GREENWICH OBSERVATIONS.

INTRODUCTION.

I. *Personal Establishment and Arrangements.*

It appears that, to the commencement of Mr. Pond's superintendance of the Royal Observatory, the regular personal establishment consisted of the Astronomer Royal and one assistant only. The latter office was then held by Mr. Taylor (late First Assistant). The establishment has been increased by the following steps: Mr. Henry was appointed in 1811, Mr. Richardson and Mr. T. G. Taylor in 1822, and Mr. Ellis and Mr. Rogerson in 1825. In 1830 Mr. T. G. Taylor was appointed Director of the East India Company's Observatory at Madras, and his office in the Royal Observatory was taken by Mr. F. W. Simms.

Mr. Pond and Mr. Taylor (First Assistant) resigned their offices on October 1, 1835, and were replaced by the present Astronomer Royal and Mr. Main. Mr. F. W. Simms resigned shortly afterwards, and was succeeded by Mr. Glaisher (formerly assistant at Cambridge Observatory), who commenced his labours at the Royal Observatory on February 11, 1836.

The employments of the Observatory 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. In the absence of the Astronomer Royal he is empowered to act in all respects as his representative.

Mr. Henry, assisted by Mr. Ellis, manages the observations with the Transit, the reductions of the Transits, 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 1ʰ mean time every day.

Mr. Richardson, assisted by Mr. Rogerson and Mr. Glaisher, makes observations with the Mural Circles, Zenith Sector, and Equatoreals; and reduces these observations.

The observations, &c. are prepared for Press, and the Proof Sheets read, by the assistants who have been engaged in making and reducing them.

The whole of these works are under the immediate direction of the Astronomer Royal, who is responsible for every part.

No assistant is employed in correspondence, &c. relating to the affairs of the Observatory, except at the immediate 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. The original observations of every kind are entered in small memorandum books from which the writing cannot easily be effaced: these are preserved for future reference.

The computations of every kind made by one person are examined by another person, whose signature is attached in its proper place in the printed skeleton form used for the calculations. The results are of course subjected to general irregular examination.

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, the two Mural Quadrants (mounted on their pier), and the Zenith Sector of Bradley and Maskelyne (mounted on its wall). These are in different states of general efficiency; but no observations have been made with them for many years. The fixed telescopes, used for investigating the parallax of α Cygni and α Aquilæ, are still in their places, and (I believe) in good order; but they have not been used for several years.

The instruments now in use are the following:

The Transit, constructed by Mr. Troughton, and erected in the year 1816. The length of the telescope is about 10 feet, and the clear aperture of the object-glass 5 inches; the length of the axis (between the extremities of the pivots)

4 feet. The internal structure of this instrument is understood to be precisely similar to that of Sir James South's transit, described in a paper in the Philosophical Transactions for 1826. As far as my experience has extended, I am inclined to believe that it is less firm than the Cambridge Transit (of the same dimensions); its collimation appearing to be more easily affected by accidental violence. A graduated circle was formerly attached to the axis of the Transit, turning with it, and read by a microscope fixed to the pier; for the purpose of directing the telescope to a given N. P. D. This was removed a few years since. The telescope is now directed by means of circles carried by the eye-end of the telescope, whose moveable index bears a spirit-level. With the exception of occasional grinding, &c. of the pivots (as mentioned in Mr. Pond's observations), no further alteration appears to have been made in the instrument. The pivots are of steel, fixed in 1825, and fresh turned in 1832, and appear to be now in excellent order. The Transit had two eye-piece-frames, referred to by Mr. Pond (Observations 1821, November 30, and 1832, Introduction) by the numbers 1 and 2. The latter was provided with a micrometer: it had not been mounted for several years. In the beginning of 1836 it was furnished with seven wires, at smaller intervals than those previously employed, and was mounted on the Transit.

The Two Mural Circles of 6 feet diameter, constructed one by Troughton, the other by Jones. A description of these, illustrated by engravings, will be found in the Greenwich Observations for 1812, 1820, 1825, and 1826. No alteration has been made, I believe, in their arrangements, subsequent to the fixation of the telescope on Troughton's circle in the year 1821. The design of Troughton appears to have been, that the telescope should occasionally be moved to different parts of the limb. This was done for several years, till, in consequence of the failure of a screw in the attaching pieces (which were very weakly connected with the telescope), the telescope was fixed in a more permanent way in 1821, and was not moved till the beginning of 1836. The telescope of Jones' Circle also was kept in the same position (though clamped upon the limb in such a manner as to admit easily of shifting), from its erection in 1825 to the beginning of 1836.

The 5-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 Royal Observatory in the year 1811. It is mounted in the 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 covered by the Great 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 declination-circle and hour-circle being read with verniers. It 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 great Zenith Sector of 25 feet in length. It appears that this instrument was projected by Troughton, at the erection of the first Mural Circle, for the purpose of determining its zenith point (by the comparing of observations of γ Draconis) as with the old quadrants: the powers of the mural circle to determine the zenith point with the aid of observations by reflexion, being not yet sufficiently understood. (It was not till 1822 that reflexion-observations were employed to any considerable extent). Many delays, however, occurred in the completion of the instrument, and it was not finally erected till 1834. Observations made with it were published by Mr. Pond in the Greenwich Observations 1834. It was, however, complained, that there was great difficulty in seeing γ Draconis, when it was perfectly visible with the other meridional instruments. In the present year several alterations have been made under my direction. The upper part of the building in which the instrument stands has been so modified, as to prevent the passage of any ascending current of air immediately before the object-glass. The micrometer, as originally constructed, appears to me to be radically defective. The plate carrying the wire was moved by a very long screw, and the accuracy of the measure depended entirely on the uniformity of this screw. This screw did not act in the plane of the wire-plate, but at the distance of nearly one inch from that plane, and the measures were therefore subject to the effects of flexure of the plane. Moreover, the resting-place of the screw, in regard to its pressure endways against a fixed support, was the side of a thin arch; which arch was held in its place only by two temporary screws. I must add, that the wire-plate was loaded with the weight and strain of a long diagonal eye-piece, not counterpoised. The construction now adopted employs a short screw, acting in the plane of the wire-plate, and bearing against a firm support: and the wire-plate does not sustain the weight of the eye-piece. The former construction required that the instrument should be placed accurately vertical, as ascertained by its plumb-line: now, micrometer-microscopes are placed to observe the top and the bottom of the plumb-line, and accurate adjustment of the vertical axis is not necessary. As no observations have been made in the present year, except for comparisons of scales and preliminary adjustments, I defer giving a more detailed account.

Two detached telescopes in the Advanced Building (the place of Flamsteed's mural arc). The length of one is 46 inches, and its aperture 3·6 inches; the length of the other 62 inches, and its aperture 3·8 inches.

The Transit Clock, constructed by Hardy, and originally finished with Hardy's escapement. The rate of the clock having been found extremely unsteady, the escapement was removed, and a dead-beat escapement substituted by Dent in the year 1829. The jewelled holes were removed by Dent in December 1836, and the pivots now turn in brass holes.

A clock in the Eastern Dome marked Arnold 1, one in the Western Dome marked Arnold 2, 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 Earnshaw, and some others not appropriated.

There are also other achromatic telescopes of small dimensions, and two reflectors, the largest being one of 10 feet, by Sir W. Herschel. The specula of these reflectors are slightly tarnished.

III. *Subjects of Observation in the Year* 1836.

The first object has been, to maintain a regular series of observations of the Sun, Moon, and Planets; the latter being continued through all hours of the night.

The observations of stars with the Transit have been directed to the following classes: Stars on the list of the Nautical Almanac; Stars observed with Halley's Comet at Cambridge Observatory in 1835; Stars observed by Lieutenant-Colonel Colby with Ramsden's Zenith Sector, on different points of the Trigonometrical Survey of Britain; Stars used for comparing Ramsden's Zenith Sector with the Mural Circles, in the summer of 1836; and Stars indicated by Mr. Baily as requiring examination for ascertaining their existence, proper motion, and magnitude.

The observations of stars with the Mural Circles have included all the preceding classes (a greater number of observations being required for the Stars observed with the Zenith Sector), together with observations of Circumpolar Stars for a new determination of the latitude, and for obtaining independent means of testing the refraction-tables adopted; and Low Southern Stars for correction of the refraction-tables by comparison with observations made at the Cape of Good Hope.

In explanation of the Comparison with Ramsden's Sector above alluded to, it is proper to state, that (at my suggestion) that Instrument was erected in the

Front Court of the Observatory in the month of June, and that, under the direction of Lieutenant-Colonel Colby, observations were made by Lieutenant Denison, R. E. upon a list of stars which were also observed (and, as nearly as was practicable, at the same times) with the Mural Circles. The principal object of these observations was the comparison of the whole arc of the Sector with the corresponding arcs on the Mural Circles. The results of the Sector-observations are in course of reduction by the able and zealous officer who made them: and it is expected that an account of these and other observations made with the Sector, will shortly be published under the auspices of the Board of Ordnance.

The observations of the elongation in right-ascension of Jupiter's fourth satellite (with the Equatoreal) were made for the purpose of determining Jupiter's mass. A few observations were also made for obtaining the differences of position between some of the planets and neighbouring stars.

The occultations of Stars by the Moon, and the eclipses of Jupiter's satellites, have been observed at every practicable opportunity. The transits of the satellites have been occasionally observed: but the observation of their shadows has been gradually omitted, from the conviction that no accurate determination of the time of the phenomenon could be attained. The observations of the Solar Eclipse were confined to differences of declination of cusps and limbs.

IV. *Explanation of the Printed Observations.*

§ 1. *Transits as observed, and calculation of Apparent Right Ascensions,* page [1] to [139].

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 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, 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 North Polar Distance: which may be a few minutes in error.

The letters affixed by Bode have in some instances been rejected and in some have been retained; it being considered desirable to make the nomenclature of the Moon-culminating stars approach to that of the Nautical Almanac. In a subsequent part of the work, greater purity of nomenclature is attempted.

The *next seven* columns contain the seconds and decimals of seconds of time (and for Polaris and δ Ursæ Minoris 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. To Jan. 19, the eye-piece No. 1 (which has been attached for several years past), containing only five metallic wires, was used: after that time the eye-piece No. 2 was employed, having been furnished with seven wires of silk.

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 on 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 to the printed observations: but every alteration of the seconds is carefully recorded.

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. γ Virginis is seen as a single star: and it does not appear that ε Bootis is usually seen double.

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 (supposing the observations perfect). The corrections which must be applied to the transit at each wire, in order to obtain the mean of the seven wires, are as follows:

For the system of wires used from Jan. 1 to Jan. 19.

For an equatoreal star.

	s
B	+36·647
C	+18·305
D	0·000
E	−18·309
F	−36·606

For Polaris, declination = 88°. 25′ + n''.

B	+22. 6·88 (m s)	+ n × 0·236 (s)
C	+11. 2·88	+ n × 0·118
D	0·00	
E	−11. 2·75	− n × 0·118
F	−22. 8·36	− n × 0·236

It will be remarked, that these numbers are not perfectly accurate, as the sum of the positive terms is not equal to the sum of the negative terms: but as no error of collimation was recognized at that time, there is a general inaccuracy of small amount.

For the new system of wires, the following intervals are used from Jan. 23 to May 30.

For an equatoreal star.

A	+38·552 (s)
B	+25·661
C	+12·962
D	+ 0·050
E	−12·876
F	−25·739
G	−38·609

For Polaris, declination = 88°. 26′ + n''.

A	+23. 32·57 (m s)	+ n × 0·254 (s)
B	+15. 39·33	+ n × 0·168
C	+ 7. 54·19	+ n × 0·085
D	+ 1·82	
E	− 7. 51·05	− n × 0·084
F	−15. 42·18	− n × 0·169
G	−23. 34·68	− n × 0·254

For δ Ursæ Minoris, declination = 86°. 34′ + n''.

A	+10. 43·99 (m s)	+ n × 0·052 (s)
B	+ 7. 8·56	+ n × 0·035
C	+ 3. 36·45	+ n × 0·017
D	+ 0·83	
E	− 3. 35·01	− n × 0·017
F	− 7. 9·86	− n × 0·035
G	−10. 44·94	− n × 0·052

The following are used from May 30 to the end of the year.

For an equatoreal star.

	s
A	+38·558
B	+25·672
C	+12·939
D	+ 0·046
E	−12·872
F	−25·749
G	−38·593

For Polaris, declination = 88°. 26′ + *n*″.

	m s				s
A	+23. 32·80	+	*n*	×	0·254
B	+15. 39·72	+	*n*	×	0·169
C	+ 7. 53·37	+	*n*	×	0·085
D	+ 1·67				
E	− 7. 50·90	−	*n*	×	0·084
F	−15. 42·55	−	*n*	×	0·169
G	−23. 34·07	−	*n*	×	0·254

For δ Ursæ Minoris, declination = 86°. 34′ + *n*″.

	m s				s
A	+10. 44·07	+	*n*	×	0·052
B	+ 7. 8·74	+	*n*	×	0·035
C	+ 3. 36·07	+	*n*	×	0·017
D	+ 0·77				
E	− 3. 34·95	−	*n*	×	0·017
F	− 7. 10·03	−	*n*	×	0·035
G	−10. 44·66	−	*n*	×	0·052

The former numbers were deduced from four transits of Polaris ending with Feb. 1, and the latter from nineteen transits ending with April 16.

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

$$1 + \frac{\text{daily increase of RA. in seconds of time}}{24 \times 60 \times 60}$$

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

$$\frac{3600 + 1}{3600} \times \frac{\text{sin Moon's geocentric } ZD}{\text{sin Moon's apparent } ZD} \times \text{secant Moon's declination,}$$

where I is the increase (in seconds of time) of the Moon's A. R. 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.

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* column contains the initials of the observer's name.

The *first* 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. To Jan. 19 no error of collimation is set down, as (the eye-piece then in use having no micrometer) it was impossible to measure the error. From Jan. 23 the following methods have been used. The use of the meridian marks at Blackwall and Chingford was given up: the former being too broad for the new fine wires, and being very frequently hidden by the rigging of ships in the river; and the latter being visible only in the finest weather. A collimator of 63 inches focal length and 3·9 inches aperture, mounted like a transit in the south opening of the transit-room, had been used by Mr. Pond for verifying the mechanical correction of collimation, by directing the transit and the collimator to the same north meridian mark, and then observing whether the middle wire of the transit, after turning its object-glass to the south, coincides with the image of the collimator's wire. This collimator is now used as a fixed mark for observation with the transit in reversed positions. The vertical wire of the collimator having been found to be a bad object for observation with the vertical wire of the transit-micrometer, it was changed between Jan. 22 and April 13 for a cross in the form of an acute X. A reflector was attached for the purpose of throwing the light of the sky upon the wires. As the smallest radiation from the sun disturbed the collimator very much, the Y's for its support were shifted from the south to the north opening between the 7th and 16th of June.

For the value of the micrometer-screw, the following process was used. The micrometer-frame carries two vertical wires, the interval between which, in parts of the screw, was ascertained by ascertaining the readings of the micrometer on their coincidence with the wire D. The results obtained at different times were $4^r{\cdot}373$, $4^r{\cdot}351$, $4^r{\cdot}364$. And by observations of the passage of Polaris and δ Ursæ Minoris, the interval in arc between the two wires was found at different times to be $71''{\cdot}91$, $71''{\cdot}49$, $71''{\cdot}09$, $71''{\cdot}02$, $70''{\cdot}60$, $71''{\cdot}10$, $71''{\cdot}05$, $71''{\cdot}06$, $71''{\cdot}13$, $71''{\cdot}55$, $70''{\cdot}41$. Adopting the two results $4^r{\cdot}364$ and $70''{\cdot}987$, the value of one revolution is $16''{\cdot}206$.

The following are the details of the observations for the error of collimation in 1836.

Jan. 22, 1^h. The transit three times reversed. Observations made by the Astronomer Royal. The micrometer-wire farthest from the micrometer-head is that used.

Illuminated end West (1st Sett).	r
Micrometer reading on coincidence with collimator (10 measures)	12·053
Illuminated end East (2nd Sett).	
Micrometer reading on coincidence with collimator (8 measures)	9·987
,, ,, on coincidence with *D* (6 measures)	10·911
Illuminated end West (3rd Sett).	
Micrometer reading on coincidence with collimator (8 measures)	12·054
Illuminated end East (4th Sett).	
Micrometer reading on coincidence with collimator (8 measures)	9·994
,, ,, on coincidence with *D* (6 measures)	10·916
Hence reading for line of collimation by 1st and 2nd Setts.	11·020
,, ,, by 3rd and 4th Setts.	11·024
Reading for true line of collimation	11·022
Reading for *D*	10·913
Hence apparent error of collimation for *D*	0·109

The value of this quantity in arc is $1''\cdot79$.

The readings of the micrometer increase as the wire is moved from the illuminated end. The reading for the line of collimation being greater than that for coincidence with *D*, *D* is too near the illuminated end, or too much to the East (in the present position of the instrument): the passages of stars above the pole are therefore too late, and the error of collimation is negative, or $= - 1''\cdot79$. Applying $- 0''\cdot19$ for diurnal aberration, the error of collimation for *D* is $-1''\cdot98$. And, considering that Polaris above the pole passes the mean of wires later than *D* (illuminated end East) by $1^s\cdot82$, or that the mean is East of *D* by $0''\cdot75$, the error of collimation for the mean of the seven wires is $- 2''\cdot73$.

