) \times \sin 1''} \times \text{error of projection of radius vector.}$$

For the other planets, the following are used:

$$\text{Error of geoc. long.} = \frac{R \times \cos.\ (\lambda - L)}{\Delta} \times \text{error of planet's heliocentric longitude}$$

$$- \frac{\sin.\ (\lambda - L)}{\Delta \times \sin.\ 1''} \times \text{error of projection of planet's radius vector}$$

$$- \frac{r \times \cos.\ (\lambda - l)}{\Delta} \times \text{error of earth's heliocentric longitude}$$

$$+ \frac{\sin.\ (\lambda - l)}{\Delta \times \sin.\ 1''} \times \text{error of earth's radius vector.}$$

$$\text{Error of Hel. E. P. D.} = \frac{\Delta}{R} \times \text{error of geocen. E. P. D.}$$

In the expressions above, different quantities are neglected for the small planets and for the other planets. For the small planets, it is not allowed to neglect the latitude in any part of the expressions, while, at the same time, their errors in general are so large that the earth may be supposed to move exactly in the orbit assigned by the tables. For the other planets, the latitude may be neglected in the formula, but it appears proper to retain the errors of the earth's place, as probably comparable in magnitude to those of the planets. A different form from that of preceding volumes has been adopted in the three last volumes, for avoiding excessively large coefficients with frequent changes of sign, and for similarity with the form adopted in the Reductions of the Planetary Observations made at Greenwich from 1750 to 1830, which are now in the press.

It is to be remarked that in the column of *Extent of Group*, the day is given which answers to the day under which the observations may be found in the sections of *Transits as Observed*, and *Observations with the Mural Circle:* but in the column of *Mean Day* the day is given whose noon is nearest to the time of observation, or to the mean of times of observation.

The errors of the tabular Longitude and Ecliptic Polar Distance of the Moon are deduced from the errors of Tabular Right Ascension and North Polar Distance, by use of the numbers P, Q, R, S.

§ 7. *Observations of γ Draconis with the Zenith Tube, and Reduction of the Observations,* page 38 to 53.

For a general description of the Zenith Tube, and an account of the steps which its construction renders necessary for the reduction of the observations, I beg to refer to the Introduction to the present volume, page vi. It will be sufficient to state here, that the upper part and the lower part of the plumb-line are viewed by micrometer-microscopes, the observation with which detects and measures any inclination of the telescope to the vertical; and that the star while passing the field of view of the telescope is bisected in reversed positions of the tube by means of two wires, V and V*, in the field of view carried by the Grand Micrometer. The values of the several micrometer-screws have been found by a process detailed in the Introduction of 1837, and are as follows: Grand Micrometer, one revolution $= 6''\cdot711$; upper plumb-line micrometer, one revolution $= 4''\cdot168$; lower plumb-line micrometer, one revolution $= 5''\cdot243$. The equivalents to the readings of the several micrometers are to be added together, and they will then give the star's apparent Zenith Distance (to be diminished by a certain constant or index-error, called $-c$ in the printed Observations, which depends upon nothing whatever but the instrumental connexion between the object-glass, the upper plumb-line microscope, the grand micrometer, and the lower plumb-line microscope). The Zenith Distance thus deduced is estimated positive towards the north when the eye-piece is west, or towards the south when the eye-piece is east.

The tube was formerly used in reversed positions for transits of γ Draconis made on different days, till near the end of the year 1841, when it was thought desirable, on account of the still unsatisfactory nature of the results, to remove the only remaining visible source of error, by rendering the instrument capable of rapid and easy reversion, for the purpose of enabling the observer to make a complete observation in reversed positions at the same transit. The method of doing this is described in the Introduction to the present volume, page vii.

The correction applicable to the reading of the grand micrometer for the bisection of the star with wire V* in order to reduce it to the reading for wire V, so that the observations in the two positions may be considered to have been made with the same wire, was found in the year 1841 to be $+ 0^{r}\cdot027$, or $+ 0''\cdot181$.

On December 1 of the present year, Mr. Richardson took off the wire plate of the Grand Micrometer, and endeavoured to remove some cobwebs which had become attached to the wires: in doing so, he broke one of the thick wires and some of the crosses, and the plate was, in consequence, sent to Mr. Simms to have a new wire and new crosses inserted. After it was reinstated, observations were made of the reading of the micrometer for each wire at its bisection of the same neighbouring cross, to determine afresh the correction which must be applied to the observations of the stars made with wire V*, and it was found by very accurate observations that the correction $-1''\cdot37$ must be applied to its readings to reduce them to what the readings would have been if the first observation had been made with wire V. This correction is applied in reducing the observation of December 6.

Let then z be the star's zenith-distance north at the time of observation; let also s_w and s_e be the respective sums, for the two observations, of the equivalents for the micrometer-readings with the eye-piece west and east.

Then $$z = s_w + c$$

And $$z = -s_e - c$$

Hence $$c = \frac{s_w + s_e}{2}$$

The values of c are given explicitly for each observation, that the general steadiness of the instrument may be at once perceived, though, according to the present mode of observation, nothing whatever depends upon the change of the values from day to day.

§ 8. *Observations of the Duration of Transit of the Moon's Diameter, with the Eastern Equatoreal*, page 56.

These observations were made for the purpose of ascertaining the error in the tabular semidiameter of the Moon adopted by Burckhardt. The times selected were as near as possible to the times of opposition in right ascension. As the Moon was then at a distance from the meridian, it is necessary to examine into the influence of the hour-angle upon the duration of transit, which may be done in the following manner:—

During each transit of a diameter, the Equatoreal is fixed relatively to the earth. Suppose, then, the Moon to stand still in space, while the earth and the equatoreal telescope which is firmly attached to it, move round. The axis of the telescope produced (or rather the plane of its meridional wire) will come in contact successively with one side and with the other side of the Moon. Produce these touching positions of the plane backwards till they intersect. Their intersection will be in a line parallel to the earth's axis: when the Moon is near the meridian, the intersection will be nearly as distant from the place of observation as the earth's axis is: when the Moon is near the six-hour angle their intersection will be near the place of observation: and generally their intersection will be at the place determined by drawing a perpendicular from the earth's axis upon the plane of the meridional wire. Consequently, the angle which the earth and telescope must describe that the plane may pass the Moon's diameter, will be found by dividing the Moon's diameter by the Moon's distance from the perpendicular dropped from the earth's axis upon the meridional plane passing through the Moon. Now, the Moon's distance here spoken of is the same as the Moon's distance from the earth's axis multiplied by the cosine of the parallax in right ascension. When the Moon is on the meridian the cosine of the parallax in right ascension is 1. Therefore the time in which the plane passes the Moon's diameter (that is, the duration of transit of the Moon's diameter) in any hour-angle, is to the duration of transit on the meridian, as unity to the cosine of the parallax in right ascension. As that parallax cannot exceed 40′, whose cosine is 0·9999323, the duration of transit cannot differ from that on the meridian by the time of transit × 0·0000677: a quantity wholly insensible. The Moon's motion in right ascension produces the same effect in all cases as if the velocity of the earth's rotation were altered in a certain proportion. The duration of transit is therefore sensibly the same at all hour-angles as if the Moon were on the meridian of the place.

The columns of the printed observations need little explanation. The correction for defect of illumination is found by estimating the Sun's perpendicular distance from the meridian passing through the Moon, produced to complete the circle: and considering the defect to be equal to the Moon's semidiameter multiplied by the versed sine of that distance. The tabular duration is interpolated for the hour-angle (found by comparing the sidereal time with the Moon's right ascension) between the tabular durations of the Nautical Almanac, which correspond to hour-angles of 0^h and 12^h successively. The correction for defective illumination was found to be insensible in each of the observations made in 1843. The deduced tabular error shews (in conformity with the results obtained in other ways) that Burckhardt's semidiameter is too small by 3″ nearly.

§ 9. *Observations of Mars and neighbouring Stars made with the East Equatoreal,* page 58 to 61.

These observations were made with the micrometer (*a*) attached to the East Equatoreal, by Mr. Hugh Breen, jun., who was at this time employed as a computer in the Reduction of the Ancient Planetary Observations.

The value of one revolution of the micrometer, viz., 31″·471, is the same that has been used in previous years. The mean N. P. D. of the star of comparison is taken from the Nautical Almanac.

The refractions and parallaxes used in reducing these and the other equatoreal observations in this volume (and in all the preceding volumes from 1836) are computed by the following formula:

For refraction. From Z, the zenith, draw a great circle ZQ, perpendicular to PS, the meridian passing through the pole P and the object S. Then, assuming vertical refraction $= 57'' \times$ tan. zen. dist., the refraction in N.P.D. $= 57'' \times \tan. (PS - PQ)$, and the refraction in R. A. $= \frac{57''}{15} \times \frac{\tan. ZQ}{\sin. PS \times \cos. (PS - PQ)}$. Tables are prepared, containing the values of PQ and tan. ZQ for different values of the hour-angle: and the computation for each instance is then very easy.

For parallax. From Z', the geocentric zenith, draw $Z'Q'$ perpendicular to PS: let r be the ratio of the geocentric radius for Greenwich to the equatoreal radius: then the whole parallax = hor. eq. parallax $\times\, r \times \sin. Z'S$, and it is in the direction of $Z'S$: the parallax in N.P.D. = hor. eq. par. $\times\, r \cos. Z'Q' \times \sin. (PS - PQ')$, and the parallax in R.A. = hor. eq. par. $\times \frac{r \sin. Z'Q'}{15} \times \frac{1}{\sin. PS}$. Tables are prepared, containing the values of PQ', $r \cos. Z'Q'$, and $\frac{r \sin. Z'Q'}{15}$, with which the calculation is easily made.

The tabular places of Mars were interpolated with second differences between the places for noon given in the Nautical Almanac.

§ 10. *Right Ascensions and North Polar Distances of Mauvais' First Comet and neighbouring Stars, observed with the South and the East Equatoreals*, page 64 to 79.

The methods of observation and reduction are in no respects different from those of all previous Equatoreal observations. The following remarks will include all the explanation which appears necessary.

In regard to Right Ascension, the clock (Earnshaw for the South Equatoreal, and Arnold 1 for the East Equatoreal) was generally compared with the Transit Clock at each set of observations, and also (on the usual system of comparison) every week; and no sensible doubt remains as to the amount of clock-error.

The hour-circle-readings with the South Equatoreal are not sufficiently accurate to give reliance on observations of the Comet that depend at all on them. If the observations be made carefully, and the verniers read with all possible accuracy, the error may vary from 2^s to 4^s. The observations of May 17 and 21, and of June 2, are therefore of little value, and the results should have been included in brackets, according to the usual custom. The relation between the hour-circle-reading and the hour-angle, in the position in which the instrument was used for these observations, is,

$$\text{Hour-circle-reading} + \text{Hour-angle East} = 6^{h}.$$

The hour-circle of the East Equatoreal admits of being read by its micrometer-microscopes with great accuracy. The errors of runs of the microscopes were very small, and no correction is applied. The graduated face of the declination-circle of this instrument was West during all the observations, and the relation between the hour-circle-reading and the hour-angle in this position is,

$$\text{Hour-circle-reading} + \text{Hour-angle East} = 12^{h}.$$

The corrections for refraction and parallax have been previously explained; and it is sufficient to mention, that the distance of the Comet from the Earth, used for the latter, was taken from an Ephemeris computed by Mr. Hind, and contained in No. 494 of the *Astronomische Nachrichten.*

The following are the assumed mean places of the stars with which the Comet was compared, which are in general taken from the Catalogue of Stars observed in the year 1843. The exceptions to this are, λ Virginis, which is taken from the Greenwich Catalogue of 1439 Stars; the star (a_2) which is taken from observations made in 1844, reduced with sufficient accuracy; Groombridge 3947, which is brought up from Groombridge's Catalogue; and Piazzi XXII. 297, which is brought up from Piazzi's Catalogue.

Star's Name, or Letter of Reference in the Observations.	Mean R.A. Jan. 1, 1843.	Mean N.P.D. Jan. 1, 1843.
	h m s	° ′ ″
λ Virginis	14. 10. 37·33	102. 38. 43·23
* (a_3)	22. 31. 51·20	61. 24. 23·76
ο Pegasi	22. 34. 23·51	61. 30. 36·49
* (a_2)	22. 36. 33·78	61. 32. 39·48
* (a_4)	22. 46. 42·37	62. 48. 57·58
* (a_5)	22. 47. 25·62	62. 49. 33·57
Groombridge 3947...	22. 53. 28·37	45. 27. 59·90
β Pegasi	22. 56. 10·18	62. 46. 2·96
Piazzi XXII. 297...	22. 57. 43·58	75. 53. 9·65
υ Pegasi	23. 17. 32·94	67. 27. 33·93
* (a_6)	23. 22. 11·12	69. 18. 52·17

The corrections to apparent R.A. and N.P.D. are computed by the formulæ equivalent to A a + B b + C c + D d and A a′ + B b′ + C c′ + D d′.

The apparent correction for index-error in R.A. is found by subtracting the corrected instrumental R.A. of the stars from the assumed R.A.

When the Comet and a star are observed in the same series, the adopted index-correction applied to the observed R.A. of the Comet is always that deduced from the star in the same series. In other cases the selection of stars for the adoption of the index-correction is explained in the notes. As a general rule, it is thought desirable to select stars observed before and after the Comet, as tending in some degree to eliminate the small errors in the computation of refraction for low objects.

The interpolated Right Ascensions and North Polar Distances of the Comet are computed from Mr. Hind's Ephemeris, published in No. 494 of the *Astronomische Nachrichten*, before mentioned.

The observed places of the Comet had been compared with the tabular places, and this part of the volume had passed through the press before it was observed that Mr. Hind had reckoned his Right Ascensions and North Polar Distances from the mean equinox and the mean equator of Jan. 1, 1843, whereas the apparent places of the stars on which the observed places of the Comet depend have been reduced, as usual, to the true equinox and the true equator of the day of observation. It will be necessary, therefore, to add to the Interpolated Right Ascensions and North Polar Distances, and to the Tabular Errors, the quantities contained in the following table, for each day of observation :—

Day of Observation.	Correction to Tabular R. A.	Correction to Tabular N. P. D.	Day of Observation.	Correction to Tabular R. A.	Correction to Tabular N. P. D.
1843.	s	″	1843.	s	″
May 17	+ 1·92	− 12·3	June 2	+ 2·13	− 14·2
21	+ 1·96	− 12·8	3	+ 2·14	− 14·4
22	+ 1·97	− 13·0	9	+ 2·22	− 14·8
25	+ 2·00	− 13·3	16	+ 2·34	− 15·4
27	+ 2·02	− 13·4	22	+ 2·42	− 16·1
			26	+ 2·47	− 16·4
June 1	+ 2·11	− 14·0	28	+ 2·50	− 16·6

The correction for runs for $5'$ of the declination-circle of the East Equatoreal for the mean of the readings of the microscopes A and B is $-2''\cdot 0$, which quantity is used throughout. This determination was obtained by observation upon the divisions, from $60°.\,5'$ to $65°.\,50'$.

From observations on May 22 it appeared that $1^{\text{div.}}$ of the sector arc of the South Equatoreal was equivalent to $17^{\text{r.}}\cdot 546$. Now, from former determinations, $1^{\text{div.}}$ was found to be equal to $5'.\,33''\cdot 72$. Hence, $1^{\text{rev.}} = 19''\cdot 020$. This value is used throughout.

The rules for adopting the index-corrections in N.P.D. are precisely similar to those used for the observed R.A. of the Comet previously mentioned.

The mean solar times for the observations of N. P. D. are the same as those for the observations of R. A.

§ 11. *Right Ascensions and North Polar Distances of Faye's Comet and neighbouring Stars, observed with the South and the East Equatoreals,* 1843 *and* 1844, page 82 to 101.

The method of observation and of computation is essentially the same as for Mauvais' First Comet, which has been described. The following additional explanation will be necessary.

The distances of the Comet from the Earth used in computing its parallax were taken from an approximate Ephemeris by Professor Henderson, which is to be found in Vol. vi. No. 5 of the *Monthly Notices* of the Royal Astronomical Society of London.

The following are the assumed mean places of the stars with which the Comet was compared, together with the authorities; the column "authority" being thus explained:

By "Greenwich Observations, 1844" is meant, that the mean place of the star is deduced from one observation with the Transit instrument and one with the Mural Circle reduced with sufficient accuracy.