April 13, 22^h. The transit reversed four times. Observations made by Mr. Main.

	r
Illuminated end East (1st Sett).	
Micrometer reading on coincidence with collimator (6 measures)	13 ·860
Illuminated end West (2nd Sett).	
Micrometer reading on coincidence with collimator (6 measures)	9 ·233
Illuminated end East (3rd Sett).	
Micrometer reading on coincidence with collimator (6 measures)	13 ·821
Illuminated end West (4th Sett).	
Micrometer reading on coincidence with collimator (6 measures)	9 ·232
Illuminated end East (5th Sett).	
Micrometer reading on coincidence with collimator (10 measures)	13 ·822
,, ,, on coincidence with *D* (44 measures)	10 ·898

The 1st Sett was rejected: it would not sensibly have altered the result.

Hence reading for line of collimation by 2nd and 3rd Setts	11 ·527
,, ,, by 4th and 5th Setts	11 ·527
Reading for true line of collimation	11 ·527
Reading for *D*	10 ·898
Hence apparent error of collimation for *D*	0 ·629

The magnitude of this error made it evident that some mistake had been committed. It appears probable that in one of the positions of observation of the collimator there has been a false reading of 1r, which (as there is no scale for the whole number of turns) may very easily have occurred. This supposition would make the error of collimation 0r·129. To remove doubt, the following observations were immediately made.

April 14, 0h. Observations made by Mr. Main.

	r
Illuminated end West (1st Sett).	
Micrometer reading on coincidence with collimator (6 measures)	8 ·784
Illuminated end East (2nd Sett).	
Micrometer reading on coincidence with collimator (6 measures)	13 ·306
Illuminated end West (3rd Sett).	
Micrometer reading on coincidence with collimator (6 measures)	8 ·995
Illuminated end East (4th Sett).	
Micrometer reading on coincidence with collimator (6 measures)	13 ·073
Hence reading for line of collimation by 1st and 2nd Setts	11 ·045
,, ,, by 3rd and 4th Setts	11 ·034
Reading for true line of collimation	11 ·039
Reading for *D*	10 ·898
Hence apparent error of collimation for *D*	0 ·141

The value of this quantity in arc is 2″·32: which, as before, is negative. Correcting it by −0″·19 for diurnal aberration and −0″·69 for the distance of *D* from the mean, the error of collimation to be used for the mean of wires is −3″·20.

The quantity −2″·32 was inadvertently used in the transit book (during my absence), and the error was not discovered till the printing had proceeded too far to allow of its correction in the body of the work. In the list of *Corrigenda* the amount of corrections where sensible will be given.

June 6, 22^h. Observations made by Mr. Main. Four sets (the first) were rejected, as it was evident that, from accidental shocks or from change of temperature, a change was going on in the position of the collimator. The means were respectively 13^r·041, 8^r·612, 13^r·602, 7^r·731. The following are preserved. The readings for *D* were taken on the preceding day.

	r
Illuminated end East (1st Sett).	
Micrometer reading on coincidence with collimator (10 measures)	13·960
Illuminated end West (2nd Sett).	
Micrometer reading on coincidence with collimator (10 measures)	6·336
,, ,, on coincidence with *D* (10 measures)	9·898
Illuminated end East (3rd Sett).	
Micrometer reading on coincidence with collimator (10 measures)	13·946
Illuminated end West (4th Sett).	
Micrometer reading on coincidence with collimator (10 measures)	6·306
Illuminated end East (5th Sett).	
Micrometer reading on coincidence with collimator (10 measures)	13·875
Illuminated end West (6th Sett).	
Micrometer reading on coincidence with collimator (10 measures)	6·477
Hence reading for line of collimation by 1st and 2nd setts	10·148
,, ,, by 3rd and 4th setts	10·126
,, ,, by 5th and 6th setts	10·176
Reading for true line of collimation	10·150
Reading for *D*	9·898
Hence apparent error of collimation for *D*	0·252

The value of this quantity in arc is 4″·14, which corrected as before gives for the error of collimation of the mean of wires −5″·02.

June 16, 22^h. Observations by Mr. Ellis.

Illuminated end East (1st Sett).	r
Micrometer reading on coincidence with collimator (10 measures)	10·898
Illuminated end West (2nd Sett).	
Micrometer reading on coincidence with collimator (10 measures)	9·622
,, ,, on coincidence with *D*	9·899
Illuminated end East (3rd Sett).	
Micrometer reading on coincidence with collimator (10 measures)	10·646
Illuminated end West (4th Sett).	
Micrometer reading on coincidence with collimator (10 measures)	9·563
Hence reading for line of collimation by 1st and 2nd setts	10·270
,, ,, by 3rd and 4th setts	10·105
Reading for true line of collimation	10·187
Reading for *D*	9·899
Hence apparent error of collimation	0·288

The value of this quantity in arc is 4″·74.

As there was considerable discordance between the results of the 1st and 3rd setts, the following measures were made at the first opportunity.

June 20, 22^h. Observations made by Mr. Ellis. The day cloudy and calm: all circumstances favourable.

Illuminated end East (1st Sett).	r
Micrometer reading on coincidence with collimator (5 measures)............	11·430
Illuminated end West (2nd Sett).	
Micrometer reading on coincidence with collimator (5 measures)............	8·731
,, ,, on coincidence with *D*	9·892
Illuminated end East (3rd Sett).	
Micrometer reading on coincidence with collimator (5 measures)............	11·459
Illuminated end West (4th Sett).	
Micrometer reading on coincidence with collimator (5 measures)............	8·738
Illuminated end East (5th Sett).	
Micrometer reading on coincidence with collimator (5 measures)............	11·464
Illuminated end West (6th Sett).	
Micrometer reading on coincidence with collimator (5 measures)............	8·714
Illuminated end East (7th Sett).	
Micrometer reading on coincidence with collimator (5 measures)............	11·472

Illuminated end West (8th Sett).	r
Micrometer reading on coincidence with collimator (5 measures)............	8·737
Hence reading for line of collimation by 1st and 2nd setts	10·080
,, ,, by 3rd and 4th setts	10·098
,, ,, by 5th and 6th setts	10·089
,, ,, by 7th and 8th setts	10·104
Reading for true line of collimation....................................	10·093
Reading for *D*..	9·892
Hence apparent error of collimation for *D*.................................	0·201

The value of this quantity in arc is 3″·31: which with the usual corrections gives for the error of collimation to be used for the mean of wires – 4″·19.

September 8, 22^{h}. Observations by Mr. Main. The morning cloudy and generally favourable.

Illuminated end East (1st Sett).	r
Micrometer reading on coincidence with collimator (12 measures)	11·128
Illuminated end West (2nd Sett).	
Micrometer reading on coincidence with collimator (8 measures)............	9·036
Illuminated end East (3rd Sett).	
Micrometer reading on coincidence with collimator (6 measures)............	11·171
Illuminated end West (4th Sett).	
Micrometer reading on coincidence with collimator (6 measures)............	9·011
Illuminated end East (5th Sett).	
Micrometer reading on coincidence with collimator (6 measures)............	11·149
Illuminated end West (6th Sett).	
Micrometer reading on coincidence with collimator (7 measures)............	9·018
,, ,, on coincidence with *D*	9·898
Hence reading for line of collimation by 1st and 2nd setts.....................	10·082
,, ,, by 3rd and 4th setts	10·091
,, ,, by 5th and 6th setts.....................	10·083
Reading for true line of collimation....................................	10·085
Reading for *D*..	9·898
Hence apparent error of collimation for *D*	0·187

The value in arc is 3″·07: which corrected as before gives for the error of collimation to be used for the mean of the seven wires – 3″·95.

December 18, 23^h. Observations made by Mr. Main. The morning calm and cloudy.

Illuminated end East (1st Sett).	r
Micrometer reading on coincidence with collimator (6 measures)............	14·156
Illuminated end West (2nd Sett).	
Micrometer reading on coincidence with collimator (6 measures)...........	6·288
Illuminated end East (3rd Sett).	
Micrometer reading on coincidence with collimator (6 measures)............	14·231
Illuminated end West (4th Sett).	
Micrometer reading on coincidence with collimator (6 measures)...........	6·271
Illuminated end East (5th Sett).	
Micrometer reading on coincidence with collimator (6 measures)............	14·221
Illuminated end West (6th Sett).	
Micrometer reading on coincidence with collimator (6 measures)...........	6·238
Hence reading for line of collimation by 1st and 2d setts	10·222
,, ,, by 3rd and 4th setts	10·251
,, ,, by 5th and 6th setts	10·229
Reading for true line of collimation	10·234
Reading for *D*	9·874
Hence apparent error of collimation for *D*	0·360

The value of this quantity in arc is 5″·92: which corrected as before gives for the error of collimation to be used for the mean of the wires −6″·80.

This error is very large, but the observations leave no doubt of its correctness. It seems to have originated (probably) in the accidental blow which the transit received on Nov. 24: and the numerical quantity just found is therefore used from that time.

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

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

Special tables of the latter factor are prepared for principal stars, and general tables for other objects; and the multiplication is performed with great ease by means of a sliding-rule.

The *second* 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. To ascertain the value of the divisions of its scales, on Jan. 27 it was lashed to Troughton's circle, and the circle being moved till the bubble was alternately near the end of one and the other scale, the microscopes A and B were read. This operation was repeated sixteen times. The mean of the results gave 2′ .0″·03. = 112·18 parts at one end = 108·93 parts at the other end of the scale: the mean value of one part is therefore 1″·086.

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 however is always mentioned in the notes.

The numerical correction to the transits is,

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

It is proper to state here that, from a series of levellings on Jan. 27, the transit being reversed after each levelling, there appeared to be no reason to think that there is any appreciable difference in the diameters of the pivots. The results were as follows:

Jan. 27, 2^h.			
Illuminated end	East,	result =	+ 1·44 parts.
,,	West	,,	+ 1·45
,,	East	,,	+ 1·41
,,	West	,,	+ 1·47
,,	East	,,	+ 2·22
,,	West	,,	+ 1·90
Jan. 27, 23^h.			
Illuminated end	East	,,	+ 1·67
,,	West	,,	+ 1·48
,,	East	,,	+ 1·67

And on Jan. 23, the level was placed on the pivots; Mr. Main watching the level-scale at one end while I observed that at the other end: in this state I turned the transit slowly till it touched the level-support both ways: this was done both with the object-glass north and with the object-glass south. In both instances the bubble moved more than one division, but this was apparently owing to some extraneous cause: for, upon reversing the motion of the transit, the bubble did not return. In fact, as far as the figure of the pivot was concerned, I had every reason to consider the bubble as stationary, and the figure of the pivots as perfect.

The *third* 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 *fourth* column contains the azimuthal error, considered positive when the eastern pivot is too far north. This is always 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 A.R., 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 3·038 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 A.R. and the clock's rate, and is therefore divided by 3·038.

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 A.R. 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.

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

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

I may record here an observation of the Chingford mark, made under very favourable atmospheric circumstances.

August 24.

	r
Reading of micrometer for Western edge of the mark	9 ·760
,, ,, for Eastern edge of the mark	10 ·338
Mean for center of the mark	10 ·049
The reading for line of collimation on June 20, was 10 ·093; and on Sept. 8, 10 ·085 : the mean is	10 ·089
The center of the mark therefore is West of the line of collimation by	0 ·040
The value of which in arc is 0″·66.	

The azimuthal error on August 17, appeared to be + 0″·36, and on August 31, − 0″·54: so that it is probable that the line of collimation on August 24, was nearly in the meridian. Hence it appears that the mark, probably, is within a second of its proper position: which is as near, I apprehend, as the thickness of the old wires and the uncertainty of horizontal refraction would allow of placing it.

The position of the micrometer, in the above observations, was checked by the reading for coincidence with D 9r·898, which agreed nearly with those for the preceding and following determinations of error of collimation.

The *fifth* 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 *sixth* column contains the seconds of the tabular A.R. of the stars which are used for determining the clock-error. These stars are taken from the list of the Nautical Almanac, those only being used whose N.P.D. exceeds 50°. The tabular A.R. of Polaris also is set down, to enable the reader to judge of the general state of adjustment of the instrument. The tabular A.R. are computed by adding to the place given in the Nautical Almanac a constant for each star, determined for the most part by the observations of the preceding year. Thus the corrections of the Nautical Almanac are adopted without adopting the mean places of that work. For Polaris, the additional correction depending on the place of the Moon is also taken into account. The following table gives the mean A.R. for 1836, 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 A.R. Jan. 1, 1836.	Correction to N. A.	Star's Name.	Assumed Mean A.R. Jan. 1, 1836.	Correction to N. A.
	h m s	s		h m s	s
γ Pegasi	0. 4. 47·91	− 0·09	12 Canum Venat.	12. 48. 20·70	− 0·25
β Ceti	0. 35. 21·15	− 0·19	Spica	13. 16. 33·71	− 0·05
Polaris	1. 1. 5·98	+ 0·28	η Bootis	13. 46. 52·51	− 0·19
θ^1 Ceti	1. 15. 49·81		Arcturus	14. 8. 11·02	− 0·01
α Arietis	1. 57. 56·58	+ 0·02	ε Bootis	14. 37. 49·49	− 0·02
γ Ceti	2. 34. 48·54	− 0·21	α^2 Libræ	14. 41. 49·12	− 0·09
α Ceti	2. 53. 42·87	+ 0·03	β Libræ	15. 8. 11·48	− 0·06
η Tauri	3. 37. 44·88	+ 0·02	α Coronæ Borealis,	15. 27. 44·79	+ 0·04
γ^1 Eridani	3. 50. 22·86		α Serpentis	15. 36. 11·68	0·00
Aldebaran	4. 26. 31·09	+ 0·02	β^1 Scorpii	15. 55. 54·79	0·00
Rigel	5. 6. 39·54	− 0·04	δ Ophiuchi	16. 5. 45·54	+ 0·06
β Tauri	5. 15. 55·81	− 0·02	Antares	16. 19. 21·80	− 0·04
δ Orionis	5. 23. 37·90	− 0·03	α Herculis	17. 7. 10·34	− 0·03
α Leporis	5. 25. 29·99		α Ophiuchi	17. 27. 19·46	− 0·01
ε Orionis	5. 27. 53·73	+ 0·03	μ^1 Sagittarii	18. 3. 57·56	
α Orionis	5. 46. 17·75	+ 0·01	α Lyræ	18. 31. 23·24	+ 0·10
μ Geminorum	6. 13. 2·31		β Lyræ	18. 44. 1·52	− 0·12
Sirius	6. 37. 55·27	+ 0·10	ζ Aquilæ	18. 57. 52·37	− 0·05
ε Canis Majoris	6. 52. 10·96		δ Aquilæ	19. 17. 13·73	+ 0·07
δ Geminorum	7. 10. 19·58	+ 0·12	γ Aquilæ	19. 38. 27·74	− 0·07
Castor	7. 24. 7·63	− 0·01	α Aquilæ	19. 42. 46·87	− 0·04
Procyon	7. 30. 42·80	− 0·15	β Aquilæ	19. 47. 15·43	− 0·07
Pollux	7. 35. 16·34	0·00	α^2 Capricorni	20. 8. 56·95	− 0·07
15 Argûs	8. 0. 33·75		ζ Cygni	21. 5. 57·64	
ε Hydræ	8. 38. 5·35		β Aquarii	21. 22. 55·13	− 0·13
α Hydræ	9. 19. 31·70	− 0·07	ε Pegasi	21. 36. 7·95	
ε Leonis	9. 36. 31·89		α Aquarii	21. 57. 21·44	− 0·15
Regulus	9. 59. 37·87	− 0·17	ζ Pegasi	22. 33. 17·10	+ 0·03
δ Leonis	11. 5. 22·75	+ 0·19	Fomalhaut	22. 48. 34·42	
δ Hydræ et Crateris	11. 11. 8·82		α Pegasi	22. 56. 35·77	− 0·07
β Leonis	11. 40. 41·44	0·00	ι Piscium	23. 31. 31·11	+ 0·07
β Corvi	12. 25. 47·08	− 0·09	α Andromedæ	23. 59. 55·45	+ 0·01

The *seventh* column contains the error of the clock, found by subtracting the numbers in the fifth column from those in the sixth. It is therefore positive when the clock is slow. The clock-error is sometimes rejected when a star has been observed on three or four wires only.

The *eighth* and *ninth* 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 the bars across these columns, whose limits are (in almost every case) the same as the limits of each individual's observations. The direct effect of *personal equation* is thus almost entirely avoided. In a few instances, where perhaps the Sun, &c. has been observed and no star could be seen, it has been necessary to connect the observation of one day with the clock-error of another: but these instances are insignificant in number. In each of these groups, the mean of the clock-errors in the seventh column (excluding those by Polaris) is taken, and is supposed to correspond with the mean of the clock-times. By comparing each mean with the preceding and following mean, a preceding and a following apparent clock-rate are obtained: and from these, without any precise rule, the rate which is conceived to hold during the group of observations is adopted. I may remark, that when the observers follow alternately (as generally happens,) the rate thus found is scarcely affected by personal equation. The proportional part of this rate, corresponding to the mean of the clock-times, is applied with sign changed to the mean of the clock-errors, and thus the clock-error at 0^h sidereal is obtained. The clock-error for the next preceding or next following 0^h sidereal (which sometimes falls within the group) is found by subtracting or adding the clock-rate.