By "Santini" is meant, that reference is made to Santini's Catalogue of 1677 Stars, contained in the 12th volume of the Memoirs of the Royal Astronomical Society of London.

Star's Name, or Letter of Reference in the Observations.	Mean R. A. Jan. 1, 1844.	Mean N. P. D. Jan. 1, 1844.	Authority.
	h m s	° ′ ″	
* (b_2)	5. 10. 27·29	86. 11. 29·00	Gr. Obs. 1844.
* (b_3)	5. 12. 48·57	85. 42. 2·28	,,
* (b_1)	5. 13. 5·83	86. 8. 57·11	,,
Santini 342.........	5. 13. 53·76	86. 35. 17·10	Santini.
m Orionis	5. 14. 38·19	86. 36. 41. 75	,,
γ Orionis...........	5. 16. 45·90	83. 47. 49·38	,,
A Orionis	5. 22. 26·25	84. 10. 36·04	Gr. Obs. 1844.
* (b_6)	5. 36.	82. 18. 5·65	,,
* (b_4)	5. 38. 36·39	82. 28. 49·38	,,
Santini 385.........	5. 39. 27·02	82. 6. 4·00	Santini.
* (b_7)	5. 40. 4·79	82. 10. 35·51	Gr. Obs. 1844.

The star (b_6) was not observed with the Transit instrument in the year 1844, and the Right Ascension deduced from the time of its passage across the central wire of the Mural Circle on March 2, 1844, viz.:—$5^h. 36^m. 58^s$, has been assumed.

The N. P. D. of the star (b_3) was derived from an observation with the Mural Circle on January 16, 1844; but, on reducing the Observations of 1844, this was found to disagree with an observation of the same star on February 22. In the Greenwich results for 1844, the observation on February 22 is assumed to be correct, and the probability is very great that the N. P. D. of this star assumed in the reduction of the Comet Observations ought to be diminished by 1′. It would then be necessary to add 1′ to the observed N. P. D. and the errors of interpolated N. P. D. of that day.

The interpolated R. A. and N. P. D. of the Comet are computed by second differences from the following Ephemeris, computed by Mr. Hind from elliptical elements deduced by himself (*Astr. Nach.*, No. 508), which are as follows:—

	° ′ ″	
Epoch of Mean Anomaly, 1844, Jan. 1. 0, Greenwich Mean Time	10. 4. 29·2	
Longitude of the Perihelion	49. 24. 15·8	From the Mean Equinox of 1844, Jan. 1.
,, Ascending Node	209. 31. 59·2	From the Mean Equinox of 1844, Jan. 1.
Inclination	11. 22. 39·8	
Angle of Eccentricity	33. 48. 52·07	
Log. of Semi-axis major	0·5811912	
Mean Daily Sidereal Motion	476″·672198	
Period of Sidereal Revolution	2719 days.	

Ephemeris of Faye's Comet from Mr. Hind's Second Elliptical Elements, published in the Astronomische Nachrichten, Nos. 522 and 523.

For Noon, Mean Solar Time at Greenwich.

Month and Day.	Comet's True Right Ascension.	Comet's True North Declination.	Log. of Distance from the Earth, Δ.	Time for Aberration = 497ˢ·8 × Δ.
1843.	° ′ ″	° ′ ″		m s
November 22	81. 2. 34·2	7. 4. 49·7	9·89571	— 6. 31. 53
24	80. 54. 8·1	6. 39. 17·6	9·89552	— 6. 31·36
26	80. 44. 13·6	6. 14. 50·2	9·89577	— 6. 31·58
28	80. 33. 2·2	5. 51. 33·3	9·89645	— 6. 32·19
30	80. 20. 45·8	5. 29. 32·2	9·89755	— 6. 33·19
December 2	80. 7. 35·8	5. 8. 51·9	9·89909	— 6. 34·59
4	79. 53. 44·0	4. 49. 36·6	9·90106	— 6. 36·38
6	79. 39. 21·9	4. 31. 49·8	9·90345	— 6. 38·57
8	79. 24. 41·2	4. 15. 34·4	9·90627	— 6. 41·16
10	79. 9. 52·4	4. 0. 52·7	9·90950	— 6. 44·16
12	78. 55. 7·0	3. 47. 46·7	9·91314	— 6. 47·56
14	78. 40. 36·5	3. 36. 17·5	9·91717	— 6. 51·36
16	78. 26. 31·7	3. 26. 25·8	9·92158	— 6. 55·56
18	78. 13. 3·2	3. 18. 11·1	9·92638	— 7. 0·16
20	78. 0. 21·5	3. 11. 32·6	9·93150	— 7. 5·16
22	77. 48. 36·7	3. 6. 28·9	9·93698	— 7. 10·56
24	77. 37. 57·9	3. 2. 57·8	9·94278	— 7. 16·35
26	77. 28. 33·0	3. 0. 56·3	9·94888	— 7. 22·52
28	77. 20. 28·9	3. 0. 21·1	9·95526	— 7. 29·07
30	77. 13. 51·7	3. 1. 8·5	9·96190	— 7. 35·98
1844.				
January 1	77. 8. 45·9	3. 3. 14·3	9·96878	— 7. 43·27
3	77. 5. 15·3	3. 6. 34·1	9·97589	— 7. 50·92

Ephemeris of Faye's Comet from Mr. Hind's Second Elliptical Elements—*concluded.*

Month and Day.		Comet's True Right Ascension.	Comet's True North Declination.	Log. of Distance from the Earth, Δ.	Time for Aberration $= 497^{s}\cdot 8 \times \Delta$.
1844.		° ′ ″	° ′ ″		m s
January	5	77. 3. 22·6	3. 11. 3·7	9·98320	− 7. 58·91
	7	77. 3. 10·0	3. 16. 38·7	9·99069	− 8. 7·24
	9	77. 4. 39·3	3. 23. 14·5	9·99834	− 8. 15·90
	11	77. 7. 51·5	3. 30. 46·8	0·00615	− 8. 24·89
	13	77. 12. 47·0	3. 39. 11·3	0·01410	− 8. 34·22
	15	77. 19. 26·9	3. 48. 23·7	0·02217	− 8. 43·86
	17	77. 27. 51·2	3. 58. 19·7	0·03034	− 8. 53·81
	19	77. 38. 0·1	4. 8. 54·9	0·03860	− 9. 4·07
	21	77. 49. 52·9	4. 20. 5·0	0·04694	− 9. 14·62
	23	78. 3. 28·0	4. 31. 45·9	0·05535	− 9. 25·45
	25	78. 18. 43·8	4. 43. 53·6	0·06380	− 9. 36·57
	27	78. 35. 38·6	4. 56. 24·0	0·07229	− 9. 47·95
	29	78. 54. 9·9	5. 9. 13·4	0·08081	− 9. 59·59
	31	79. 14. 14·5	5. 22. 18·3	0·08934	−10. 11·48
February	2	79. 35. 49·5	5. 35. 35·4	0·09788	−10. 23·63
	4	79. 58. 52·0	5. 49. 1·7	0·10642	−10. 36·02
	6	80. 23. 18·8	6. 2. 34·5	0·11495	−10. 48·64
	8	80. 49. 7·2	6. 16. 11·1	0·12346	−11. 1·47
	10	81. 16. 14·6	6. 29. 49·1	0·13195	−11. 14·53
	12	81. 44. 38·2	6. 43. 26·2	0·14042	−11. 27·81
	14	82. 14. 15·8	6. 57. 0·2	0·14886	−11. 41·31
	16	82. 45. 5·3	7. 10. 29·0	0·15726	−11. 55·01
	18	83. 17. 3·9	7. 23. 50·6	0·16561	−12. 8·90
	20	83. 50. 8·9	7. 37. 3·1	0·17392	−12. 22·97
	22	84. 24. 18·0	7. 50. 4·6	0·18218	−12. 37·23
	24	84. 59. 28·2	8. 2. 53·4	0·19038	−12. 51·67
	26	85. 35. 36·4	8. 15. 28·1	0·19852	−13. 6·27
	28	86. 12. 40·1	8. 27. 47·3	0·20660	−13. 21·03

The Right Ascensions and Declinations are referred to the Mean Equinox and the Mean Equator of 1844, January 1.

Corrections similar to those already explained as necessary to be applied to the Tabular places of Mauvais' First Comet, will also be necessary for Faye's Comet, as a similar error was committed in reducing the observed places to the True Equinox for each day, and to the true Equator. The following table contains the corrections to be applied to the Interpolated Right Ascensions and North Polar Distances and to the Tabular Errors:—

Day of Observation.		Correction to Tabular R. A.	Correction to Tabular N. P. D.	Day of Observation.		Correction to Tabular R. A.	Correction to Tabular N. P. D.
1843.		s	″	1844.		s	″
Nov.	29	+ 0·75	+ 0·4	Jan.	26	+ 1·39	− 0·1
Dec.	11	+ 0·88	+ 0·4	Feb.	8	+ 1·51	− 0·4
	15	+ 0·91	+ 0·3		19	+ 1·60	+ 0·4
1844.					20	+ 1·62	+ 0·3
Jan.	15	+ 1·26	− 0·1		22	+ 1·63	+ 0·4
	22	+ 1·33	− 0·2				

The correction for runs for $5'$ of the declination-circle of the East Equatoreal for the mean of the two microscopes is, for the observations of November 29, $+ 0''\cdot 9$, and, for those of December 11, $- 2''\cdot 8$. These results were deduced by observations on the divisions from $95°. 30'$ to $95°. 55'$, and from $86°. 0'$ to $86°. 5'$.

From observations on 1843, December 16, and 1844, January 23, it appeared that one division of the sector arc of the South Equatoreal was equivalent to $17^{r}\cdot 953$, and, one division being also equal to $5'. 33''\cdot 72$, it follows that $1^{rev.} = 18''\cdot 60$ very nearly, which value is used throughout.

In Series 36, 44, 45, and 54 the Right Ascension of the Comet was not observed; and the clock times of observation, used in computing the Mean Solar Times were,

$8^{h}. 4^{m}. 26^{s}$, $4^{h}. 4^{m}. 28^{s}$, $4^{h}. 9^{m}. 30^{s}$, and $4^{h}. 45^{m}. 40^{s}$.

§ 12. *Observations on the Appearance and Position of the Great Comet of* 1843, page 104 to 106.

The remarks require no explanation. The attention of the observers attached to the Magnetic Department was first drawn to the Comet with the impression of its being a meteorological phenomenon, and about the same time letters on the subject were received from Sir John Herschel, and from other persons. From that time a rigorous search was made for the nucleus at every favourable opportunity, but without success.

§ 13. *Eclipses, Occultations, and Transits of Jupiter's Satellites; and Occultations of Stars by the Moon; with the Equations deduced from the Occultations,* page 108 to 116.

The tabular statement of observations appears to require no remark, except that the clocks were always compared (by setting an adjustible chronometer or click in accordance with the Transit Clock, and carrying it for comparison with the clock in question), as near as possible to the time of observation, and that a regular weekly comparison of all the clocks is used to check the incidental comparisons.

For the computation, the star's place is taken from the "Elements for facilitating the Computations of Occultations" in the Nautical Almanac. The Moon's geocentric place, semidiameter, and hor. eq. parallax, are interpolated with second differences from the Nautical Almanac for the observed instant of the occultation. The correction to be applied to the parallax of the Moon's center to obtain that for the point of the limb at which the occultation takes place is investigated in the following manner.

Let P = Moon's horizontal parallax; S = semidiameter in arc; V = angle from the vertical at which the occultation takes place, as seen in an inverting telescope; and Z the apparent Zenith Distance of that point. (V is taken from the Nautical Almanac, and Z is found by means of a celestial globe.) Let also r = the earth's radius for Greenwich. This radius produced will form an angle with the astronomical vertical equal to 11′. 12″. Draw a plane through it and through the point of the Moon at which the occultation takes place. The radius of the section of the Moon thus formed will be (in terms of the earth's radius) $\frac{r}{\sin. P}$ sin. S cos. V; $\frac{r}{\sin. P}$ being the distance between the earth and Moon's center. Now let two lines, one from the earth's center and the other from the place of observation, touching this section of the Moon, intersect each other and form an angle p. Then the whole length of the tangent from the earth's center will be seen to be,

$$\frac{r \sin. Z}{\sin p.} + \text{rad. of Moon's section} \times \tan. \frac{p}{2}$$

$$= \frac{r \sin. Z}{\sin. p} + \frac{r \sin. S}{\sin. P} \cos. V \tan. \frac{p}{2}$$

which is also plainly equal to

cos. Moon's radius in arc × dist. between centers of Earth and Moon

$$= \frac{r}{\sin. P} \cos. S = \frac{r}{\sin. P} \sqrt{1 - \sin.^2 S}.$$

Equating these two expressions and multiplying each term by sin. P sin. p, we have—

$$\sin. P \sin. Z + \sin. S \cos. V \sin. p \tan. \frac{p}{2} = \sin. p \sqrt{1 - \sin.^2 S}$$

in which the second term is of an order inferior to the others, and, in a first approximation, may be neglected, as well as the difference between the factor $\sqrt{1 - \sin.^2 S}$ and unity.

An approximate solution is therefore

$$\sin. p = \sin. P \sin. Z$$

$$\text{whence } \tan. \frac{\;}{2} = \frac{1}{2} \sin. P \sin. Z \text{ approximately.}$$

Substituting these expressions in the equation, and, for $\sqrt{1 - \sin.^2 S}$, writing $1 - \frac{1}{2} \sin.^2 S$, we get

$$\sin. P \sin. Z + \frac{1}{2} \cos. V \sin. S \sin.^2 P \sin.^2 Z = \sin. p \left(1 - \frac{1}{2} \sin.^2 S\right)$$

$$\text{whence } \sin. p = \sin. P \sin Z + \frac{1}{2} \sin.^2 S \sin. P \sin. Z + \frac{1}{2} \sin. S \sin.^2 P \cos. V \sin.^2 Z$$

which is erroneous only in the fourth dimensions of the parallax and semidiameter.

The correction to the Moon's horizontal parallax P or sin. P, will be, therefore,

$$\frac{1}{2}\,\text{sin.}^2\, S\ \text{sin.}\ P + \frac{1}{2}\,\text{sin.}\ S\ \text{sin.}^2\, P\ \text{cos.}\ V\ \text{sin.}\ Z$$

of which the following table is found, using the mean values of P and S, viz., 57′. 3″ and 15′. 33″.

Correction to the Moon's Horizontal Parallax, to be used when the Parallax is applied to the Limb.

Angle from the Vertical as seen in an inverting Telescope.		Zenith Distance.									
		0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
°	°	″	″	″	″	″	″	″	″	″	″
0	360	+0·04	+0·06	+0·08	+0·10	+0·12	+0·13	+0·15	+0·16	+0·16	+0·16
10	350	+0·04	+0·06	+0·08	+0·10	+0·12	+0·13	+0·15	+0·15	+0·16	+0·16
20	340	+0·04	+0·06	+0·08	+0·10	+0·11	+0·13	+0·14	+0·15	+0·15	+0·16
30	330	+0·04	+0·05	+0·07	+0·09	+0·11	+0·12	+0·13	+0·14	+0·15	+0·15
40	320	+0·04	+0·05	+0·07	+0·08	+0·10	+0·11	+0·12	+0·13	+0·13	+0·13
50	310	+0·04	+0·05	+0·06	+0·08	+0·09	+0·10	+0·11	+0·11	+0·12	+0·12
60	300	+0·04	+0·05	+0·06	+0·07	+0·08	+0·08	+0·09	+0·10	+0·10	+0·10
70	290	+0·04	+0·04	+0·05	+0·06	+0·06	+0·07	+0·07	+0·08	+0·08	+0·08
80	280	+0·04	+0·04	+0·04	+0·05	+0·05	+0·05	+0·05	+0·06	+0·06	+0·06
90	270	+0·04	+0·04	+0·04	+0·04	+0·04	+0·04	+0·04	+0·04	+0·04	+0·04
100	260	+0·04	+0·03	+0·03	+0·02	+0·02	+0·02	+0·02	+0·01	+0·01	+0·01
110	250	+0·04	+0·03	+0·02	+0·01	+0·01	0·00	0·00	−0·01	−0·01	−0·01
120	240	+0·04	+0·02	+0·01	0·00	−0·01	−0·01	−0·02	−0·03	−0·03	−0·03
130	230	+0·04	+0·02	+0·01	−0·01	−0·02	−0·03	−0·04	−0·04	−0·05	−0·05
140	220	+0·04	+0·02	0·00	−0·01	−0·03	−0·04	−0·05	−0·06	−0·06	−0·06
150	210	+0·04	+0·02	0·00	−0·02	−0·04	−0·05	−0·06	−0·07	−0·08	−0·08
160	200	+0·04	+0·01	−0·01	−0·03	−0·04	−0·06	−0·07	−0·08	−0·08	−0·09
170	190	+0·04	+0·01	−0·01	−0·03	−0·05	−0·06	−0·08	−0·08	−0·09	−0·09
180	180	+0·04	+0·01	−0·01	−0·03	−0·05	−0·06	−0·08	−0·09	−0·09	−0·09