Sometimes a clock-error for the same 0^h sidereal occurs in each of two successive groups, and has different values. This may depend on the personal equation of the observers: or it may be a consequence of the fluctuation of the clock's rate. For it must be remarked, that the clock-error at 0^h is a purely fictitious quantity, invented only for practical convenience in the calculations through the group, and formed by carrying backwards the rate which is supposed to hold in the group, but which does not really hold for times preceding it.

The *tenth* 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.

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

§ 2. *Apparent Right Ascensions of Polaris, and Mean Right Ascensions of Stars observed in the Year* 1836, *page* [124] *to* [139].

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

The mean right ascensions of Polaris are formed from these, by applying with sign changed, the corrections of the Nautical Almanac, found by taking the difference between the mean place of that work and the apparent place in the same (corrected for the Moon's longitude). Those of δ Ursæ Minoris are formed in the same manner.

The mean right ascensions of the other stars of the Nautical Almanac are found by subtracting from the apparent right ascensions in the eleventh column of the right-hand page of the ***Transits as observed,*** &c. the corrections found by taking the difference between the mean place and the apparent place of the Nautical Almanac.

For the mean right ascensions of all other stars, the corrections to be subtracted from the apparent right ascensions are computed by the formula

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

or

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

$$\mathrm{n^o.\,log.\,0{\cdot}1259} + \frac{\mathrm{D}}{15}\,\mathrm{cos.\,A.R.\,cotan.\,N.P.D.} + \mathrm{C.} \times \mathrm{n^o.\,log.\,0{\cdot}4869.}$$

according 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.

Mr. Baily's edition of Flamsteed's British Catalogue is adopted as the standard for nomenclature; but Flamsteed's or Bode's letters, rejected in that edition, are occasionally set down, but in brackets.

The places in the catalogue, page [137], &c. are the means of all the mean right ascensions of each star, excluding only those which are included in brackets. The annual variations of Polaris, δ Ursæ Minoris, and **61** Cygni, are taken from the Nautical Almanac: the others are taken from the Astronomical Society's Catalogue, or are computed with the same formula and the same numerical coefficients. The nomenclature of Baily's Flamsteed only is preserved in this catalogue.

§ 3. *Observations with the Mural Circles, page* (2) *to* (123).

Before explaining the columns of the printed work, it may be desirable to state the results of observations relating to the accuracy of division and the correctness of position of the circles.

The divisions 0°, 5°, 10°, &c. being successively brought to the pointer (as nearly as possible) the six microscopes were read. As there is reason to think that the center of the circle is liable to small disturbances from the intrusion of dust, &c. the different degrees of end-shake, the action of the clamps, and other causes, no reliance could be placed upon any attempt to investigate the errors of single divisions: but the sum of the errors of opposite divisions, or the error of a diameter, is not liable to any such uncertainty. Adding together, therefore, the opposite readings (as A + B, C + D, E + F), readings were obtained independent of the shake of the center. To eliminate from these the accidental position of the divisions under the microscopes (as depending on the accidental position of the circle), the mean of the three sums thus obtained was subtracted from each, and thus a result was found for each diameter, depending on the error of the diameter and the irregular position of the microscopes only. The latter is eliminated by taking the mean of each of the three last-mentioned columns, and subtracting each mean from all the numbers in its column: the columns of differences thus obtained depend solely upon the errors of diameters. Then observing that the same divisions, which with the pointer reading 0° are under A, B, are under C, D, with the pointer reading 60°, and are under E, F, with the pointer reading 120°, &c. it will be seen that the errors of each diameter occur six times. Taking the mean of these, the sum of errors of division in the diameter is obtained. This, it must be remarked, is not an absolute error of the diameter, but an error on the assumption, that the mean error of three diameters inclined to each other at angles of 60° is nothing: an assumption probably untrue, but untrue only from accidental causes, since the graduation of the circle was not made by first dividing it into six parts. The whole process here therefore can only be considered as giving a *presumption* as to the amount of errors. The error of each diameter thus found, being subtracted from each of its six apparent errors, gives the discordance in the reading of the diameter according to its position under the microscopes: a discordance which may be caused by irregular change of the circle's figure, or (which is far more probable) by uncertainty of reading: but which at all events will exhibit the probable uncertainty in every reading of a diameter. It must be observed that the reading of the division under microscope A is less by 5° than that shewn by the pointer.

READINGS OF TROUGHTON'S CIRCLE.

Nov. 30th, 1835.

Pointer.	A.	B.	C.	D.	E.	F.	A + B − ⅓ sum.	C + D − ⅓ sum.	E + F − ⅓ sum.	A + B − ⅓ sum − 1·6.	C + D − ⅓ sum + 2·0.	E + F − ⅓ sum − 0·4.
°	″	″	″	″	″	″	″	″	″	″	″	″
0	8·0	13·0	9.9	9·8	10·9	9·6	+0·6	−0·7	+0·1	−1·0	+1·3	−0·3
5	9·4	13·3	11·7	11·7	13·9	8·8	−0·2	+0·5	−0·2	−1·8	+2·5	−0·6
10	9·1	16·8	11·8	8.6	13·4	11·0	+2·3	−3·2	+3·8	+0·7	−1·2	+0·4
15	6·2	12·5	9·2	11·9	11·0	9·8	−1·5	+0·9	+0·6	−3·1	+2·9	+0·2
20	8·8	14·0	8·0	9·7	10·6	9·0	+2·8	−2·3	−0·4	+1·2	−0·3	−0·8
25	7·4	11·6	8·2	10·4	9·6	8·4	+0·5	+0·1	−0·5	−1·1	+2·1	−0·9
30	8·4	12·3	7·7	8·9	11·3	8·2	+1·8	−2·3	+0·6	+0·2	−0·3	+0·2
35	9·4	13·5	9·4	9·6	13·2	10·5	+1·0	−2·9	+1·8	−0·6	−0·9	+1·4
40	7·2	12·7	9·6	9·3	12·2	9·7	−0·3	−1·3	+1·7	−1·9	+0·7	+1·3
45	8·6	13·7	8·6	8·2	9·6	7·7	+3·5	−2·0	−1·5	+1·9	0·0	−1·9
50	7·4	9·8	6·9	8·4	10·2	8·2	+0·2	−1·7	+1·4	−1·4	+0·3	+1·0
55	8·8	11·7	7·3	6·7	12·3	8·6	+2·0	−4·5	+2·4	+0·4	−2·5	+2·0
60	6·0	9·0	5·5	5·9	8·0	6·0	+1·5	−2·1	+0·5	−0·1	−0·1	+0·1
65	5·0	10·2	4·0	4·7	9·4	6·4	+2·0	−4·5	+2·6	+0·4	−2·5	+2·2
70	7·8	12·0	7·8	8·7	11·6	8·6	+1·0	−2·3	+1·4	−0·6	−0·3	+1·0
75	4·8	6·8	1·4	3·4	7·4	6·4	+1·5	−5·3	+3·7	−0·1	−3·3	+3·3
80	6·3	8·4	4·8	5·9	8·6	4·4	+1·9	−2·1	+0·2	+0·3	−0·1	−0·2
85	8·4	11·6	7·8	8·7	10·5	9·5	+1·2	−2·3	+1·2	−0·4	−0·3	+0·8
90	8·3	13·0	7·7	8·6	11·3	11·2	+1·3	−3·7	+2·5	−0·3	−1·7	+2·1
95	7·4	8·4	4·7	4·0	5·7	5·4	+3·9	−3·2	−0·8	+2·3	−1·2	−1·2
100	9·4	11·0	5·0	7·5	9·7	8·8	+3·3	−4·6	+1·4	+1·7	−2·6	+1·0
105	9.2	12·2	7·5	10·6	9·1	9·0	+2·2	−1·1	−1·1	+0·6	+0·9	−1·5
110	10·6	12·4	8·8	9·6	11·2	10·4	+2·0	−2·6	+0·6	+0·4	−0·6	+0·2
115	7·6	11·7	6·7	7·2	6·3	5·6	+4·3	−1·1	−3·1	+2·7	+0·9	−3·5
120	7·3	10·2	7·4	5.8	8·4	8·0	+1·8	−2·5	+0·7	+0·2	−0·5	+0·3
125	5·0	9·4	2·8	5·0	4·1	5·3	+3·9	−2·7	−1·1	+2·3	−0·7	−1·5
130	6·6	11·0	6·4	7·3	8·0	6·3	+2·4	−1·5	−0·9	+0·8	+0·5	−1·3
135	8·8	11·7	8·4	8·0	9·0	7·2	+2·8	−1·3	−1·5	+1·2	+0·7	−1·9
140	5·5	8·0	4·4	3·2	5·5	5·0	+3·0	−2·9	0·0	+1·4	−0·9	−0·4
145	8·6	11·2	7·4	7·8	8·7	8·0	+2·6	−2·0	−1·5	+1·0	0·0	−0·9
150	6·6	8·0	1·6	4·4	6·0	4·4	+4·3	−4·3	+0·1	+2·7	−2·3	−0·3
155	9·4	12·4	9·7	9·0	10·9	9·3	+1·6	−1·5	0·0	0·0	+0·5	−0·4
160	6·8	10·7	7·0	6·2	7·0	6·3	+2·8	−1·5	−1·4	+1·2	+0·5	−1·8
165	6·3	8·5	5·6	5·0	6·2	5·6	+2·4	−1·8	−0·6	+0·8	+0·2	−1·0
170	8·6	11·0	9·5	6·2	9·4	6·2	+2·6	−1·3	−1·4	+1·0	+0·7	−1·8
175	8·4	12·1	13·2	10·5	14·5	10·6	−2·6	+0·6	+2·0	−4·2	+2·6	+1·6
180	7·4	10·6	9·4	6·7	12·8	5·4	+0·6	−1·3	+0·8	−1·0	+0·7	+0·4
185	4·2	7·2	7·4	5·8	9·3	5·0	−1·6	+0·2	+1·3	−3·2	+2·2	+0·9
190	6·8	12·4	9·3	7·1	10·6	5·5	+2·0	−0·8	−1·1	+0·4	+1·2	−1·5
195	7·6	12·4	11·4	8·5	14·1	5·6	+0·1	0·0	−0·2	−1·5	+2·0	−0·6
200	10·4	14·8	12·0	10·5	15·4	9·1	+1·1	−1·6	+0·4	−0·5	+0·4	0·0
205	9·2	14·9	12·6	9·8	14·7	8·6	+0·8	−0·9	0·0	−0·8	+1·1	−0·4
210	6·5	13·3	10·5	6·5	11·4	6·6	+1·5	−1·3	−0·3	−0·1	+0·7	−0·7
215	7·4	12·7	9·8	7·0	13·5	7·1	+0·9	−2·4	+1·4	−0·7	−0·4	+1·0
220	8·0	12·2	10·2	9·4	14·3	7·8	−0·4	−1·0	+1·5	−2·0	+1·0	+1·1
225	7·2	13·0	8·8	9·6	11·4	7·7	+1·0	−0·8	−0·1	−0·6	+1·2	−0·5
230	6·5	13·4	9·6	8·6	12·3	7·3	+0·7	−1·0	+0·4	−0·9	+1·0	0·0

READINGS OF TROUGHTON'S CIRCLE—*continued.*

Pointer.	A.	B.	C.	D.	E.	F.	A + B − ⅓ sum.	C + D − ⅓ sum.	E + F − ⅓ sum.	A + B − ⅓ sum − 1·6.	C + D − ⅓ sum + 2·0.	E + F − ⅓ sum − 0·4.
°	″	″	″	″	″	″	″	″	″	″	″	″
235	9·4	16·4	8·6	10·3	14·0	11·2	+2·5	−4·4	+1·9	+0·9	−2·4	+1·5
240	7·0	15·2	9·8	9·6	13·4	6·5	+1·7	−1·1	−0·6	+0·1	+0·9	−1·0
245	6·4	13·4	8·4	7·0	13·5	9·3	+0·5	−3·9	+3·5	−1·1	−1·9	+3·1
250	8·9	16·3	9·6	11·7	14·5	10·3	+1·4	−2·5	+1·0	−0·2	−0·5	+0·6
255	5·4	14·4	7·7	7·6	15·0	8·0	+0·4	−4·1	+3·6	−1·2	−2·1	+3·2
260	6·1	14·6	9·0	9·1	11·6	6·2	+1·8	−0·8	−1·1	+0·2	+1·2	−1·5
265	8·0	15.8	9·7	11·4	15·6	11·0	0·0	−2·7	+2·8	−1·6	−0·7	+2·4
270	6·3	11·7	6·5	7·3	12·4	5·3	+1·5	−2·7	+1·2	−0·1	−0·7	+0·8
275	6·0	12·7	5·8	6·3	9·6	6·2	+3·2	−3·4	+0·3	+1·6	−1·4	−0·1
280	8·6	15·2	7·8	7·7	11·7	9·3	+3·7	−4·6	+0·9	+2·1	−2·6	+0·5
285	9·2	13·7	7·6	10·6	10·2	8·8	+2·9	−1·8	−1·0	+1·3	+0·2	−1·4
290	5·6	13·0	7·5	7·6	9·8	8·4	+1·3	−2·2	+0·9	−0·3	−0·2	+0·5
295	4·8	10·6	5·5	7·5	4·0	3·6	+3·4	+1·0	−4·4	+1·8	+3·0	−4·8
300	6·4	13·1	5·4	11·1	9·2	7·1	+2·1	−0·9	−1·1	+0·5	+1·1	−1·5
305	7·2	11·4	10·4	7·5	11·6	9·2	−0·5	−1·2	+1·7	−2·1	+0·8	+1·3
310	8·7	13·8	7·6	10·6	10·2	8·3	+2·8	−1·5	−1·2	+1·2	+0·5	−1·6
315	5·2	11·1	2·0	6·7	7·0	6·0	+3·6	−4·0	+0·3	+2·0	−2·0	−0·1
320	8·8	14·0	5·6	11·7	12·1	10·3	+2·0	−3·5	+1·6	+0·4	−1·5	+1·2
325	7·3	13·6	4·2	9·6	8·6	8·1	+3·8	−3·3	−0·4	+2·2	−1·3	−0·8
330	7·5	15·6	8·2	10·6	11·0	11·1	+1·8	−2·5	+0·8	+0·2	−0·5	+0·4
335	5·0	10·5	4·4	6·6	6·7	6·4	+2·3	−2·2	−0·1	+0·7	−0·2	−0·5
340	7·8	12·6	7·4	9·0	9·6	6·5	+2·8	−1·2	−1·5	+1·2	+0·8	−1·9
345	5·6	8·6	4·7	7·2	6 7	5·4	+1·5	−0·8	−0·6	−0·1	+1·2	−1·0
350	5·6	10·2	4·8	6·0	7·3	5·2	+2·8	−2·2	−0·5	+1·2	−0·2	−0·9
355	5·7	10·0	8·2	8·5	9·3	7·4	−0·7	+0·3	+0·3	−2·3	+2·3	−0·1

APPARENT ERROR OF EACH DIAMETER OF TROUGHTON'S CIRCLE.

Diameters.	Sum of Errors of Division.	Diameters.	Sum of Errors of Division.	Diameters.	Sum of Errors of Division.
° °	″	° °	″	° °	″
355 — 175	− 0·4	55 — 235	+ 0·1	115 — 295	+ 0·3
0 — 180	− 1·6	60 — 240	− 0·1	120 — 300	+ 1·7
5 — 185	− 0·4	65 — 245	− 0·2	125 — 305	+ 0·6
10 — 190	− 2·0	70 — 250	− 0·5	130 — 310	+ 2·4
15 — 195	+ 0·4	75 — 255	− 0·5	135 — 315	0·0
20 — 200	− 0·8	80 — 260	− 0·8	140 — 320	+ 1·6
25 — 205	− 0·4	85 — 265	− 0·6	145 — 325	+ 1·0
30 — 210	− 0·8	90 — 270	+ 1·1	150 — 330	− 0·3
35 — 215	− 2·1	95 — 275	+ 1·3	155 — 335	+ 0·9
40 — 220	+ 0·1	100 — 280	+ 0·2	160 — 340	− 0·3
45 — 225	− 1·0	105 — 285	+ 0·3	165 — 345	+ 0·7
50 — 230	+ 1·1	110 — 290	+ 2·2	170 — 350	− 3·3

VARIATION IN THE APPARENT ERRORS OF EACH DIAMETER OF TROUGHTON'S CIRCLE,

According to its Position under the Microscopes.