Let now δ and θ be the N.P.D. and hour angle of the star; δ' and θ' those of the corresponding point of the limb as seen from the earth's center; and l the geocentric latitude of the place; and imagine the spherical triangles in which P is the pole of the heavens, Z the zenith, and S and S' the geocentric and apparent positions of the point of the Moon's limb in the same vertical circle.

$$\begin{aligned}\text{Then sin. } S\,S' = \text{sin. } p &= \text{sin. corrected hor. par.} \times \text{sin. } Z\\ &= \text{sin. } P' \times \text{sin. } Z \text{ suppose;}\end{aligned}$$

$$\begin{aligned}\text{and sin. } S\,P\,S' = \text{sin. } (\theta - \theta') &= \text{sin. } p.\,\frac{\text{sin. } Z\,S'\,P}{\text{sin. } S\,P}\\ &= \frac{\text{sin. } P' \times \text{sin. } Z \times \text{sin. } Z\,S'\,P}{\text{sin. } S\,P}\\ &= \frac{\text{sin. } Z\,P \times \text{sin. } Z\,P\,S'}{\text{sin. } S\,P}\,\text{sin. } P'\\ &= \frac{\text{cos. } l\ \text{sin. } \theta}{\text{sin. } \delta'}\,\text{sin. } P'\end{aligned}$$

and, to adapt this for computation,

$$\text{seconds of } \frac{\theta - \theta'}{2} = \frac{\theta - \theta'}{\sin.\,(\theta - \theta')} \cdot \frac{\cos.\, l \sin.\, \theta}{2 \sin.\, \delta'} \cdot \frac{\sin.\, P'}{P'} \times \text{seconds of } P'.$$

$$\text{Again; } \quad \cos.\, S'\,Z\,P = \frac{\cos.\,\delta - \cos.\, Z\,S' \sin.\, l}{\sin.\, Z\,S' \cos.\, l} = \text{(also) } \frac{\cos.\,\delta' - \cos.\, Z\,S \sin.\, l}{\sin.\, Z\,S \cos.\, l}$$

$$\text{or, } \frac{\cos.\,\delta - (\cos.\,\theta \cos.\, l \sin.\,\delta + \sin.\, l \cos.\,\delta) \sin.\, l}{\frac{\sin.\,\theta \sin.\,\delta}{\sin.\, S'ZP}} = \frac{\cos.\,\delta' - (\cos.\,\theta' \cos.\, l \sin.\,\delta' + \sin.\, l \cos.\,\delta') \sin\, l}{\frac{\sin.\,\theta' \sin.\,\delta'}{\sin.\, S'\,Z\,P}}$$

whence, by reduction,

$$\frac{\cos.\,\delta \cos.\, l - \cos.\,\theta \sin.\,\delta \sin.\, l}{\sin.\,\theta \sin.\,\delta} = \frac{\cos.\,\delta' \cos.\, l - \cos.\,\theta' \sin\,\delta' \sin\, l}{\sin.\,\theta' \sin.\,\delta'}$$

$$\text{or, } \cot.\,\delta \frac{\cos.\, l}{\sin.\,\theta} - \cot.\,\theta \sin.\, l = \cot.\,\delta' \frac{\cos.\, l}{\sin.\,\theta'} - \cot.\,\theta' \sin.\, l$$

Then, substituting for cos. l its value $\frac{\sin.\,\delta'}{\sin.\,\theta} \cdot \frac{\sin.\,(\theta - \theta')}{\sin.\, P'}$

(previously deduced) and reducing, we get—

$$\sin.\,\delta' \left\{ \frac{\cot.\,\delta'}{\sin.\,\theta'} - \frac{\cot.\,\delta}{\sin.\,\theta} \right\} = \frac{\sin.\, l}{\sin.\,\theta'} \sin.\, P'$$

$$\text{or, } \sin.\,\delta \cos.\,\delta' \sin.\,\theta - \cos.\,\delta \sin.\,\delta' \sin.\,\theta' = \sin.\, l \sin.\,\delta \sin.\,\theta \sin.\, P'$$

which may be put under the form

$$\frac{1}{2}\left\{\sin.\,(\delta - \delta')\,(\sin.\,\theta + \sin.\,\theta') + \sin.\,(\delta + \delta')\,(\sin.\,\theta - \sin.\,\theta')\right\} = \sin.\, l \sin.\,\delta \sin.\,\theta \sin.\, P'$$

$$\text{whence, } \sin.\,(\delta - \delta') = \frac{2 \sin.\, l \sin.\,\delta \sin.\,\theta \sin.\, P'}{\sin.\,\theta + \sin.\,\theta'} - \frac{\sin.\,(\delta + \delta')\,(\sin.\,\theta - \sin.\,\theta')}{\sin.\,\theta + \sin.\,\theta'}$$

$$= \frac{\sin.\, l \sin.\,\delta \sin.\,\theta}{\sin.\,\frac{1}{2}\,(\theta + \theta') \cos.\,\frac{1}{2}\,(\theta - \theta')} \sin.\, P' - \cot.\,\tfrac{1}{2}\,(\theta + \theta') \tan.\,\tfrac{1}{2}\,(\theta - \theta') \sin.\,(\delta + \delta')$$

or, in a form adapted for computation,

$$\text{seconds of } \delta - \delta' = \frac{(\delta - \delta')}{\sin.\,(\delta - \delta')} \cdot \frac{\sin.\, l \sin.\,\delta \sin.\,\theta}{\sin.\,\frac{1}{2}\,(\theta + \theta') \cos.\,\frac{1}{2}\,(\theta - \theta')} \cdot \frac{\sin.\, P'}{P'} \times \text{seconds in } P'$$

$$- \frac{\delta - \delta'}{\sin.\,(\delta - \delta')} \cot.\,\tfrac{1}{2}\,(\theta + \theta') \sin.\,(\delta + \delta') \frac{\tan.\,\frac{1}{2}\,(\theta - \theta')}{\frac{1}{2}\,(\theta - \theta')} \times \text{seconds in } \tfrac{1}{2}\,(\theta - \theta')$$

The following quantities are then formed :—

F = log. sin. star's hour-angle + log. seconds of corrected eq. hor. parallax + 9·4942187.

G = log. sin. star's N.P.D. + log. sin. star's hour-angle + log. seconds of corrected eq. hor. parallax + 9·8913921.

(The former constant is the logarithm of half the distance of Greenwich from the earth's axis, and the latter is the logarithm of the distance of Greenwich from the plane of the equator; supposing the earth's ellipticity $= \frac{1}{300}$.)

The preceding formulæ are then adapted to logarithmic computation, and the equations are solved by successive trials, assuming a value for δ', in the following manner:

$$\log. \tfrac{1}{2}(\theta - \theta') \text{ in seconds} = F - \log. \sin. \delta' + \log. \frac{\text{sine}}{\text{arc}} \text{ for hor. parallax}$$
$$+ \log. \frac{\text{arc}}{\text{sine}} \text{ for } (\theta - \theta')$$

$$\log 1^{\text{st}} \text{ n}^\circ = G + \log. \text{secant } \tfrac{1}{2}(\theta - \theta') + \log. \frac{\text{sine}}{\text{arc}} \text{ for hor. parallax}$$
$$+ \log. \frac{\text{arc}}{\text{sine}} \text{ for } (\delta - \delta') - \log. \text{sine } \tfrac{1}{2}(\theta + \theta')$$

$$\log. 2^{\text{nd}} \text{ n}^\circ = \log. \tfrac{1}{2}(\theta - \theta') \text{ in seconds} + \log. \frac{\text{tan.}}{\text{arc}} \text{ for } \tfrac{1}{2}(\theta - \theta')$$
$$+ \log. \sin. (\delta + \delta' - 180^\circ) + \log. \cot. \tfrac{1}{2}(\theta + \theta') + \log. \frac{\text{arc}}{\text{sine}} \text{ for } (\delta - \delta')$$

$$\delta - \delta' = 1^{\text{st}} \text{ n}^\circ + 2^{\text{nd}} \text{ n}^\circ.$$

In the first trials the log. $\frac{\text{arc}}{\text{sine}}$, &c. are omitted. The convergence of these approximations is extremely rapid. When δ' and θ' are found accurately, the distance of the corresponding point from the Moon's center is thus found, by means of a subsidiary angle ψ.

If log. tan. ψ = log. diff. R. A. of Moon's center and corresponding point + $\frac{1}{2}$ log. sin. N. P. D. of Moon's center + $\frac{1}{2}$ log. sin. δ' — log. diff. N. P. D. of Moon's center and corresponding point.

log. dist. = log. diff. N. P. D. — log. cos. ψ.

or = log. diff. R. A. + $\frac{1}{2}$ log. sin. N. P. D. of center + $\frac{1}{2}$ log. sin. δ'—log. sin. ψ.

The co-efficients of small variations of the North Polar Distances and of the Difference of Right Ascension (in the expression for distance), are computed by the formulæ,

log. 1^{st} n° = 2 log. diff. R.A. + log. sine (sum of N.P.D.)—log. dist. + 4·0835.
log. 2^{nd} n° = log. diff. N. P. D. —log. distance.

Co-efficient of variation of greater N.P.D. = 1^{st} n° + 2^{nd} n°.
Co-efficient of variation of smaller N.P.D. = 1^{st} n° − 2^{nd} n°.
Log. co-efficient of variation of diff. R.A. =

log. diff. R.A. + log. sin. δ' + log. sin. Moon's N.P.D. — log. distance.

The variation of the R.A. of the corresponding point contains the following terms:

1st. The alteration of the R.A. of the star by the quantity e'' will alter the R.A. of the corresponding point by very nearly the same quantity e''.

2nd. The alteration of the horizontal equatoreal parallax in the proportion of $1 : 1 + \frac{m}{1000}$ will alter all the deduced parallaxes (in R.A. and in N.P.D.) in nearly the same proportion: and therefore the R.A. of the corresponding point will be altered by $\frac{m}{1000}$ × correction for parallax in R.A.

3rd. The alteration in the position of the Moon with regard to the meridian, depending on the alteration of time t^s, will introduce an alteration in the correction for parallax. It is computed by the following formula; in which P is the horizontal parallax, and l is the geocentric latitude of Greenwich.

Alteration, in correction of R.A. of corresponding point for parallax, depending on the alteration of time =

$$15'' \times t \times \left\{ \begin{array}{l} \text{sin. } P \text{ cos. } l \text{ cosec. N.P.D. cos. hour-angle} \\ + \text{sin.}^2 P \text{ cos.}^2 l \text{ cosec.}^2 \text{ N.P.D. cos. 2 hour-angle.} \end{array} \right\}$$

This supposes that the star's place is correct. If the Moon's place were supposed correct, the factor instead of $15'' \times t$ would be $(15'' -$ Moon's change of R.A.$) \times t$.

The variation of the R.A. of the Moon's center is $x'' + t \times$ change of R.A. in 1^s.

The variation of the N.P.D. of the corresponding point contains three terms analogous to those for the R.A.: namely—

1st. The alteration of the star's N.P.D. by the quantity f'' will alter the N.P.D. of the corresponding point by f'' nearly.

2nd. The correction for parallax in N.P.D. will be altered by $\frac{m}{1000} \times$ correction for parallax in N.P.D.

3rd. The increase of hour-angle (considered positive when the Moon is west of the meridian), depending on the alteration of time t^s, will alter the correction for parallax in N.P.D. by the following quantity:

$$15'' \times t \times \left\{ \begin{array}{l} (-\text{ sin. } P \text{ cos. } l \text{ cos. N.P.D.} - \text{sin.}^2 P \text{ sin. } l \text{ cos. } l \text{ cos. 2 N.P.D.) sin. hour-angle.} \\ (-\tfrac{3}{2} \text{ sin.}^2 P \text{ cos.}^2 l \text{ cot. N.P.D.} + \text{sin.}^2 P \text{ cos.}^2 l \text{ cot. N.P.D. cos.}^2 \text{ N.P.D.) sin. 2 hour-angle.} \end{array} \right.$$

The variation of the N.P.D. of the Moon's center is $y'' + t \times$ change of N.P.D. in 1^s.

The computed distance, altered by the sum of the products of the preceding variations by their proper co-efficients, is made equal to the semidiameter altered by the term semidiameter $\times \frac{n}{1000}$: and thus the final equation is formed.

The following table contains the values of log. $\left(\frac{\text{arc}}{\text{sin.}}\right)$, log. $\left(\frac{\text{sin.}}{\text{arc}}\right)$, and log. $\left(\frac{\text{tan.}}{\text{arc}}\right)$ to the extent to which they are needed for these computations:—

′	Log. $\left(\frac{\text{Arc.}}{\text{Sin.}}\right)$	Log. $\left(\frac{\text{Sin.}}{\text{Arc.}}\right)$	′	Log. $\left(\frac{\text{Arc.}}{\text{Sin.}}\right)$	Log. $\left(\frac{\text{Sin.}}{\text{Arc.}}\right)$
1	0 ·0000000	0 ·0000000	31	0 ·0000058	9 ·9999942
2	0 ·0000000	0 ·0000000	32	0 ·0000062	9 ·9999938
3	0 ·0000000	0 ·0000000	33	0 ·0000066	9 ·9999934
4	0 ·0000000	9 ·9999999	34	0 ·0000070	9 ·9999930
5	0 ·0000001	9 ·9999999	35	0 ·0000074	9 ·9999926
6	0 ·0000002	9 ·9999998	36	0 ·0000078	9 ·9999922
7	0 ·0000003	9 ·9999997	37	0 ·0000083	9 ·9999917
8	0 ·0000004	9 ·9999996	38	0 ·0000088	9 ·9999912
9	0 ·0000005	9 ·9999995	39	0 ·0000093	9 ·9999907
10	0 ·0000006	9 ·9999994	40	0 ·0000098	9 ·9999902
11	0 ·0000007	9 ·9999993	41	0 ·0000103	9 ·9999897
12	0 ·0000008	9 ·9999992	42	0 ·0000108	9 ·9999892
13	0 ·0000010	9 ·9999990	43	0 ·0000113	9 ·9999887
14	0 ·0000012	9 ·9999988	44	0 ·0000118	9 ·9999882
15	0 ·0000014	9 ·9999986	45	0 ·0000124	9 ·9999876
16	0 ·0000016	9 ·9999984	46	0 ·0000129	9 ·9999871
17	0 ·0000018	9 ·9999982	47	0 ·0000135	9 ·9999865
18	0 ·0000020	9 ·9999980	48	0 ·0000141	9 ·9999859
19	0 ·0000022	9 ·9999978	49	0 ·0000147	9 ·9999853
20	0 ·0000024	9 ·9999976	50	0 ·0000153	9 ·9999847
21	0 ·0000026	9 ·9999974	51	0 ·0000159	9 ·9999841
22	0 ·0000029	9 ·9999971	52	0 ·0000165	9 ·9999835
23	0 ·0000032	9 ·9999968	53	0 ·0000171	9 ·9999829
24	0 ·0000035	9 ·9999965	54	0 ·0000178	9 ·9999822
25	0 ·0000038	9 ·9999962	55	0 ·0000185	9 ·9999815
26	0 ·0000041	9 ·9999959	56	0 ·0000192	9 ·9999808
27	0 ·0000044	9 ·9999956	57	0 ·0000199	9 ·9999801
28	0 ·0000047	9 ·9999953	58	0 ·0000206	9 ·9999794
29	0 ·0000051	9 ·9999949	59	0 ·0000213	9 ·9999787
30	0 ·0000055	9 ·9999945	60	0 ·0000221	9 ·9999779

′	Log. $\left(\frac{\text{Tan.}}{\text{Arc.}}\right)$	′	Log. $\left(\frac{\text{Tan.}}{\text{Arc.}}\right)$
2	0 ·0000000	14	0 ·0000024
3	0 ·0000001	15	0 ·0000027
4	0 ·0000002	16	0 ·0000031
5	0 ·0000003	17	0 ·0000035
6	0 ·0000004	18	0 ·0000039
7	0 ·0000006	19	0 ·0000044
8	0 ·0000008	20	0 ·0000049
9	0 ·0000010	21	0 ·0000054
10	0 ·0000012	22	0 ·0000059
11	0 ·0000015	23	0 ·0000065
12	0 ·0000018	24	0 ·0000071
13	0 ·0000021	25	0 ·0000077

§ 14. *Observations of the Distances and Positions of Double Stars and of the Diameters of Planets, with a double-image eye-piece attached to the South Equatoreal,* page 118 to 120.