Diameter.	Position of the Diameter.					
	Under A B.	Under C D.	Under E F.	Under B A.	Under D C.	Under F E.
° °	″	″	″	″	″	″
355 — 175	− 0·6	+ 0·3	+ 0·7	− 0·6	+ 1·3	− 1·1
0 — 180	− 0·2	− 0·9	+ 0·1	− 1·6	− 0·3	+ 2·9
5 — 185	+ 1·1	+ 0·1	− 0·9	+ 0·8	− 0·1	− 1·2
10 — 190	− 1·1	− 1·3	+ 0·1	+ 0·5	− 0·1	+ 1·9
15 — 195	+ 0·8	− 0·5	− 0·8	− 0·9	+ 0·8	+ 0·8
20 — 200	− 0·3	+ 0·5	− 0·1	0·0	+ 0·1	0·0
25 — 205	+ 0·6	− 1·3	+ 0·1	+ 0·3	− 0·3	+ 0·8
30 — 210	+ 0·2	− 0·4	+ 0·4	+ 0·1	− 0·6	+ 0·3
35 — 215	+ 0·2	− 0·5	+ 0·3	+ 0·1	− 0·5	+ 0·2
40 — 220	+ 1·8	+ 0·8	− 1·1	− 0·7	+ 0·1	− 1·1
45 — 225	− 0·4	+ 0·4	− 0·8	+ 0·1	+ 0·8	+ 0·1
50 — 230	− 0·7	− 0·2	+ 0·5	− 0·2	+ 1·9	− 1·2
55 — 235	− 0·2	− 0·6	+ 0·3	0·0	+ 1·0	− 0·4
60 — 240	+ 0·5	− 0·6	+ 1·0	− 1·0	+ 0·9	− 0·5
65 — 245	− 0·4	+ 0·7	− 1·3	0·0	+ 0·7	+ 0·6
70 — 250	+ 0·4	+ 1·2	− 0·1	− 0·7	− 1·5	+ 0·7
75 — 255	+ 0·8	− 0·4	+ 0·5	+ 0·7	− 1·0	− 0·3
80 — 260	+ 0·4	+ 0·8	+ 0·4	− 0·8	− 0·5	− 0·1
85 — 265	+ 0·3	− 1·7	− 0·1	+ 0·5	+ 0·1	+ 0·8
90 — 270	+ 1·2	− 0·6	− 0·1	+ 0·5	− 1·3	+ 0·3
95 — 275	+ 0·4	− 0·8	− 0·2	+ 0·8	− 0·5	0·0
100 — 280	+ 0·4	0·0	− 0·7	+ 1·1	+ 1·0	− 2·1
105 — 285	+ 0·1	+ 0·4	− 0·3	− 0·6	− 0·5	+ 0·7
110 — 290	+ 0·5	+ 0·4	− 0·7	− 0·4	+ 0·1	− 0·2
115 — 295	− 0·1	+ 0·4	− 1·3	+ 0·2	+ 1·0	− 0·2
120 — 300	+ 0·6	+ 0·5	+ 1·4	− 3·8	+ 0·8	+ 0·5
125 — 305	+ 0·2	+ 0·6	0·0	+ 0·6	− 1·8	+ 0·4
130 — 310	− 1·2	− 0·4	+ 0·8	− 0·4	+ 0·5	+ 0·9
135 — 315	+ 1·4	+ 0·4	− 1·5	+ 0·4	− 0·3	− 0·2
140 — 320	− 0·6	− 0·5	+ 0·8	+ 0·6	+ 0·5	− 0·8
145 — 325	+ 1·7	− 0·3	− 0·2	− 0·8	− 1·3	+ 1·1
150 — 330	+ 0·3	− 0·1	+ 0·2	+ 1·0	− 0·6	− 0·9
155 — 335	+ 0·3	+ 0·1	− 0·4	+ 0·3	− 0·2	+ 0·1
160 — 340	+ 1·1	+ 1·5	− 1·1	+ 0·2	+ 0·3	− 1·2
165 — 345	+ 0·3	+ 0·3	− 0·2	+ 0·5	− 0·4	− 0·5
170 — 350	− 0·9	+ 0·9	− 1·5	+ 1·0	+ 0·8	− 0·2

READINGS OF JONES'S CIRCLE.

Nov. 30th, 1835.

Pointer.	A.	B.	C.	D.	E.	F.	A + B − ⅓ sum.	C + D − ⅓ sum.	E + F − ⅓ sum.	A + B − ⅓ sum + 0·4.	C + D − ⅓ sum − 0·5.	E + F − ⅓ sum + 0·1.
°	″	″	″	″	″	″	″	″	″	″	″	″
0	11·4	9·4	7·3	9·4	6·8	9·8	+2·8	−1·3	−1·4	+3·2	−1·8	−1·3
5	10·6	8·6	6·4	12·6	7·0	12·4	0·0	−0·2	+0·2	+0·4	−0·7	+0·3
10	11·5	10·0	6·0	14·4	9·6	11·6	+0·5	−0·6	+0·2	+0·9	−1·1	+0·3
15	10·6	10·6	7·6	12·7	8·8	10·4	+1·0	+0·1	−1·0	+1·4	−0·4	−0·9
20	10·6	9·4	5·8	13·5	8·2	8·9	+1·2	+0·5	−1·7	+1·6	0·0	−1·6
25	12·0	12·7	7·8	14·5	10·5	12·4	+1·4	−1·0	−0·4	+1·8	−1·5	−0·3
30	8·1	9·6	5·7	12·0	8·9	9·4	−0·2	−0·2	+0·4	+0·2	−0·7	+0·5
35	8·6	9·5	5·8	12·4	10·0	9·2	−0·4	−0·3	+0·7	0·0	−0·8	+0·8
40	12·0	13·6	9·8	17·3	14·7	11·5	−0·7	+0·8	−0·1	−0·3	+0·3	0·0
45	12·0	12·3	8·3	15·6	11·6	12·4	+0·2	−0·2	−0·1	+0·6	−0·7	0·0
50	9·4	9·0	5·4	13·1	6·7	8·6	+1·0	+1·1	−2·1	+1·4	+0·6	−2·0
55	10·0	8·4	5·1	12·2	8·3	9·3	+0·6	−0·5	−0·2	+1·0	−1·0	−0·1
60	12·4	12·3	10·7	16·8	12·4	10·5	−0·3	+2·5	−2·1	+0·1	+2·0	−2·0
65	10·4	9·0	6·1	13·5	8·2	10·6	+0·1	+0·3	−0·5	+0·5	−0·2	−0·4
70	8·8	9·6	5·8	13·2	7·2	10·0	+0·2	+0·8	−1·0	+0·6	+0·3	−0·9
75	10·6	11·7	8·7	17·2	11·6	11·4	−1·4	+2·2	−0·7	−1·0	+1·7	−0·6
80	10·2	12·0	9·2	15·5	10·5	12·4	−1·1	+1·4	−0·4	−0·7	+0·9	−0·3
85	10·6	12·2	9·0	14·9	11·6	10·2	0·0	+1·1	−1·0	+0·4	+0·6	−0·9
90	7·4	10·5	5·2	12·5	8·6	7·8	+0·6	+0·4	−0·9	+1·0	−0·1	−0·8
95	7·7	11·6	6·2	13·3	9·0	8·6	+0·5	+0·7	−1·2	+0·9	+0·2	−1·1
100	12·0	17·7	12·1	19·4	15·8	14·6	−0·8	+1·0	−0·1	−0·4	+0·5	0·0
105	12·6	15·6	11·3	18·6	15·2	12·7	−0·5	+1·2	−0·8	−0·1	+0·7	−0·7
110	11·0	17·0	11·6	20·2	14·8	15·3	−2·0	+1·8	+0·1	−1·6	+1·3	+0·2
115	9·2	17·6	9·4	19·2	13·9	13·9	−0·9	+0·9	+0·1	−0·5	+0·4	+0·2
120	11·1	18·2	11·4	19·7	16·2	16·6	−1·8	0·0	+1·7	−1·4	−0·5	+1·8
125	9·5	14·3	7·2	18·2	12·0	13·4	−1·1	+0·5	+0·5	−0·7	0·0	+0·6
130	9·0	12·6	4·5	18 0	10·0	12·6	−0·6	+0·3	+0·4	−0·2	−0·2	+0·5
135	10·0	14·6	6·2	19·0	11·8	14·8	−0·9	−0·3	+1·1	−0·5	−0·8	+1·2
140	10·0	12·6	4·7	17·5	10·7	12·6	−0·1	−0·5	+0·6	+0·3	−1·0	+0·7
145	12·2	15·5	8·8	19·5	13·0	16·4	−0·8	−0·2	+0·9	−0·4	−0·7	+1·0
150	9·7	13·2	7·0	19·0	10·0	14·5	−1·6	+1·5	0·0	−1·2	+1·0	+0·1
155	9·5	12·5	6·6	18·6	10·2	15·0	−2·1	+1·1	+1·1	−1·7	+0·6	+1·2
160	12·5	13·8	6·5	19·8	10·8	14·9	+0·2	+0·2	−0·4	+0·6	−0·3	−0·3
165	11·7	13·4	8·3	18·2	11·7	15·4	−1·1	+0·3	+0·9	−0. 7	−0·2	+1·0
170	11·8	13·9	6·6	17·3	11·5	15·1	+0·3	−1·5	+1·2	+0·7	−2·0	+1·3
175	8·8	11·2	4·6	16·6	9·1	12·6	−1·0	+0·2	+0·7	−0·6	−0·3	+0·8
180	11·2	11·0	3·0	15·4	7·6	11·6	+2·3	−1·5	−0·7	+2·7	−2·0	−0·6
185	7·4	9·0	2·2	14·0	5·6	10·3	+0·2	0·0	−0·3	+0·6	−0·5	−0·2
190	9·8	10·0	4·0	14·2	5·4	12·6	+1·1	−0·5	−0·7	+1·5	−1·0	−0·6
195	9·6	8·8	1·8	14·7	3·6	11·4	+1·8	−0·1	−1·6	+2·2	−0·6	−1·5
200	11·4	11·8	4·8	16·6	5·6	14·1	+1·8	0·0	−1·7	+2·2	−0·5	−1·6
205	10·6	9·4	4·4	15·0	6·7	12·6	+0·4	−0·2	−0·3	+0·8	−0·7	−0·2
210	9·4	9·1	3·2	15·2	5. 7	14·0	−0·4	−0·5	+0·8	0·0	−1·0	+0·9
215	12·3	12·4	6·4	17·2	8·0	17·1	+0·2	−0·9	+0·7	+0·6	−1·4	+0·8
220	11·0	10·3	6·3	16·4	5·8	16·1	−0·7	+0·7	−0·1	−0·3	+0·2	0·0
225	9·4	9·0	4·1	14·6	6·1	11·4	+0·2	+0·5	−0·7	+0·6	0·0	−0·6
230	7·4	7·3	0·4	12·2	1·4	8·5	+2·3	+0·2	−2·5	+2·7	−0·3	−2·4

READINGS OF JONES'S CIRCLE—*continued.*

Pointer.	A.	B.	C.	D.	E.	F.	A + B − ⅓ sum.	C + D − ⅓ sum.	E + F − ⅓ sum.	A + B − ⅓ sum + 0·4.	C + D − ⅓ sum − 0·5.	E + F − ⅓ sum + 0·1.
°	"	"	"	"	"	"	"	"	"	"	"	"
235	14·0	14·0	8·1	20·4	8·6	18·4	+0·2	+0·7	−0·8	+0·6	+0·2	−0·7
240	10·8	6·2	5·4	16·0	3·5	14·4	−1·8	+2·6	−0·9	−1·4	+2·1	−0·8
245	11·4	9·0	5·0	18·0	4·2	15·5	−0·6	+2·0	−1·3	−0·2	+1·5	−1·2
250	10·5	5·6	2·7	14·4	2·2	11·7	+0·4	+1·4	−1·8	+0·8	+0·9	−1·7
255	11·0	5·5	4·8	16·2	2·6	14·7	−1·8	+2·7	−1·0	−1·4	+2·2	−0·9
260	9·7	3·2	2·2	14·1	2·2	12·0	−1·6	+1·8	−0·3	−1·2	+1·3	−0·2
265	9·0	5·0	2·5	13·5	1·5	11·6	−0·4	+1·6	−1·3	+0·0	+1·1	−1·2
270	9·5	5·2	1·8	14·0	1·5	11·6	+0·2	+1·3	−1·4	+0·6	+0·8	−1·3
275	10·0	5·6	3·0	14·5	2·9	11·8	−0·3	+1·6	−1·2	+0·1	+1·1	−1·1
280	10·2	4·8	4·0	13·3	4·5	11·0	−0·9	+1·4	−0·4	−0·5	+0·9	−0·3
285	10·3	8·8	6·2	15·5	6·5	13·1	−1·0	+1·6	−0·5	−0·6	+1·1	−0·4
290	12·7	10·5	9·3	19·7	9·3	17·1	−3·0	+2·8	+0·2	−2·6	+2·3	+0·3
295	10·7	7·8	5·4	16·4	6·4	14·4	−1·9	+1·4	+0·4	−1·5	+0·9	+0·5
300	10·0	5·5	4·4	12·6	6·9	12·6	−1·8	−0·3	+2·2	−1·4	−0·8	+2·3
305	11·2	9·6	5·8	16·7	8·2	13·7	−0·9	+0·8	+0·2	−0·5	+0·3	+0·3
310	9·5	9·8	6·4	14·6	8·5	12·5	−1·1	+0·6	+0·6	−0·7	+0·1	+0·7
315	11·4	8·0	4·6	13·6	7·3	13·5	−0·1	−1·3	+1·3	+0·3	−1·8	+1·4
320	11·2	9·8	6·2	14·2	8·0	14·7	−0·4	−1·0	+1·3	0·0	−1·5	+1·4
325	10·7	8·1	6·7	15·4	8·2	13·5	−2·1	+1·2	+0·8	−1·7	+0·7	+0·9
330	9·6	7·3	7·4	14·0	6·7	13·5	−2·6	+1·9	+0·7	−2·2	+1·4	+0·8
335	7·7	5·2	4·8	12·4	5·4	11·8	−2·9	+1·4	+1·4	−2·5	+0·9	+1·5
340	8·6	7·2	5·4	11·8	5·0	12·0	−0·9	+0·5	+0·3	−0·5	0·0	+0·4
345	7·4	7·1	3·6	14·0	5·4	12·3	−2·1	+1·0	+1·1	−1·7	+0·5	+1·2
350	11·7	10·3	6·0	14·4	8·5	16·7	−0·5	−2·1	+2·7	−0·1	−2·6	+2·8
355	11·2	9·6	7·6	14·6	7·7	14·6	−1·0	+0·4	+0·5	−0·6	−0·1	+0·6

APPARENT ERROR OF EACH DIAMETER OF JONES'S CIRCLE.

Diameter.	Sum of Errors of Divisions.	Diameter.	Sum of Errors of Divisions.	Diameter.	Sum of Errors of Divisions.
° °	"	° °	"	° °	"
355 — 175	+ 2·4	55 — 235	− 0·8	115 — 295	− 1·6
0 — 180	+ 0·5	60 — 240	+ 0·1	120 — 300	− 0·7
5 — 185	+ 0·8	65 — 245	+ 0·2	125 — 305	− 0 9
10 — 190	+ 1·7	70 — 250	− 1·2	130 — 310	− 0·5
15 — 195	+ 1·4	75 — 255	− 1·3	135 — 315	− 0·1
20 — 200	+ 1·0	80 — 260	0·0	140 — 320	− 1·1
25 — 205	+ 0·3	85 — 265	+ 0·9	145 — 325	− 1·2
30 — 210	+ 0·8	90 — 270	+ 0·7	150 — 330	− 1·4
35 — 215	+ 0·2	95 — 275	− 0·2	155 — 335	+ 0·1
40 — 220	+ 0·9	100 — 280	− 0·2	160 — 340	− 0·7
45 — 225	+ 2·0	105 — 285	− 2·2	165 — 345	+ 0·2
50 — 230	+ 0·7	110 — 290	− 0·5	170 — 350	− 0·2

VARIATION IN THE APPARENT ERRORS OF EACH DIAMETER OF JONES'S CIRCLE,

According to its Position under the Microscopes.