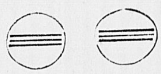
The eye-piece with which these observations are made is a four-glass erecting eye-piece, in which the lenses are so arranged that the axis of the pencil of rays, from each point of an observed object, passes through the center of the lens which is second (as measured from the object-glass), or third (as measured from the eye). This lens is divided by a plane passing through the axis of the telescope. One half of the lens is fixed, the other is moved by means of a micrometer-screw with graduated head. The whole eye-piece is made to revolve round an axis coinciding sensibly with the axis of the telescope, by a toothed-wheel-and-pinion movement: the position circle is graduated so that the readings increase when the eye-piece revolves in the direction opposite to that of the hands of a watch.

The power of the eye-piece is altered by using different lenses in the position nearest to the eye, without alteration of the other three lenses.

Since the axis of the pencil of rays, coming from any object or any point of an object, passes through the centre of the divided lens, it is evident that one half of that lens receives the light which comes from one half of the object-glass, and the other half receives the light which comes from the other half of the object-glass. When the moveable half of the lens is in that position in which its surface is continuous with the surface of the fixed half (or in the position corresponding to the zero point of its scale), the axis of every semi-pencil on either half passes through that part of the lens in which the surfaces are parallel; but when the moveable half is moved from that zero position, the axis of the semi-pencil incident on that half falls upon a part in which the two surfaces are not parallel, their inclination being proportional (with sufficient accuracy) to the distance through which that half of the lens has been slid, and the plane which is perpendicular to both surfaces being the plane passing through the line of division and the axis of the telescope. This semi-pencil therefore emerges, inclined to the other; the plane of inclination being the plane just mentioned, and the extent of inclination being proportional to the movement of the moveable half-lens. On tracing the effect of this upon the image viewed by the eye-glass, it is seen that two images of the same object are formed by the light from the two halves of the object-glass, the line joining them being (sensibly) parallel to the dividing line of the lens, and their apparent distance being (sensibly) proportional to the movement of the half-lens, in whatever part of the visible field of view they may be.

The following circumstances are worthy of remark, in estimating the value of a construction like that now described.

1. The image formed by each semi-pencil is really formed by light from only one half of the object-glass, and therefore has all the defects of an image formed by a half lens. But one of the images is formed by one half, and the other by the other half. Suppose now that the object-glass has sensible dispersion (from which no object-glass that I have ever seen is free). It is well known, in the use of an entire object-glass, that by selecting as the point for the effective image a place intermediate to the points at which the most refrangible and the least refrangible rays converge, the most refrangible rays from one half of the object-glass will be mingled with the least refrangible from the other half, and their general effect of colour will be almost destroyed. But in the separate images formed by the divided lens in this construction, no such compensation of colours exists with regard to the direction *perpendicular* to the plane of division: because, if the semi-pencil be examined with reference to that direction, it evidently comes from half an object-glass, without any opposed half whose colours may be mingled with it. If, however, the semi-pencil be examined with reference to the direction *parallel* to the plane of division, it is easily seen that each half of the semi-pencil on one side is balanced by a half on the opposite side, whose colours will be mingled with it. Thus, the two images of the object may appear very much coloured, but they will be coloured only on those sides which are measured from the center of each image transversely to the line of separation. For instance, suppose Jupiter to be observed, and suppose the two images to be separated as in the accompanying figure.



Then, in the first image the top may be red and the bottom blue, while in the second, the top will be blue and the bottom red; but the sides will be no more and no less coloured than when the whole object-glass is used to form a single image; and thus, in spite of the colour which immediately catches the eye, the images are (for the purposes of measurement of distance) as good as it is possible to have.

2. With reference to the measurement of angle of position of the two images, the circumstance that has been mentioned may cause some uncertainty, or even some difference as estimated by different eyes, which are differently sensitive to the different colours. The last inconvenience, however, is completely overcome by the method of double observation, of which we shall presently speak; and ceases to exist on applying the method of putting the eye-piece in focus, to which we shall shortly advert.

3. In regard to the effects of diffraction on the image, the image of a star is not round, but is elongated in the direction perpendicular to the line of separation of the images.

m 2

This distortion operates nearly in the same manner as that described above: it produces no uncertainty whatever on the estimation of distances, but it does introduce uncertainty in the estimation of direction of separation of images.

4. From these remarks it will be gathered, that a divided eye-piece of this construction is particularly advantageous for the estimation of the distances between the double images of objects, but it is not particularly advantageous for the estimation of their position. From the statements of Sir J. Herschel, it appears that the distance is usually the more inaccurate co-ordinate, and therefore that this eye-piece, and others on the same general principle, supply what was formerly a defect. The angles, however, are also observed, as I believe, with great accuracy.

5. The method used for putting the eye-piece (practically) in focus is founded on the following consideration, it being premised that the eye-piece tube is so constructed that on sliding the eye-piece it receives no sensible rotation. Suppose the images to be separated right and left; one of them (for instance, the fixed image) is then formed by light coming from the upper half of the object-glass, and the other (the moveable image) by light coming from the lower half. Suppose the eye-piece to be drawn away from the object-glass; then the center of the section of the pencil forming the fixed image (not the center of the semi-circular outline, but the center of the general mass of light) which is viewed at the distance of distinct vision by the eye-piece, and on which the visible place depends, falls lower; and the center of the section of the pencil forming the moveable image, on which the visible place of the moveable image depends, rises higher. And this rise and fall may amount to a very sensible quantity within the limits in which the alteration of the visible size of the image is nearly insensible (the former being proportional to the movement of the eye-piece while the latter is nearly proportional to the square of that movement). Thus it is possible to make the moveable image slide above the fixed one, or through it, or below it. And these different appearances may present themselves to different eyes, in the same state of the eye-piece, according to the difference of sensitiveness of the eyes to different colours. If (as may happen) one of the halves of the lens is brought by the instrument-maker a very little too near to the other, or a very little too far from it (which, separately considered, would make the moveable image slide above or below the fixed image), advantage may be taken of this principle to correct that defect by thrusting in or drawing out the eye-piece. The principle therefore upon which the adjustment to focus is determined is, to adjust the eye-piece so that the moveable image shall pass as accurately as possible *through* the fixed image: and the practical method of using this principle is, to adjust it so that the angle of position of a double star (determined as hereafter mentioned) shall be the same when the observation is made by bringing the moveable image to the right of the fixed one, as when it is made by bringing it to the left of the fixed one. If there is error of adjustment, it affects both equally, one + and the other −; and the rule

therefore is: determine the apparent values of the angles of position in the two directions of separation, the mean of these is the correct value; place the position-circle of the eye-piece in the position corresponding to that correct value: then thrust in or draw out the eye-piece until the line of separation of the images coincides with the line joining the two individual stars of the double star; then the adjustment to focus is completed. But after all precautions are taken, it is thought prudent always to observe angles of position with the moveable image on both sides of the fixed image, and to take the mean.