Diameter.	Position of the Diameter. Under A B.	Under C D.	Under E F.	Under B A.	Under D C.	Under F E.
355° — 175°	+ 0″·8	− 0″·4	− 0″·6	+ 0″·3	− 0″·3	− 0″·1
0 — 180	− 0·1	− 0·7	+ 0·1	+ 0·1	+ 1·0	− 0·2
5 — 185	+ 0·1	− 0·5	− 0·3	+ 0·7	+ 0·1	− 0·1
10 — 190	− 0·3	0·0	− 0·5	+ 0·5	+ 0·5	− 0·3
15 — 195	+ 0·2	− 0·5	− 0·7	+ 0·8	− 0·1	0·0
20 — 200	+ 0·8	− 0·4	0·0	− 0·2	+ 0·1	+ 0·1
25 — 205	− 0·1	− 0·4	− 0·2	− 0·3	+ 0·5	+ 0·5
30 — 210	− 0·8	− 0·6	+ 0·4	− 0·2	+ 0·3	+ 0·7
35 — 215	− 0·5	+ 0·3	− 0·5	− 0·5	+ 0·7	+ 0·2
40 — 220	− 0·3	− 0·2	+ 0·1	− 0·3	+ 0·2	+ 0·3
45 — 225	− 0·6	− 0·7	− 0·7	+ 0·7	+ 0·3	+ 0·8
50 — 230	+ 0·3	− 0·3	+ 0·1	− 0·1	+ 0·2	− 0·1
55 — 235	+ 0·9	+ 0·3	+ 0·2	− 0·6	0·0	− 0·5
60 — 240	+ 0·4	− 0·1	− 0·3	− 0·3	+ 0·2	+ 0·2
65 — 245	+ 0·4	− 0·4	− 0·8	+ 0·6	− 0·1	+ 0·1
70 — 250	+ 0·2	+ 0·4	− 0·3	− 0·2	− 0·6	+ 0·3
75 — 255	+ 0·6	+ 0·3	− 0·3	+ 0·1	− 0·2	− 0·3
80 — 260	+ 0·4	− 0·7	− 0·2	0·0	+ 0·7	− 0·3
85 — 265	+ 0·1	+ 0·1	0·0	− 0·3	+ 0·5	− 0·4
90 — 270	+ 0·2	− 0·1	+ 0·1	− 0·6	+ 0·2	+ 0·1
95 — 275	− 0·2	− 0·1	+ 0·2	− 0·3	+ 0·2	+ 0·2
100 — 280	+ 0·1	0·0	− 0·4	− 0·4	+ 0·7	+ 0·2
105 — 285	+ 0·6	+ 0·2	− 0·2	− 0·4	− 0·4	− 0·2
110 — 290	0·0	+ 0·2	− 0·2	− 1·0	+ 0·4	+ 0·4
115 — 295	+ 0·2	− 0·4	+ 0·8	+ 0·2	− 0·2	− 0·4
120 — 300	0·0	+ 0·2	− 0·5	+ 0·2	0·0	+ 0·3
125 — 305	+ 0·7	− 0·1	− 0·8	+ 0·2	− 0·2	0·0
130 — 310	0·0	− 0·1	− 0·4	+ 0·8	+ 0·1	− 0·1
135 — 315	+ 0·4	− 0·4	− 0·1	+ 0·1	+ 0·1	− 0·2
140 — 320	+ 0·7	+ 0·4	− 0·1	− 0·6	− 0·4	+ 0·2
145 — 325	0·0	+ 0·2	− 0·1	− 1·0	+ 0·5	+ 0·4
150 — 330	− 0·3	0·0	+ 0·3	− 1·1	+ 0·6	+ 0·3
155 — 335	+ 0·5	+ 0·1	− 0·4	− 0·6	+ 0·2	− 0·1
160 — 340	0·0	+ 0·7	+ 0·3	− 1·0	0·0	0·0
165 — 345	+ 0·5	− 0·5	+ 0·1	− 0·3	+ 0·4	0·0
170 — 350	− 0·4	+ 0·4	+ 0·7	− 0·4	− 0·8	+ 0·4

It appears probable from these numbers, that there is no irregular change of figure of the circles during a revolution; and that the probable error of division is so nearly of the same order with the errors of the most careful readings as to make any further investigation unnecessary.

The position of each circle, as to the approximate coincidence of the circle described by its telescope with the astronomical meridian, has been verified by transits of different stars, as noted by the clock which is near the circles. This clock is immediately compared with the transit clock, and the sidereal time of transit is therefore easily found, and admits of comparison with the right ascension, or the correct time of transit over the astronomical meridian. The following tables contain the principal steps; the parts omitted having been carefully verified.

TRANSITS FOR THE POSITION OF TROUGHTON'S CIRCLE.

Day, 1836.		Object.	Transit by Graham 2.	Time by Hardy.	Sidereal Time.	Sec. of A.R.	Error.
			h m s	h m s	h m s	s	s
March ...	7	δ Canis Majoris ...	7. 2. 11·38	7. 1. 12·46	7. 1. 43·30	43·94	− 0·64
	,,	Pollux	7. 35. 48·80	7. 34. 45·00	7. 35. 15·86	16·98	− 1·12
	,,	Regulus	10. 0. 22·70	9. 59. 7·73	9. 59. 38·74	39·09	− 0·35
April	11	Spica	13. 16. 11·06	13. 16. 6·46	13. 16. 33·21	34·95	− 1·74
	,,	η Bootis..........	13. 46. 30·30	13. 46. 25·70	13. 46. 52·49	54·16	− 1·67
May	6	Polaris S. P......	12. 59. 46·00	12. 59. 21·65	13. 0. 29·61	12·90	+ 16·71
	,,	Spica............	13. 15. 49·76	13. 15. 25·41	13. 16. 33·39	35·03	− 1·64
	,,	Arcturus.........	14. 7. 27·35	14. 7. 3·00	14. 8. 11·04	12·61	− 1·57
	12	Polaris S.P......	13. 0. 0·00	13. 0. 13·50	13. 0. 31·29	15·85	+ 15·44
June	8	Polaris S. P......	13. 0. 55·00	12. 59. 53·00	13. 0. 56·51	33·17	+ 23·34
	,,	ζ Ursæ Majoris ...	13. 17. 17·30	13. 16. 15·30	13. 17. 18·81	19·11	− 0·30
	9	δ Ophiuchi	16. 5. 43·20	16. 4. 40·00	16. 5. 45·03	47·31	− 2·28
	11	Arcturus.........	14. 8. 5·24	14. 8. 2·94	14. 8. 11·19	12·57	− 1·38
July	1	Antares	16. 18. 33·86	16. 18. 38·66	16. 19. 22·21	23·95	− 1·74
	18	α Aquarii.........	21. 56. 34·80	21. 57. 9·70	21. 57. 21·83	23·69	− 1·86
August ..	3	α Aquarii	21. 56. 23·98	21. 56. 46·72	21. 57. 21·72	23·97	− 2·25
	7	Sirius	6. 36. 46·68	6. 37. 11·38	6. 37. 53·80	55·05	− 1·25
October..	10	Polaris S. P......	13. 1. 32·25	13. 2. 17·00	13. 2. 30·41	43·06	+ 47·35
	28	α Aquarii	21. 55. 58·75	21. 56. 43·05	21. 57. 22·01	23·86	− 1·83
	,,	Fomalhaut	22. 47. 12·23	22. 47. 56·13	22. 48. 35·13	37·45	− 2·32
November	5	Fomalhaut	22. 46. 50·40	22. 47. 51·40	22. 48. 35·69	37·34	− 1·65
	,,	α Andromedæ	23. 58. 10·20	23. 59. 11·20	23. 59. 55·52	58·06	− 2·54
	,,	γ Pegasi	0. 3. 4·95	0. 4. 5·95	0. 4. 50·27	50·69	− 0·42
December	8	35 Arietis........	2. 34. 24·05	2. 33. 4·05	2. 33. 51·75	53·56	− 1·81
	,,	39 Arietis........	2. 38. 43·03	2. 37. 23·03	2. 38. 10·73	12·92	− 2·19
	,,	τ Eridani	2. 44. 9·20	2. 42. 49·20	2. 43. 36·91	39·14	− 2·23

TRANSITS FOR THE POSITION OF JONES'S CIRCLE.

Day, 1836.	Object.	Transit by Graham 2.	Time by Hardy.	Sidereal Time.	Sec. of A. R.	Error.
		h m s	h m s	h m s	s	s
March ... 7	δ Canis Majoris ...	7. 2. 11·60	7. 1. 12·68	7. 1. 43·52	43·94	− 0·42
May 9	β Leonis	11. 40. 2·87	11. 40. 28·97	11. 40. 42·11	42·50	− 0·39
,,	Polaris S. P.	12. 59. 31·67	12. 59. 57·67	13. 0. 10·90	14·32	− 3·42
,,	Spica	13. 15. 54·80	13. 16. 20·70	13. 16. 33·94	35·04	− 1·10
12	Polaris S. P.	12. 59. 33·00	12. 59. 46·50	13. 0. 4·29	15·89	− 11·56
30	Polaris S. P.	13. 0. 22·00	12. 59. 36·50	13. 0. 27·19	26·80	+ 0·39
June 8	Polaris S. P.	13. 0. 29·00	12. 59. 27·00	13. 0. 30·51	33·17	− 2·66
,,	ζ Ursæ Majoris ...	13. 17. 18·50	13. 16. 16·50	13. 17. 20·01	19·11	+ 0·90
11	Arcturus	14. 8. 5·23	14. 8. 2·93	14. 8. 11·18	12·57	− 1·39
July 1	Antares	16. 18. 35·17	16. 18. 39·97	16. 19. 23·52	23·95	− 0·43
20	α Aquarii	21. 56. 30·53	21. 57. 8·73	21. 57. 23·78	23·73	+ 0·05
August... 7	Sirius	6. 36. 48·13	6. 37. 12·83	6. 37. 53·19	55·05	− 1·86
October.. 11	Polaris S. P.	13. 0. 50·00	13. 1. 34·75	13. 1. 48·16	43·06	+ 5·10
November 5	Fomalhaut	22. 46. 52·20	22. 47. 53·20	22. 48. 37·59	37·34	+ 0·25
,,	γ Pegasi	0. 3. 4·60	0. 4. 5·60	0. 4. 50·03	50·69	− 0·66

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.) 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 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 stands, having brackets at different elevations, for sustaining the troughs; the stands being placed upon stone piers at the distance of thirty inches nearly from the circle-piers.

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 latter part of the fourth quarter of Observations 1835: 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.

In order to determine the mean reading of the microscopes, the mean of the seconds in these six columns 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. Such is the difficulty of the mechanical adjustment, that after every care had been used by a skilful person, it has been found, that the sum of the errors of the six microscopes in passing over 5′ each has exceeded 12″.

As a historical record, I think it proper to state here that, as far as I can learn, the adjustments of the microscopes were not altered during Mr. Pond's direction of the Observatory, except when the circles were taken down or the microscopes taken off. I think it probable, therefore, that the results in some cases may be sensibly affected by a periodic error such as I have mentioned.

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, at the bottom of each page, 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. 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 note "the micrometers placed on the next divisions." A different amount of correction is then necessary.

The following tables contain the amount of the error in each microscope for a reading of 5′, as ascertained in each of these positions of the circles, in the different weeks of 1836.

ERROR OF EACH MICROSCOPE OF TROUGHTON'S CIRCLE, FOR A READING OF 5′.

Day.	Pointer Reading.	MICROSCOPES A	B	C	D	E	F	Sum.
	°	″	″	″	″	″	″	″
January .. 8	..	− 2·1	− 0·5	+ 0·6	+ 0·8	− 1·8	+ 0·6	− 2·4
9	..	+ 0·2	+ 0·5	− 0·8	− 1·2	− 2·7	+ 0·7	− 3·3
18	..	− 1·2	+ 1·5	− 0·5	0·0	+ 0·2	− 0·4	− 0·4
20	..	− 2·3	+ 0·1	+ 0·1	+ 0·6	− 0·8	+ 0·9	− 1·4
25	0	− 0·8	− 1·3	− 0·1	+ 0·5	+ 1·5	− 1·0	− 1·2
,,	45	− 1·2	− 0·7	− 2·0	− 0·5	− 0·1	+ 0·3	− 4·2
,,	90	− 1·2	− 0·4	− 1·2	+ 0·1	− 1·6	− 0·2	− 4·5
February.. 1	310	− 0·5	− 0·3	− 2·1	− 1·1	− 0·2	− 0·1	− 4·3
,,	220	− 1·8	− 0·6	− 1·0	− 1·0	− 1·4	− 0·4	− 6·2
,,	30	− 0·9	− 0·2	− 2·0	− 1·4	− 1·7	− 0·1	− 6·3
8	230	− 0·4	− 0·4	− 1·5	+ 0·6	− 1·2	+ 0·6	− 2·3
,,	308	− 1·2	− 0·4	− 1·3	− 0·3	− 0·8	− 0·7	− 4·7
,,	25	− 2·4	− 1·5	− 1·6	− 0·5	− 1·3	− 0·4	− 7·7
15	230	− 1·3	− 0·9	− 1·0	− 1·8	− 0·9	− 2·6	− 8·5
,,	308	− 1·8	− 1·9	− 1·1	− 0·5	− 0·8	− 1·3	− 7·4
,,	25	− 1·9	− 2·1	− 1·4	− 0·2	− 0·4	− 0·9	− 6·9
22	10	− 1·8	− 1·7	− 1·5	− 0·3	+ 3·1	− 1·4	− 3·6
,,	310	− 0·5	− 0·6	+ 0·6	+ 0·3	− 1·9	− 1·9	− 4·0
,,	230	+ 0·2	0·0	− 2·3	− 0·1	− 1·1	− 1·0	− 4·3
March ... 1	231	− 1·5	+ 1·2	− 3·2	+ 1·5	+ 2·0	− 1·6	− 1·6
,,	306	+ 1·9	+ 0·1	− 2·7	+ 1·1	− 0·2	− 1·5	− 1·3
,,	22	− 0·6	+ 0·6	+ 1·1	+ 1·1	0·0	− 0·4	+ 1·8

TROUGHTON'S CIRCLE—*continued.*

Day.		Pointer Reading.	MICROSCOPES A	B	C	D	E	F	Sum.
		°	″	″	″	″	″	″	″
March ...	2	220	+ 0·8	− 0·4	− 0·8	− 1·6	− 2·8	− 1·7	− 6·5
	,,	310	+ 2·9	− 0·2	− 1·5	− 0·2	− 0·4	− 0·4	+ 0·2
	,,	30	+ 2·9	+ 0·2	− 2·7	+ 0·3	+ 0·4	− 1·6	− 0·5
	7	235	+ 0·4	− 0·6	− 0·5	− 0·2	− 0·9	0·0	− 1·8
	,,	310	+ 1·1	+ 0·8	− 2·4	+ 0·4	+ 0·4	− 0·9	− 0·6
	,,	20	+ 0·9	− 1·1	− 2·1	+ 1·0	− 1·2	− 0·3	− 2·8
	14	230	+ 2·9	− 1·2	− 0·2	+ 0·7	+ 1·0	− 1·1	+ 2·1
	,,	312	+ 1·1	− 0·6	+ 0·7	+ 1·7	− 0·2	− 0·2	+ 2·5
	,,	28	+ 0·6	− 1·4	− 0·5	+ 1·2	− 2·4	+ 0·7	− 1·8
	21	234	+ 1·0	− 0·6	− 2·1	+ 0·2	+ 0·7	+ 1·6	+ 0·8
	,,	307	+ 1·5	− 1·2	− 2·7	+ 0·6	+ 1·0	+ 0·7	− 0·1
	,,	..	+ 1·9	− 1·0	− 0·9	+ 1·2	+ 1·4	+ 0·4	+ 3·0
	28	230	+ 1·5	− 1·1	− 1·2	− 0·9	− 0·2	− 1·4	− 3·3
	,,	310	+ 2·3	− 0·2	− 0·9	+ 1·7	+ 0·5	− 0·2	+ 3·2
	,,	20	+ 0·3	0·0	− 1·1	+ 0·7	+ 0·2	0·0	+ 0·1
April	4	230	+ 3·0	− 1·4	− 0·4	− 1·6	+ 0·5	− 1·3	− 1·2
	,,	310	+ 2·3	− 1·1	+ 0·2	− 0·3	+ 1·3	− 1·9	+ 0·5
	,,	30	+ 1·2	− 0·5	− 0·4	− 1·1	− 0·1	− 0·7	− 1·6
	11	225	+ 1·3	− 1·2	− 1·5	− 1·9	− 1·1	− 0·3	− 4·7
	,,	310	+ 1·3	+ 0·4	− 3·1	+ 0·1	− 0·7	− 0·1	− 2·1
	,,	30	+ 0·4	− 0·5	− 0·6	− 0·7	− 1·6	− 1·7	− 4·7
	18	220	+ 1·4	+ 0·1	− 0·8	− 1·9	− 2·1	− 0·8	− 4·1
	,,	305	+ 1·5	− 0·2	+ 0·4	− 0·5	− 1·2	− 0·6	− 0·6
	,,	40	+ 2·1	− 1·2	− 0·7	+ 0·4	− 0·5	− 0·4	− 0·3
	25	20	+ 2·5	+ 0·5	+ 0·1	+ 1·2	+ 2·3	− 1·0	+ 5·6
	,,	200	+ 2·6	− 0·5	− 0·3	+ 0·8	+ 0·5	− 1·2	+ 1·9
	,,	110	+ 1·5	+ 0·3	+ 0·6	− 0·9	+ 3·7	+ 0·4	+ 5·6
May	2	180	+ 0·6	− 1·9	− 2·8	+ 1·4	− 1·9	− 0·2	− 4·8
	,,	320	− 0·5	− 0·4	0·0	− 0·2	− 2·0	− 1·3	− 4·4
	,,	80	+ 1·5	− 2·0	− 0·2	0·0	− 1·2	+ 0·6	− 1·3
	9	180	+ 2·5	− 2·3	− 2·3	+ 0·1	− 1·7	− 1·1	− 4·8
	,,	300	+ 2·1	− 3·1	− 1·1	− 1·6	− 0·2	− 1·5	− 5·4
	,,	60	+ 0·6	− 1·1	− 1·9	− 1·2	− 0·9	− 1·2	− 5·7