6. As the separation of the images is effected by a species of prismatic refraction, it will be different for rays of different colours, and the moved image will therefore be changed into a spectrum, in which (beyond a certain distance) the colours will be sensible. And, as the lenses of the eye-piece will produce a certain degree of distortion, it will happen that where the object observed is large, or where its images are separated widely, the apparent magnitude is slightly altered, and the line of position of the two stars of a double star is sensibly altered. The extent, at which these combined causes begin to operate sensibly, can only be judged from experience. My impression from my own observations is, that the separation ought in no case to exceed ninety seconds of arc.

These remarks on the general properties of the eye-piece being premised, I shall now proceed to describe the method of making the fundamental determinations for reduction.

7. To determine the reading of the position-circle, corresponding to that position of the eye-piece in which the separation of the two images takes place in the direction of the celestial meridian passing through any object.

A tube is prepared, containing only one lens (the eye-glass, or lens nearest to the eye), and furnished with a single wire in the focus of that eye-glass. It slides upon the tube containing the other three lenses of the eye-piece (namely, the divided lens and one on each side of it), and is held safely upon it, in the same manner as the other change-tubes with eye-glasses of different powers, by two pins and bayonet notches. This tube, however, has four bayonet notches, which permit it to be mounted, so that the wire may be placed either in the direction of separation of the images or in the direction perpendicular to that, the notches being sufficiently long to allow of considerable motion for adjustment. To determine the reading of the position-circle corresponding to separation in the direction of the astronomical meridian, the eye-tube is attached with its wire nearly parallel to the direction of separation, the telescope is directed to a star, and the clock-work of the equatoreal is put in action; then the micrometer-screw is turned through a considerable number of revolutions backwards and forwards, and the eye-tube is turned by hand (without moving the rest of the eye-piece) till the moveable image of the star, as moved by the micrometer-screw, runs well upon the wire. Thus the position of the wire is made to correspond accurately to the direction of separation. Then the clock-work is stopped, the star passes the field of view by its diurnal motion, and the position-circle is turned (without independent movement of the eye-glass tube), till the diurnal motion makes the star run well along the wire; then the position of the wire, and consequently the direction of separation, coincides accurately with the direction of diurnal motion: and the reading of the position-circle, increased or diminished by 90°, is therefore the reading corresponding to separation in the direction of the meridian, or is the Polar point. As the defects in the adjustment of the equatoreal make different planes in the telescope to coincide with the astronomical meridian in different positions of the telescope, it is necessary to ascertain the Polar point for several different positions of the telescope.

8. To determine the value of one revolution of the micrometer-screw.

The eye-glass tube carrying the wire is placed in such a position that the wire is nearly perpendicular to the line of separation (extreme accuracy is not necessary). Then, by moving the position-circle, the line of separation is made to coincide pretty accurately with the direction of diurnal movement; the telescope is directed to a single star, and by turning the micrometer through a known number of revolutions, this single star is converted into two stars, which in the diurnal motion follow each other across the field of view, and whose transits across the wire can be separately observed. The interval in time is converted into arc, and is multiplied by the sine of the star's N.P.D., and thus the arc is found which corresponds to a known number of revolutions of the micrometer.

In the year 1842 observations were made for the value of one revolution of the head of the micrometer. By the means of the differences of the times of transit of the images of α Ursæ Majoris, at the distance of 5^{r} on the opposite sides of the zero, it appeared that 10 revolutions were equivalent to $24^{s}\cdot54$, and the N. P. D. of the star being 27°.24′.12″, the value of $1^{rev.}$ was thus found to be equal to 16″·942.

Again by 10 transits of the images of β Ursæ Minoris, made in the same way, it was found that the intervals in time for 10 revolutions was equal to $43^{s}\cdot30$, and, the N. P. D. of β Ursæ Minoris being 15°.12′.24″, the value of one revolution was found to be 17″·036.

The value of $1^{rev.}$ used throughout the year 1843 is 17″.

Again, by observations of three stars in the year 1842, it was found that the value of the polar point, or zero of position of the double-image micrometer, was 39°.15′. There being no reason to suspect any change, this value was used for the measures of the stars γ Virginis and 29 Ophiuchi; and, for the measures of the diameters of the planets, 39° has been used throughout the year.

The observed diameters of Venus are compared with the tabular values given for each day in the Nautical Almanac, and the tabular breadth of the illuminated part is computed by second differences from the values given for every month in the same work. On August 10 and August 19, when Venus was very nearly full, the direction of the line of cusps was computed by a formula similar to that explained on page xlv of the Introduction, for determining the correction to be applied to the observed diameters of Venus when horned.

The observers have attempted to measure in two directions nearest to the polar and equatoreal diameters of Mars, for the purpose of determining whether any sensible ellipticity exists. The diameters are compared with those given in the Nautical Almanac.

In the reduction of the observations of Jupiter's diameters, corrections have been applied for the defective illumination of Jupiter, computed thus:—The angle made at Jupiter by lines drawn to the Sun and to the Earth (the difference of Jupiter's geocentric and heliocentric longitudes) being ascertained, the correction to the equatoreal diameter is, observed semidiameter $\times$ versine of that angle. The correction for a diameter inclined at an angle θ to the equatoreal diameter is, correction to equatoreal diameter $\times$ $\cos.^2 \theta$ nearly.

The diameters thus measured and corrected are compared with those computed from Struve's elements in the Memoirs of the Astronomical Society, vol. III. page 301, namely,

	″
Equatoreal diameter	38 ·327
Polar diameter..............	35 ·538
The distance of Jupiter being..	5 ·20279

$$\text{Ellipticity} = \frac{38 \cdot 327 - 35 \cdot 538}{38 \cdot 327} = \frac{1}{13 \cdot 7}$$

The polar and equatoreal diameters at the times of observation are computed from these by the inverse proportion of distance: the diameter inclined at the angle θ to the major axis is computed by the formula,

$$\text{Equatoreal diameter} \times \left\{1 - \frac{1}{13 \cdot 7} \sin.^2 \theta - \frac{3}{2} \cdot \frac{1}{(13 \cdot 7)^2} \sin.^2 \theta \cos.^2 \theta \right\}$$

The comparison of results seems to show that Struve's ellipticity is too large.

From the observations for the years 1840 to 1842 inclusive, the mean value of the ellipticity of Jupiter appeared to be 0·05600, or $\frac{1}{17 \cdot 9}$, and, to this result, the weight 178 is attached. The following is a table of the values deduced from the separate observations of 1843, the weights being determined by the number of measures in each observation, and by an arbitrary estimate of the goodness of the observation deduced from the notes given by the observers.

Day of Observation.		Value of the Ellipticity.	Weight.	Ellipticity × Weight.	Weight for the Year.	Mean Value for the Year.
1843.						
July	29	$\frac{1}{17 \cdot 2}$ = 0·05814	10	0·58140		
	31	$\frac{1}{14 \cdot 7}$ = ·06803	10	0·68030		
Aug.	1	$\frac{1}{15 \cdot 8}$ = ·06329	16	1·01264		
	12	$\frac{1}{14 \cdot 9}$ = ·06711	8	0·53688	70	0·06094
	21	$\frac{1}{22 \cdot 0}$ = ·04545	10	0·45450		
Sep.	6	$\frac{1}{16 \cdot 0}$ = ·06250	16	1·00000		

Hence the mean value for the year 1843 is 0·06094, or $\frac{1}{16 \cdot 4}$.

Combining this with the mean value for the previous years above given, the mean of the values from the year 1840 to 1843 inclusive is 0·05740, or $\frac{1}{17 \cdot 4}$

The measures of Saturn are compared with numbers, deduced by simple alteration in the inverse proportion of distances, from Struve's Elements in the Mem. Ast. Society, vol. III. page 301, namely,

	″
Major axis of outside of ring..................	40·095
Major axis of inside of ring....................	26·668
Major axis of ball............................	8·995
The distance being supposed to be..............	9·53877

As a general remark, applying to every class of observation above mentioned, I may state that the original entries of observations are in all cases preserved. The greater part of the regular observations are entered in small memorandum books, in which the entries are written with a metallic pencil, whose marks are not easily effaced: but some observations are written down at once with ink in the skeleton forms in which the calculations are to be made, or in the copy which is sent to the press. All, however, are preserved. The proof sheets are read with the first skeleton form in which the observations are entered (and in which, in fact, the examination for accidental errors, &c., is made).

END OF INTRODUCTION TO GREENWICH ASTRONOMICAL OBSERVATIONS.