TROUGHTON'S CIRCLE—*continued.*

Day.	Pointer Reading.	MICROSCOPES A	B	C	D	E	F	Sum.
	°	"	"	"	"	"	"	"
May 16	180	+ 2·1	+ 0·1	− 1·3	+ 1·6	+ 0·9	− 0·9	+ 2·5
,,	300	+ 0·7	− 0·4	− 1·0	+ 1·3	+ 0·3	− 0·2	+ 0·7
,,	60	+ 2·2	0·0	+ 0·7	+ 0·5	+ 1·7	+ 0·1	+ 5·2
23	21	+ 2·0	− 0·3	+ 0·1	− 0·1	− 0·8	− 0·5	+ 0·4
,,	306	− 1·3	− 0·4	+ 0·2	− 0·1	+ 1·9	− 1·1	− 0·8
,,	230	+ 1·8	+ 0·2	− 0·8	− 0·2	+ 1·0	− 0·4	+ 1·6
30	160	+ 2·7	− 1·5	− 1·9	− 0·2	− 1·6	− 1·1	− 3·6
,,	280	+ 1·5	− 1·5	− 1·6	− 0·2	+ 0·5	− 3·4	− 4·7
,,	40	+ 1·2	− 1·2	+ 0·2	− 0·4	− 0·5	− 1·3	− 2·0
June 6	13	+ 1·4	+ 1·2	+ 1·7	+ 1·0	− 0·2	− 0·3	+ 4·8
,,	125	+ 1·6	+ 0·6	+ 2·0	− 0·2	− 0·9	− 2·1	+ 1·0
,,	212	+ 1·2	+ 0·6	0·0	+ 1·1	0·0	+ 0·7	+ 3·6
13	72	+ 2·9	− 2·0	+ 2·1	+ 2·0	+ 1·6	− 1·1	+ 5·5
,,	307	+ 2·7	+ 0·1	+ 3·9	+ 1·9	+ 1·7	+ 1·4	+11·7
,,	230	+ 3·1	+ 0·3	+ 2·0	− 1·8	+ 1·0	+ 1·0	+ 5·6
20	20	+ 2·7	+ 1·8	+ 0·8	+ 0·7	+ 2·6	0·0	+ 8·6
,,	304	+ 3·3	+ 2·8	+ 1·4	− 0·3	+ 3·3	+ 0·3	+10·8
,,	230	+ 3·8	+ 3·0	+ 1·0	− 1·0	+ 0·6	− 1·6	+ 5·8
27	21	+ 1·8	+ 1·2	+ 0·5	+ 1·3	− 0·2	+ 0·8	+ 5·4
,,	..	+ 1·0	− 0·2	− 1·0	+ 0·2	− 1·1	+ 0·8	− 0·3
,,	..	+ 2·0	+ 1·0	− 0·1	+ 0·9	− 0·9	+ 0·2	+ 3·1
July 4	170	+ 2·2	− 1·3	+ 0·4	+ 0·2	+ 1·9	+ 0·7	+ 4·1
,,	290	+ 1·6	− 0·1	− 0·4	+ 1·2	− 0·3	+ 0·2	+ 2·2
,,	50	+ 1·7	+ 0·9	− 0·9	− 0·9	+ 1·6	− 1.1	+ 1·3
11	240	+ 2·9	+ 0·3	+ 0·4	+ 1·3	+ 1·3	− 1·1	+ 5·1
,,	0	+ 3·2	+ 0·8	+ 1·5	+ 1·6	+ 0·3	+ 0·3	+ 8·2
,,	120	+ 3·7	+ 1·5	+ 0·6	+ 2·1	+ 2·5	− 1·5	+ 8·9
18	0	+ 2·5	− 0·8	+ 0·1	− 0·8	+ 0·2	+ 0·3	+ 1·5
,,	300	+ 1·5	+ 0·8	+ 1 9	− 1·1	+ 0·8	+ 1·1	+ 5·0
,,	220	+ 2·8	+ 0·4	+ 0·9	+ 2·9	+ 1·9	+ 0·4	+ 9·3
25	25	+ 1·6	+ 0·8	+ 0·6	0·0	+ 1·0	+ 0·3	+ 4·3
,,	308	+ 2·7	+ 1·1	+ 1·0	+ 0·1	+ 1·2	+ 0·4	+ 6·5
,,	230	+ 3·3	+ 0·6	− 0·9	+ 0·2	+ 1·2	+ 1·1	+ 5·5

TROUGHTON'S CIRCLE—*continued.*

Day.		Pointer Reading.	MICROSCOPES A	B	C	D	E	F	Sum.
		°	"	"	"	"	"	"	"
August...	1	20	+ 3·0	+ 2·1	0·0	+ 1·0	+ 2·4	0·0	+ 8·5
	,,	310	+ 2·4	+ 0·8	+ 1·0	+ 0·1	+ 0·6	+ 3·5	+ 8·4
	,,	170	+ 2·8	− 0·3	+ 0·4	+ 0·2	+ 1·0	0·0	+ 4·1
	8	170	+ 2·5	− 3·1	+ 0·4	− 0·4	− 0·3	+ 0·1	− 0·8
	,,	320	+ 1·4	+ 0·4	− 1·7	− 0·2	+ 1·1	− 0·5	+ 0·5
	,,	75	+ 2·8	+ 1·1	− 0·6	− 0·1	+ 1·3	− 0·4	+ 4·1
	15	0	+ 2·1	+ 0·2	− 0·9	+ 0·1	+ 1·7	+ 1·1	+ 4·3
	,,	120	+ 1·3	+ 1·4	+ 0·6	+ 1·6	+ 1·9	+ 0·9	+ 7·7
	,,	240	+ 1·3	− 0·3	+ 0·6	+ 0·5	− 0·6	− 0·8	+ 0·7
	22	170	+ 2·4	− 3·2	− 0·7	− 0·2	0·0	+ 1·4	− 0·3
	,,	310	+ 4·2	+ 0·3	− 1·8	− 1·0	+ 0·4	− 0·4	+ 1·7
	,,	110	+ 2·1	− 2·7	− 1·0	− 1·4	+ 0·1	− 2·0	− 4·9
	29	180	+ 1·5	− 0·4	− 0·9	+ 0·2	− 0·2	+ 0·8	+ 1·0
	,,	300	+ 2·3	− 0·4	− 0·3	− 1·3	+ 0·2	− 1·2	− 0·7
	,,	60	+ 1·2	+ 0·3	− 1·7	+ 0·2	+ 1·9	− 0·3	+ 1·6
September	5	163	+ 1·8	+ 0·3	+ 0·9	0·0	+ 0·8	+ 0·6	+ 4·4
	,,	66	+ 1·3	+ 1·8	+ 0·5	− 2·6	+ 2·3	+ 2·2	+ 5·5
	,,	310	+ 3·7	− 0·4	+ 1·1	+ 0·5	+ 1·7	0·0	+ 6·6
	12	90	+ 0·6	+ 0·9	+ 1·7	+ 0·1	− 0·2	+ 1·9	+ 5·0
	,,	180	+ 0·8	+ 1·8	+ 0·5	+ 0·2	+ 1·0	+ 0·6	+ 4·9
	,,	208	+ 2·4	+ 1·4	+ 1·0	+ 0·1	+ 0·6	− 1·8	+ 3·7
	19	90	+ 0·6	0·0	+ 1·3	0·0	+ 1·3	− 0·1	+ 3·1
	,,	330	+ 2·3	+ 2·3	− 0·3	− 1·9	+ 1·4	0·0	+ 3·8
	,,	270	+ 1·7	− 1·7	0·0	− 0·6	+ 0·6	− 0·3	− 0·3
	26	80	+ 0·5	+ 2·2	− 0·4	+ 0·5	+ 1·0	0·0	+ 3·8
	,,	200	+ 3·8	+ 0·7	+ 1·6	+ 1·5	− 1·5	+ 3·8	+ 9·9
	,,	320	+ 1·8	+ 3·3	− 0·3	+ 0·2	− 0·2	+ 1·1	+ 5·9
October ..	3	0	+ 1·7	− 0·4	− 0·6	− 1·3	+ 0·3	− 1·7	− 2·0
	,,	120	+ 1·5	− 0·3	− 1·1	− 0·6	− 0·8	− 1·6	− 2·9
	,,	240	+ 2·4	− 2·4	− 0·7	− 0·5	− 0·9	− 2·4	− 4·5
	10	10	+ 0·9	− 0·1	+ 0·5	− 0·4	− 0·2	− 0·2	+ 0·5
	,,	130	+ 1·3	+ 0·2	− 1·3	− 0·6	− 0·2	+ 0·5	− 0·1
	,,	250	+ 1·1	+ 0·1	+ 1·6	+ 0·1	+ 0·2	+ 0·2	+ 3·3

TROUGHTON'S CIRCLE — *concluded.*

Day.	Pointer Reading.	MICROSCOPES. A	B	C	D	E	F	Sum.
	°	″	″	″	″	″	″	″
October .. 17	310	+ 3·2	+ 1·3	− 0·1	− 1·2	+ 0·8	− 0·5	+ 3·5
,,	130	+ 2·8	+ 2·0	+ 0·5	+ 0·5	+ 1·0	+ 0·8	+ 7·6
,,	200	+ 2·5	+ 1·1	− 0·2	+ 1·4	+ 1·0	+ 0·2	+ 6·0
24	0	+ 2·6	+ 0·2	+ 2·2	− 0·4	− 0·1	− 1·3	+ 3·2
,,	120	+ 0·8	− 0·9	− 1·1	+ 1·3	− 1·5	− 0·4	− 1·8
,,	240	+ 1·5	− 0·6	− 1·7	− 0·6	+ 2·1	+ 0·5	+ 1·2
31	355	+ 0·4	+ 0·3	− 1·2	− 2·0	+ 1·0	+ 1·0	− 0·5
,,	250	+ 0·7	− 0·8	+ 0·3	− 2·2	− 0·3	+ 1·2	− 1·1
,,	128	+ 1·0	+ 1·7	− 0·4	− 0·3	+ 0·9	− 3·1	− 0·2
November 7	20	− 0·8	− 1·2	− 2·4	0·0	− 0·4	− 0·1	− 4·9
,,	140	+ 0·8	− 1·6	− 1·6	− 1·8	− 0·2	− 0·4	− 4·8
,,	260	− 0·8	− 0·4	− 1·5	− 0·2	− 0·4	− 0·6	− 3·9
14	50	− 0·5	− 1·6	− 2·4	− 1·1	− 2·9	− 1·6	− 10·1
,,	170	− 1·3	− 3·0	− 1·4	− 0·2	− 1·8	0·0	− 7·7
,,	290	+ 1·0	− 2·3	− 0·5	− 0·4	− 0·1	− 1·1	− 3·4
21	340	+ 2·9	+ 2·2	+ 1·9	+ 0·3	+ 1·8	− 0·6	+ 8·5
,,	245	+ 0·9	0·0	− 0·9	+ 0·2	+ 3·2	+ 0·7	+ 4·1
,,	133	+ 1·6	+ 4·0	+ 3·3	− 1·8	+ 0·4	− 1·7	+ 5·8
28	250	+ 4·0	+ 3·1	+ 2·0	+ 1·0	+ 0·8	+ 1·2	+ 12·1
,,	190	+ 3·7	+ 2·3	+ 2·5	+ 2·2	+ 1·6	+ 1·2	+ 13·5
,,	80	+ 0·9	+ 3·9	+ 0·7	+ 1·6	+ 3·0	+ 1·0	+ 11·1
December 5	0	+ 1·5	− 0·1	+ 0·6	+ 0·5	+ 1·3	− 1·2	+ 2·6
,,	120	+ 2·6	+ 0·3	− 1·3	+ 0·9	− 0·1	+ 0·2	+ 2·6
,,	240	+ 2·1	− 0·6	− 0·7	+ 0·2	+ 0·6	+ 0·4	+ 2·0
12	10	+ 0·7	+ 0·5	+ 2·2	− 0·6	+ 0·8	+ 0·4	+ 4·0
,,	130	+ 1·9	− 0·4	+ 0·4	− 0·2	+ 0·2	+ 0·3	+ 2·2
,,	250	+ 2·6	+ 0·9	+ 1·1	0·0	+ 0·5	+ 0·2	+ 5·3
20	20	+ 1·1	− 1·3	− 1·8	− 0·4	+ 0·2	+ 0·9	− 1·3
,,	140	+ 1·8	− 1·4	− 0·6	+ 0·2	− 0·2	+ 1·4	+ 1·2
,,	260	+ 2·1	+ 1·8	− 0·1	− 1·2	+ 1·4	+ 0·1	+ 4·1
26	150	− 0·2	− 1·4	− 1·3	+ 0·6	− 2·2	+ 1·1	− 3·4
,,	270	+ 1·4	+ 0·1	− 0·3	− 1·1	+ 0·2	− 1·3	− 1·0
,,	30	− 0·6	+ 0·9	− 2·0	− 1·4	− 0·6	− 0·2	− 3·9

ERROR OF EACH MICROSCOPE OF JONES'S CIRCLE, FOR A READING OF 5′.

Day.	Pointer Reading.	MICROSCOPES A	B	C	D	E	F	Sum.
	° ′	″	″	″	″	″	″	″
January .. 8	45. 0	− 1·6	− 0·9	− 0·9	− 3·7	− 3·4	− 2·2	−12·7
9	..	− 1·9	− 1·5	− 0·4	− 2·4	− 2·2	− 1·3	− 9·7
,,	..	− 2·2	− 2·7	− 1·3	− 4·1	− 1·3	− 2·3	−13·9
18	45. 30	− 0·9	+ 0·1	− 0·2	− 1·4	− 0·2	− 0·4	− 3·0
,,	90. 5	− 0·9	− 1·2	− 0·7	− 1·4	− 1·9	− 0·8	− 6·9
,,	0. 0	− 1·1	− 0·7	− 0·0	− 0·6	− 1·8	− 0·2	− 4·4
25	0. 0	− 2·0	− 2·0	+ 0·2	− 0·8	− 1·6	− 1·5	− 7·7
,,	45. 0	− 2·8	− 2·1	+ 0·7	− 0·7	− 2·2	− 1·3	− 8·4
,,	90. 0	− 2·8	− 2·9	− 0·2	− 2·4	− 0·6	− 1·6	−10·5
February .. 1	353. 0	− 1·8	− 1·0	+ 0·4	− 0·4	− 0·3	− 1·8	− 4·9
,,	267. 0	− 2·8	− 2·0	− 0·1	− 1·5	− 1·7	− 1·8	− 9·9
,,	80. 0	− 2·3	− 0·9	− 0·1	− 1·5	− 0·5	− 2·1	− 7·4
8	271. 0	− 1·9	− 1·0	− 0·5	− 3·3	− 0·5	− 2·2	− 9·4
,,	355. 0	− 1·7	− 1·3	− 1·4	− 2·7	− 1·2	− 2·5	−10·8
,,	70. 0	− 1·8	− 2·3	− 1·2	− 2·3	− 1·8	− 2·8	−12·2
15	271. 0	− 1·9	− 2·3	− 0·4	− 1·3	− 1·6	− 2·1	− 9·6
,,	355. 0	− 2·7	− 2·8	− 1·4	− 0·6	− 1·2	− 3·4	−12·1
,,	70. 0	− 2·4	− 2·5	− 0·9	− 2·3	− 2·6	− 1·9	−12·6
22	61. 0	− 2·4	− 0·8	+ 1·9	− 1·4	− 2·2	− 1·9	− 6·8
,,	357. 30	− 1·0	− 0·2	+ 1·6	− 3·0	− 2·8	− 1·8	− 7·2
,,	277. 0	− 1·9	− 0·7	− 1·0	− 1·9	− 1·0	− 1·3	− 7·8
March 1	38. 0	− 1·7	− 2·4	+ 1·1	− 3·9	− 0·8	− 3·6	−11·3
,,	354. 0	− 2·4	+ 0·3	+ 0·7	− 2·7	− 0·1	− 2·0	− 6·2
,,	73. 0	− 1·7	+ 2·6	+ 1·5	− 3·4	+ 0·2	− 1·2	− 2·0
7	270. 0	− 2·0	− 2·6	− 0·2	− 0·4	− 2·1	− 2·1	− 9·4
,,	355. 0	− 2·4	− 2·1	− 0·2	− 1·1	− 1·4	− 1·1	− 8·3
,,	75. 0	− 2·2	− 1·7	− 1·4	− 1·9	− 3·2	− 1·7	−12·1
14	270. 0	− 3·0	− 2·3	− 0·4	− 0·5	− 0·2	− 1·7	− 8·1
,,	0. 0	− 2·3	− 2·1	+ 0·4	− 1·3	− 1·1	− 1·1	− 7·5
,,	80. 0	− 3·3	− 2·6	+ 0·3	− 1·4	− 1·6	− 1·8	− 9·4
21	275. 0	− 1·8	− 2·1	+ 1·0	− 1·1	− 1·3	− 1·6	− 6·9
,,	356. 0	− 1·2	− 1·2	+ 0·6	− 0·5	− 1·6	− 0·9	− 4·8
,,	70. 0	− 0·4	− 2·3	− 0·1	− 0·2	− 1·1	− 0·9	− 5·0

JONES's CIRCLE — *continued.*

Day.		Pointer Reading.	MICROSCOPES A	B	C	D	E	F	Sum.
		°	"	"	"	"	"	"	"
March ...	28	280	− 1·5	− 3·6	− 0·1	− 0·4	− 2·5	− 2·3	−10·4
	,,	305	− 2·2	− 3·4	− 0·3	− 0·4	− 1·7	− 3·1	−11·1
	,,	80	− 2·4	− 3·1	− 0·4	− 1·1	− 0·8	− 2·6	−10·4
April	4	60	− 2·6	− 1·5	− 1·4	− 2·4	− 3·8	− 3·0	−14·7
	,,	357	− 2·1	− 2·1	− 0·6	− 2·0	− 2·5	− 0·6	− 9·9
	,,	280	− 2·6	− 0·2	− 0·5	− 2·4	− 0·5	− 1·5	− 7·7
	11	280	− 1·8	− 3·4	+ 0·4	− 2·0	− 2·9	− 1·9	−11·6
	,,	355	− 1·4	− 4·0	− 1·0	− 1·5	− 1·6	− 2·0	−11·5
	,,	70	− 0·8	− 4·0	− 0·3	− 2·8	− 1·2	− 1·0	−10·1
	18	275	− 2·0	− 4·0	+ 0·5	− 2·2	− 1·7	− 1·4	−10·8
	,,	0	− 1·0	− 3·2	+ 1·1	− 1·2	− 1·8	− 1·4	− 7·5
	,,	75	− 1·4	− 2·2	+ 0·5	− 2·0	− 2·2	− 1·5	− 8·8
	25	290	− 1·0	− 3·2	− 0·6	− 0·6	− 1·1	− 3·3	− 9·8
	,,	30	− 0·8	− 1·6	− 0·4	− 1·9	− 2·4	− 1·1	− 8·2
	,,	140	− 1·9	− 4·1	− 0·4	− 1·1	− 1·5	− 0·5	− 9·5
May	2	..	− 2·5	− 3·2	− 0·5	− 0·5	− 0·2	− 1·9	− 8·8
	,,	..	− 3·0	− 1·3	− 0·5	− 0·8	− 2·0	− 3·0	−10·6
	,,	..	− 1·9	− 0·6	− 0·3	− 1·5	− 1·3	− 1·4	− 7·0
	9	220	− 2·4	− 1·6	+ 0·7	− 2·6	− 0·8	− 2·5	− 9·2
	,,	350	− 1·5	− 1·4	+ 1·0	− 0·6	− 2·3	− 2·1	− 6·9
	,,	120	− 2·7	− 2·5	+ 0·6	− 0·5	− 1·8	− 1·5	− 8·4
	16	220	− 3·2	− 2·3	+ 1·6	− 2·3	+ 0·1	− 0·5	− 6·6
	,,	350	− 2·2	− 0·9	+ 0·7	− 1·1	− 2·1	− 1·5	− 7·1
	,,	100	− 1·0	− 0·5	+ 0·9	− 0·6	− 1·2	− 1·0	− 3·4
	23	250	− 2·8	− 1·9	+ 1·6	− 0·9	− 1·3	− 1·6	− 6·9
	,,	355	− 2·8	− 1·4	+ 0·7	0·0	− 0·5	− 2·1	− 6·1
	,,	110	− 2·5	− 2·2	+ 1·6	− 1·4	− 1·0	− 0·6	− 6·1
	30	230	− 2·6	− 2·0	+ 0·7	− 0·7	− 2·3	− 1·0	− 7·9
	,,	0	− 1·0	− 1·5	+ 1·5	− 0·7	− 1·8	− 0·3	− 3·8
	,,	120	− 1·1	− 1·4	+ 0·8	− 1·1	− 2·4	− 1·6	− 6·8
June	6	300	− 0·9	− 0·1	+ 0·8	− 0·3	+ 0·3	− 1·7	− 1·9
	,,	0	− 1·7	− 0·4	+ 2·3	− 0·3	+ 0·4	− 1·9	− 1·6
	,,	60	− 1·1	− 0·1	+ 1·3	+ 0·2	− 0·8	− 2·1	− 2·6

JONES's CIRCLE — *continued.*

Day.		Pointer Reading.	MICROSCOPES A	B	C	D	E	F	Sum.
		°	"	"	"	"	"	"	"
June	13	0	− 0·7	− 1·4	+ 1·4	+ 0·1	− 0·2	− 0·2	− 1·0
	,,	120	− 1·7	− 0·6	+ 1·1	− 0·8	− 0·8	− 0·9	− 3·7
	,,	240	− 1·2	− 0·5	+ 1·4	+ 1·2	− 0·2	− 0·7	0·0
	20	230	− 2·4	− 1·6	+ 2·8	− 0·9	− 2·3	− 0·4	− 4·8
	,,	5	− 2·5	− 2·0	+ 2·2	− 1·1	− 2·8	+ 0·6	− 5·6
	,,	115	− 1·2	− 1·3	+ 2·5	− 1·4	− 1·4	− 0·7	− 3·5
	27	215	− 1·4	− 0·5	− 1·4	− 2·5	− 1·5	− 0·9	− 8·2
	,,	355	− 2·0	− 1·8	− 0·2	− 0·4	− 1·0	− 0·6	− 6·0
	,,	125	− 1·4	− 1·0	+ 1·1	− 0·6	− 1·4	− 0·7	− 4·0
July	4	215	− 2·2	0·0	+ 1·5	− 0·7	− 1·3	− 1·2	− 3·9
	,,	10	− 1·4	− 0·4	+ 0·6	+ 0·5	− 1·2	+ 0·7	− 1·2
	,,	140	− 2·7	− 1·3	+ 2·0	+ 0·4	− 0·1	− 0·6	− 2·3
	11	75	− 0·7	+ 1·4	+ 3·3	0·0	+ 0·2	+ 0·3	+ 4·5
	,,	353	− 1·0	+ 0·4	+ 1·3	+ 2·3	− 0·2	− 0·5	+ 2·3
	,,	280	− 1·1	− 1·5	+ 2·9	+ 1·6	− 0·7	− 0·7	+ 0·5
	18	0	− 1·1	+ 0·1	+ 1·8	+ 0·1	− 1·8	− 0·7	− 1·6
	,,	120	− 0·3	+ 1·1	+ 2·5	+ 0·2	+ 0·3	− 0·5	+ 3·3
	,,	240	− 2·3	+ 0·1	+ 2·3	+ 0·3	− 0·4	− 1·1	− 1·1
	25	0	− 0·8	− 0·4	+ 1·1	+ 0·2	− 0·8	+ 0·1	− 0·6
	,,	120	− 0·9	− 0·2	+ 1·2	− 0·7	+ 0·1	+ 0·2	− 0·3
	,,	240	− 1·2	− 1·2	+ 0·8	− 0·1	− 1·1	− 1·5	− 4·3
August ..	1	340	− 1·1	− 1·4	+ 2·2	− 2·2	− 1·2	− 0·5	− 4·2
	,,	100	− 1·9	− 1·3	+ 0·9	+ 1·3	− 0·8	+ 0·2	− 1·6
	,,	220	− 1·3	− 1·2	+ 0·2	− 0·5	− 0·6	+ 1·2	− 2·2
	8	120	+ 0·3	− 1·3	+ 2·1	− 1·5	− 1·9	− 0·8	− 3·1
	,,	240	− 0·6	− 0·4	− 0·7	− 0·9	− 1·9	− 0·1	− 4·6
	,,	0	− 0·5	− 0·6	− 0·4	− 1·2	− 1·1	− 0·8	− 4·6
	15	210	− 1·3	− 0·4	+ 1·0	− 1·0	− 1·8	− 0·6	− 4·1
	,,	0	− 1·0	− 0·3	+ 2·8	− 0·4	− 1·2	− 0·6	− 0·7
	,,	160	− 1·2	− 1·5	+ 1·0	− 0·4	− 0·5	− 1·1	− 3·7
	22	50	− 0·3	+ 1·8	+ 0·3	+ 0·7	+ 0·3	− 0·5	+ 2·3
	,,	170	− 1·4	− 3·1	+ 0·1	+ 1·1	− 0·7	+ 1·8	− 2·2
	,,	290	− 2·7	− 2·3	+ 3·4	− 0·3	+ 0·6	− 0·5	− 1·8

JONES'S CIRCLE — *continued.*

Day.		Pointer Reading.	MICROSCOPES A	B	C	D	E	F	Sum.
		°	″	″	″	″	″	″	″
August ..	29	20	− 0·7	− 1·8	− 0·9	− 1·4	− 1·6	+ 0·2	− 6·2
	,,	140	− 1·3	− 1·4	− 1·6	− 1·3	− 1·2	− 0·6	− 7·4
	,,	260	− 1·1	− 0·9	− 0·9	− 0·7	− 1·2	− 1·9	− 6·7
September	5	210	− 1·8	− 0·6	− 0·3	− 0·9	− 1·0	+ 0·4	− 4·2
	,,	330	− 1·4	− 1·5	+ 0·5	− 1·1	− 0·2	− 0·4	− 4·1
	,,	90	− 2·9	+ 0·2	+ 2·2	− 0·8	− 1·6	− 0·2	− 3·1
	12	205	− 0·2	− 0·8	+ 1·9	− 0·6	− 1·7	− 0·1	− 1·5
	,,	325	− 0·5	0·0	+ 2·6	− 0·2	− 1·4	+ 0·2	+ 0·7
	,,	85	− 2·1	− 1·0	+ 0·3	+ 0·6	− 1·6	− 0·1	− 3·9
	19	250	− 2·6	− 1·6	− 0·4	− 1·3	− 2·4	− 1·4	− 9·7
	,,	10	− 1·5	− 2·0	− 1·6	− 0·8	− 1·5	− 1·2	− 8·6
	,,	130	− 1·2	− 1·2	− 0·3	− 1·2	− 1·2	− 1·4	− 6·5
	26	220	− 1·2	− 1·2	− 0·5	− 1·7	− 1·4	− 0·7	− 6·7
	,,	340	− 1·5	− 2·4	− 0·6	− 0·5	− 1·2	− 1·1	− 7·3
	,,	100	− 1·1	− 2·2	+ 0·4	− 1·1	− 0·7	− 1·5	− 6·2
October ..	3	130	− 1·8	− 0·6	− 0·7	− 1·5	− 1·6	− 3·0	− 9·2
	,,	230	− 2·5	− 1·9	− 1·5	− 1·0	− 1·1	− 0·8	− 8·8
	,,	350	− 1·6	− 1·2	− 0·8	− 0·2	− 1·9	− 2·5	− 8·2
	10	180	+ 0·3	− 0·3	+ 1·3	+ 0·2	+ 0·6	− 2·3	− 0·2
	,,	60	− 0·5	− 0·6	+ 2·0	+ 2·2	+ 1·8	+ 1·2	+ 6·1
	,,	0	− 0·4	+ 0·1	+ 2·5	− 0·1	− 0·2	+ 0·6	+ 2·5
	17	180	− 1·5	+ 0·1	+ 2·5	+ 0·4	− 1·0	− 0·8	− 0·3
	,,	300	0·0	− 1·0	+ 1·7	0·0	− 1·2	− 1·2	− 1·7
	,,	60	− 1·0	− 1·2	+ 3·0	0·0	− 0·9	− 0·1	− 0·2
	24	190	− 2·7	− 1·4	+ 1·3	− 1·2	− 1·4	− 0·1	− 5·5
	,,	310	− 2·6	− 1·3	+ 1·1	− 1·2	− 0·7	− 0·6	− 5·3
	,,	50	− 2·0	− 1·4	+ 2·9	− 0·8	− 0·7	− 0·5	− 2·5
	31	0	− 0·3	− 2·4	− 0·2	− 1·1	− 1·2	− 1·7	− 6·9
	,,	120	− 0·4	− 0·7	+ 0·2	− 0·5	− 0·1	− 0·5	− 2·0
	,,	240	− 2·3	− 1·4	+ 0·8	0·0	+ 0·2	− 0·8	− 3·5
November	7	210	− 3·0	− 2·4	0·0	− 2·7	− 2·1	− 2·1	−12·3
	,,	330	− 3·6	− 1·8	+ 0·7	− 2·0	− 1·0	− 1·7	− 9·4
	,,	90	− 2·6	− 2·0	− 0·1	− 1·1	− 1·3	− 2·7	− 9·8

JONES's CIRCLE—*concluded.*

Day.		Pointer Reading.	MICROSCOPES.						Sum.
			A	B	C	D	E	F	
		°	″	″	″	″	″	″	″
November	14	200	− 3·5	− 2·2	+ 0·6	− 0·9	− 1·0	− 2·1	− 9·1
	,,	320	− 2·8	− 2·5	+ 1·5	− 0·9	− 2·2	− 2·3	− 9·2
	,,	80	− 2·3	− 1·2	+ 1·0	− 1·2	− 1·1	− 1·2	− 6·0
	21	60	− 2·6	− 2·5	− 0·1	− 0·2	− 1·1	− 0·1	− 6·6
	,,	180	− 1·3	− 1·1	0·0	− 0·5	− 0·8	− 2·2	− 5·9
	,,	300	− 2·4	− 2·4	− 1·2	− 1·2	− 1·5	− 1·8	−10·5
	28	190	+ 0·1	− 2·5	+ 3·2	+ 0·2	− 1·3	− 1·3	− 1·6
	,,	310	− 0·8	− 2·1	+ 1·1	− 1·0	− 2·3	− 0·3	− 5·4
	,,	70	− 0·2	− 2·4	+ 1·2	− 0·7	− 1·7	− 0·6	− 4·4
December	5	220	− 0·5	0·0	+ 1·9	+ 0·2	− 2·3	− 0·1	− 0·8
	,,	340	− 1·4	− 1·3	+ 1·7	− 0·5	− 1·7	− 0·1	− 3·3
	,,	100	− 1·5	− 0·6	+ 0·7	− 0·5	− 1·8	+ 0·4	− 3·3
	12	220	− 1·4	− 1·4	+ 1·5	+ 0·1	− 2·1	− 0·1	− 3·4
	,,	340	− 2·3	− 1·5	+ 2·5	− 0·7	− 1·2	− 0·6	− 3·8
	,,	100	− 2·0	− 0·3	+ 0·6	0·0	− 1·5	− 0·9	− 4·1
	20	300	− 0·3	− 1·0	+ 1·0	− 0·1	− 0·9	− 0·1	− 1·4
	,,	120	+ 0·7	+ 0·2	0·0	+ 1·8	− 0·8	− 0·1	+ 1·8
	,,	0	− 1·1	+ 0·7	+ 1·0	− 0·2	+ 1·1	+ 0·5	+ 2·0
	26	0	− 1·4	− 3·1	+ 1·9	− 0·5	− 1·1	+ 0·5	− 3·7
	,,	240	+ 1·8	− 2·9	− 0·3	− 0·5	− 0·9	− 1·2	− 4·0
	,,	120	− 1·5	− 2·8	− 0·3	+ 0·2	0·0	− 1·4	− 5·8

The *eleventh* column contains the reading of the micrometer in the eye-piece of the circle-telescope. It is used either when two objects pass in rapid succession in the same field, or for the observation of one limb of a planet when the other limb is observed on the fixed wire, or for the Moon when observed several times in passing the field. The reading of the micrometer when its wire coincides with the fixed wire is ascertained every week: this reading is given at the bottom of the page. The wires being not perfectly parallel, it was at length thought desirable to ascertain the coincidence-reading at each of the points where the horizontal wire is intersected by the five vertical wires. It does not appear necessary to give any further details of the observations for the coincidences.

The *twelfth* column contains the value, in minutes and seconds, of the arc measured with the micrometer. The value of one revolution, as given at the bottom of the page, has been found by the following process. A window-sill at Blackwall having been fixed on as a well-defined object, the fixed wire was made to coincide with its image, and the microscopes A and B were read: then the micrometer wire, whose reading was noted, was made to coincide with it, and the microscopes were again read. The operation was repeated five times for each of the circles. Corrections for runs were applied to the two microscopes. The results are as follow:

TROUGHTON.

Feb. 18. 22^h.

	′ ″
Micrometer at 11^r·99, mean of 5 observations of A and B.	59. 46 ·87
Fixed wire (or micrometer at 4·963), mean of 5 observations of A and B. ...	66. 3 ·24
Difference for 7^r·027	6. 16 ·37

Hence 1^r=53″·56.

JONES.

Feb. 18. 22^h.

Micrometer at 17^r·875, mean of 5 observations of A and B.	12. 38 ·81
Fixed wire (or micrometer at 10·875), mean of 5 observations of A and B. ..	17. 20 ·62
Difference for 7^r·000.	4. 41 ·81

Hence 1^r=40″·26

The *thirteenth* 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 Troughton's circle contains five vertical wires: that of Jones only three: but for convenience the middle wire in both is always called the third. 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 interval of Troughton's wires is considered 20^s equatoreal, and that of Jones's wires 21^s.

The *fourteenth* 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., the other due to the difference between the small circle described by the body and the great circle of which the horizontal wires form 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 decl. in 10^m (from Nautical Almanac) $\times$ sec. declination $\times \frac{3600 + I}{3600} \times$ n°. (log. = 8·523) $\times$ number of intervals of wires:

where I has the same meaning as in page x. The latter is calculated by this formula: tan. declination × n°. (log. = 9·350) × (number of intervals of wires) [2]. The two numbers are combined together to form the number in the fourteenth column.

The *fifteenth* 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 for columns 12 and 14.

The *sixteenth* column contains the initials of the Observers' names. W. R, is Mr. Richardson's signature, and R, Mr. Rogerson's: the others explain themselves.

The same remarks apply, *mutatis mutandis*, to the columns on the right hand page, for Jones's circle, (all numerical differences having been already given), except the *two last* columns. The former of these contains the seconds only of the arc by which the reading of Troughton exceeds that of Jones when the same object is observed directly with both. The latter contains the seconds only of the sum of the readings when the same object has been observed directly with one circle and by reflexion with the other. They 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 a day), the mean sum of the readings T + J is increased by 180° and divided by 2: and this result would be the Zenith Point if the readings of the two circles for the same object were identical. As they are not, it is necessary to add to this result the mean value of $\frac{1}{2}(T - J)$, in order to obtain the Zenith Point of Troughton's circle: and the same quantity must be subtracted, to obtain the Zenith Point of Jones's circle. The Zenith Points thus determined are given at the bottom of the page. It will be seen from this description, that every day's result as to Zenith Distance is, for the most part, completely independent.

No further explanation of this section appears necessary, except for the computation of the correction to be applied to the observation of one limb of the Moon (when both are observed) for defect of illumination. If the Moon is horned, her place, on a common celestial globe, is brought to the zenith, and a quadrant of altitude being made to pass over the sun's place, its deviation from the East or West point is noted. If the Moon is gibbous, her place is brought to the intersection of the meridian and horizon, and the sun's elevation above or depression below the horizon is noted. The correction to be applied is, the Moon's semidiameter × versine of angle noted: if the sun's place is nearer the north pole than the E. or W. point in one case, or than the horizon of the globe in the other case, the correction is + for the south limb: if the contrary, it is – for the north limb. This correction is not applied to the numbers in this section, though its quantity is noted.

§ 4. *Calculation of Geocentric North Polar Distances, &c.* (page 2 to 53.)

The *first* and *second* columns on each page contain the day and the name of the object, as in the preceding section. For the planets, the limb or center observed with the fixed wire in each circle is noted, that for Troughton being always placed first.

The *third* and *fourth* columns contain the zenith distance, the degrees and minutes being given in the third column only. The zenith distance is found by subtracting the zenith point (in the preceding section) 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. The letter R is affixed when the object was observed by reflexion.

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. The vernier is so bad as to make this barometer wholly useless 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 a small thermometer by Newman, in a glass cylinder, on the outside of one of the north windows of the Circle-room.

The *seventh* column contains the reading of the interior thermometer. This is by Newman: it is suspended on the north wall in the inside of the circle-room.

The difference between these thermometers has, in several instances, exceeded in amount the quantity which I should have thought it prudent to permit. This has occurred in general at noon, when (probably from uncertainty of weather) the shutters have been closed till near the time of the sun's passage. It arises also from the circumstance, that there are no windows on the south side of the room: an exclusion of the sun's influence far too complete. The disagreement at night is much smaller. Measures will be taken in future to diminish if possible this discordance.

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 present volume. 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: and of which the details of computation are given in the Cambridge Observations, vol. iv. for 1831.

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 *tenth* and *eleventh* columns contain the semidiameter used with each circle, the minutes being given in the tenth column only. 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 between this semidiameter and the whole micrometrical measure is to be applied. Any departure from these rules is recorded in the notes.

The *twelfth* and *thirteenth* columns contain 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″.

§ 5. *Mean North Polar Distances of Stars,* (page 56 to 90.)

The corrections by which the apparent N.P.D. of the last section are converted into mean N.P.D. Jan. 1, 1836, are found as follows. 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. A.R. cos. N.P.D. + B. cos. A.R. cos. N.P.D. + C. cos. A.R. × n°. (log. = 1·3020) − D. sin. A.R.

The results of direct and reflected observations are kept separate, with the view of ascertaining whether there is any discordance between them, as has been observed in the results of other circles, and (formerly) with these 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 (a few excepted, for which the number of reflexion-observations is small, and which occur at nearly the same distance from the zenith as many other stars which have frequently been so 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.

TROUGHTON.

Name.	N.P.D.	R − D.	No. of Obs. D.	No. of Obs. R.	Name.	N.P.D.	R − D.	No. of Obs. D.	No. of Obs. R.
	° ′	″				° ′	″		
ε Cephei S.P.	−33. 46	−4·13	1	1	η Cephei	+ 28. 48	+2·10	7	4
δ² Cephei S.P.	−32. 25	+1·34	13	1	υ Ursæ Majoris	30. 12	−0·22	4	9
β Cassiopeiæ S.P.	−31. 45	+0·18	15	1	ο Draconis	30. 49	−0·48	3	2
υ Ursæ Majoris S. P.	−30. 12	+3·74	9	1	θ Draconis	31. 0	−0·53	5	6
η Cephei S. P.	−28. 48	−0·89	8	2	β Cassiopeiæ	31. 45	+0·69	7	3
α Cephei S. P.	−28. 6	−0·95	13	9	δ Ursæ Majoris	32. 3	+0·72	13	13
θ Cephei S. P.	−27. 33	−1·58	5	3	δ¹ Cephei	32. 25	+0·52	6	6
α Ursæ Minoris S. P.	−27. 22	+0·59	9	1	η Cassiopeiæ	33. 3	−0·08	2	4
ι Cephei S. P.	−24. 40	+0·19	11	2	ξ Draconis	33. 6	−0·58	3	2
β Cephei S. P.	−20. 9	−1·51	12	2	ε Ursæ Majoris	33. 9	−1·31	6	5
ε Draconis S. P.	−20. 9	−3·51	6	1	ζ Ursæ Majoris	34. 13	+0·53	14	4
ξ Ursæ Minoris S. P.	−19. 47	−0·53	3	1	α Cassiopeiæ	34. 22	−0·47	8	3
κ Draconis S. P.	−19. 18	+0·29	2	1	γ Ursæ Majoris	35. 23	+0·09	10	11
γ² Ursæ Minoris S. P.	−17. 35	−0·43	2	1	θ Cygni	40. 9	−0·14	9	3
β Ursæ Minoris S. P.	−15. 10	−0·85	12	4	δ Persei	42. 45	+0·27	6	5
γ Cephei S. P.	−13. 17	+1·64	16	3	λ Bootis	43. 9	+1·63	3	2
κ Cephei S. P.	−12. 47	−0·48	6	5	Capella	44. 11	−0·02	14	9
ε Ursæ Minoris S. P.	− 7. 42	−0·16	3	1	ψ Ursæ Majoris	44. 37	−0·20	6	14
O¹ Camelopard. S. P.	− 5. 41	−0·18	2	1	β Aurigæ	45. 5	−0·02	7	5
O² Camelopard. S. P.	− 5. 41	−2·26	2	1	δ Cygni	45. 16	+0·60	11	5
Polaris S. P.	− 1. 34	−0·72	36	17	α Cygni	45. 18	+0·63	6	5
Polaris	+ 1. 34	−0·99	25	10	λ Ursæ Majoris	46. 16	+1·34	7	10
δ Ursæ Minoris	3. 25	+0·56	6	2	ε Aurigæ	46. 26	+0·97	7	7
κ Cephei	12. 47	−1·03	8	4	γ Andromedæ	48. 28	+2·24	4	2
γ Cephei	13. 16	−0·86	10	7	α Lyræ	51. 22	−0·08	45	47
β Ursæ Minoris	15. 10	−1·04	13	5	79¹ Cygni	52. 28	+0·81	3	2
κ Draconis	19. 18	−0·40	10	8	Castor	57. 46	+0·05	9	5
β Cephei	20. 9	−0·14	9	6	β Tauri	61. 32	+0·41	3	3
δ Draconis	22. 38	+0·01	8	3	Pollux	61. 35	+0·01	7	7
34 Cephei	22. 47	−0·75	4	2	ε Bootis	62. 14	+0·36	8	2
55 Cassiopeiæ	24. 15	−1·18	3	2	α Coronæ Borealis	62. 44	+0·84	5	3
ι Cephei	24. 40	−0·93	9	5	α Arietis	67. 19	−0·31	4	2
Piazzi III. 7	24. 57	−1·26	2	3	δ Geminorum	67. 43	+0·31	2	3
ε Cassiopeiæ	27. 8	+0·23	2	2	Arcturus	69. 58	+0·07	14	4
Piazzi III. 105	27. 11	+0·85	2	3	Aldebaran	73. 50	−0·87	2	4
α Ursæ Majoris	27. 22	−0·77	9	7	β Leonis	74. 31	+1·18	11	4
θ Cephei	27. 33	−0·39	9	4	Regulus	77. 14	+1·29	8	8
κ Cassiopeiæ	27. 58	+0·35	4	2	α Ceti	86. 33	+0·75	5	1
25 Cephei	28. 1	+2·40	3	2	γ Ceti	87. 28	+0·66	4	1
α Cephei	28. 6	+1·20	12	5	t Piscium	88. 58	+0·92	2	1
71 Draconis	28. 16	−0·91	3	2	α Hydræ	97. 57	−0·03	1	2
19 Cephei	28. 31	−0·53	3	2	Spica	100. 18	−0·61	13	4
9 Cassiopeiæ	+28. 37	+0·11	2	2	Sirius	+106. 30	+4·10	13	1

JONES.

Name.	N.P.D.	R—D.	No. of Obs. D.	No. of Obs. R.	Name.	N.P.D.	R—D.	No. of Obs. D.	No. of Obs. R.
	° ′	″				″ ′	″		
η Ursæ Majoris S. P.	−39. 52	−1·01	9	1	θ Draconis	+ 31. 0	−1·32	8	3
ζ Ursæ Majoris S. P.	−34. 13	+1·10	18	1	β Cassiopeiæ	31. 45	−0·60	7	3
ε Ursæ Majoris S. P.	−33. 9	+1·62	1	4	δ Ursæ Majoris	32. 3	−0·60	16	10
δ Ursæ Majoris S. P.	−32. 3	−0·08	7	2	δ^2 Cephei	32. 25	−0·70	10	2
η Cephei S. P.	−28. 48	−1·54	9	1	η Cassiopeiæ	33. 3	+0·22	4	2
η Draconis S. P.	−28. 7	+0·25	6	2	45 Draconis	33. 5	0·00	1	4
α Cephei S. P.	−28. 6	−1·14	14	3	ζ Ursæ Majoris	34. 13	−0·08	15	3
θ Cephei S. P.	−27. 33	−1·05	7	1	α Cassiopeiæ	34. 22	−1·43	6	4
α Ursæ Majoris S. P.	−27. 22	+1·91	9	1	γ Ursæ Majoris	35. 23	−0·87	16	5
β Cephei S. P.	−20. 9	+0·49	12	3	θ Cygni	40. 9	+1·06	10	2
ε Draconis S. P.	−20. 9	+0·68	7	1	δ Persei	42. 45	−0·89	5	4
β Ursæ Minoris S. P.	−15. 10	−1·59	15	1	λ Bootis	43. 9	+0·01	2	3
γ Cephei S. P.	−13. 17	+0·65	17	2	τ Herculis	43. 18	+0·79	3	4
ε Ursæ Minoris S. P.	− 7. 42	−3·52	4	1	* A.R. $19^h. 11^m$	43. 18	+1·26	1	2
δ Ursæ Minoris S. P.	− 3. 25	−0·71	2	1	74 Herculis	43. 36	+0·07	1	2
Polaris S. P.	− 1. 34	+0·19	47	7	ι Herculis	43. 54	+0·52	3	2
Polaris	+ 1. 34	−0·69	27	10	Capella	44. 10	−0·37	16	7
δ Ursæ Minoris	3. 25	−3·04	4	4	ψ Ursæ Majoris	44. 37	−0·83	15	4
θ Ursæ Minoris	12. 6	−0·48	2	1	β Aurigæ	45. 5	−0·01	8	4
κ Cephei	12. 47	−0·94	5	7	δ Cygni	45. 16	+0·31	6	10
γ Cephei	13. 17	−1·37	10	7	α Cygni	45. 18	+0·54	8	3
β Ursæ Minoris	15. 10	−1·16	10	8	Piazzi XVI. 307	45. 58	−0·93	3	2
γ^2 Ursæ Minoris	17. 35	−0·46	3	2	λ Ursæ Majoris	46. 16	+1·11	12	5
κ Draconis	19. 18	−1·13	9	9	13 Lyræ	46. 16	+0·89	3	2
β Cephei	20. 9	−0·41	11	4	ε Aurigæ	46. 26	+1·34	9	5
ε Draconis	20. 9	−0·48	4	3	α Lyræ	51. 22	+0·61	54	38
δ Draconis	22. 38	−0·75	3	8	Castor	57. 46	+0·64	8	6
55 Cassiopeiæ	24. 15	−0·39	3	2	β Tauri	61. 32	+1·20	4	2
10 Draconis	24. 27	−0·97	3	2	Pollux	61. 35	+0·74	7	7
42 Draconis	24. 32	−1·67	2	4	ε Bootis	62. 14	+0·43	6	4
ι Cephei	24. 40	−0·52	8	6	α Coronæ Borealis	62. 44	−0·80	5	3
α Draconis	24. 50	−1·88	1	2	α Arietis	67. 19	+3·41	3	4
ε Cassiopeiæ	27. 8	−1·48	2	2	δ Geminorum	67. 43	+1·15	4	1
Piazzi III. 105	27. 11	+0·05	3	2	Arcturus	69. 58	+1·42	9	9
α Ursæ Majoris	27. 22	+0·26	9	7	β Leonis	74. 31	+0·29	11	4
θ Cephei	27. 33	−0·73	8	5	Regulus	77. 14	+1·85	12	4
α Cephei	28. 6	−1·87	6	11	α Orionis	82. 38	+0·06	2	1
71 Draconis	28. 16	−0·19	3	2	α Ceti	86. 33	+0·39	4	3
η Cephei	28. 48	−0·96	6	5	γ Ceti	87. 28	+0·60	5	1
υ Ursæ Majoris	30. 12	+0·06	10	3	Spica	100. 18	+0·12	16	1
ο Draconis	+30. 49	−0·66	2	3	Sirius	+106. 30	+0·08	13	1

To exhibit more clearly to the eye the law which these quantities follow approximately, I have grouped them, and have taken the mean of the values of R—D for each group, giving to each star a weight proportional to the smaller of the two numbers of observations. The following table exhibits the particulars of each group, and the result for R—D.

TROUGHTON.				JONES.			
Extent of Group.	No. of Obs.	Mean N.P.D.	R—D.	Extent of Group.	No. of Obs.	Mean N.P.D.	R—D.
		° ′	″			° ′	″
ε Cephei S.P. to υ U. Maj. S.P.	4	− 32. 2	+0·28	η U.Maj.S.P. to δ U.Maj.S.P.	5	− 34.16	+0·31
η Cephei S.P. to ι Cephei S.P.	17	− 27.38	−0·83	η Cephei S.P. to α U.Maj S.P.	8	− 28. 2	−0·45
β Cephei S.P. to γ² U. Min. S.P.	6	− 19.32	−1·20	β Cephei S.P. to γ Cephei S.P.	7	− 17.29	+0·27
β U. Min. S.P. to κ Cephei S.P.	12	− 13.42	−0·07	ε U. Min. S.P. to Polaris S.P.	9	− 2.21	−0·32
ε U. Min. S.P. to Polaris S.P.	20	− 2.17	−0·74	Polaris to δ Ursæ Minoris ..	14	+ 2. 6	−1·36
Polaris to δ Ursæ Minoris....	12	+ 1.52	−0·73	θ Ursæ Minoris to γ Cephei.	13	+ 13. 0	−1·14
κ Cephei to β Ursæ Minoris..	16	+ 13.44	−0·96	β Ursæ Minoris to ε Draconis	26	+ 18. 7	−0·90
κ Draconis to 34 Cephei.... ..	19	+ 20.28	−0·29	δ Draconis to α Draconis.. ..	16	+ 24.12	−0·83
55 Cassiopeiæ to Piazzi III. 7	9	+ 24.38	−1·06	ε Cassiopeiæ to η Cephei....	29	+ 27.50	−0·73
ε Cassiopeiæ to θ Cephei.....	15	+ 27.22	−0·32	υ U. Majoris to δ U. Majoris	21	+ 31.11	−0·61
κ Cassiopeiæ to η Cephei.....	19	+ 28.20	+0·91	δ Cephei to γ Ursæ Majoris..	17	+ 34.11	−0·66
υ Ursæ Majoris to δ Cephei ..	33	+ 31.16	+0·30	θ Cygni to ι Herculis	15	+ 42.49	+0·22
η Cassiopeiæ to γ Urs. Majoris	26	+ 34.18	−0·24	Capella to α Cygni	24	+ 44.49	−0·10
θ Cygni to Capella..........	19	+ 43. 4	+0·21	Piazzi XVII. 307 to ε Aurigæ	14	+ 46.24	+0·87
ψ U. Majoris to α Cygni.....	21	+ 45. 3	+0·23	α Lyræ..................	38	+ 51.22	+0·61
λ U. Majoris to γ Andromedæ	16	+ 46.37	+1·29	Castor to α Coronæ Borealis	22	+ 60.49	+0·49
α Lyræ..................	45	+ 51.22	−0·08	α Arietis to Regulus	21	+ 71.44	+1·72
79¹ Cygni to α Coronæ Borealis	22	+ 60. 6	+0·29	α Orionis to γ Ceti........	5	+ 85.57	+0·37
α Arietis to Arcturus........	8	+ 68.44	+0·93	Spica to Sirius...........	2	+103.24	+0·10
Aldebaran to Regulus	14	+ 75.59	+0·95				
α Ceti to ι Piscium	3	+ 87.40	+0·78				
α Hydræ to Sirius......... ..	6	+100.56	+0·27				

It is, I think, perfectly certain that here is a real discordance between the results of direct and reflected observations, depending on the point of the meridian at which the star is observed, and of such a nature that the apparent zenith-distance of a star deduced from a reflexion-observation is greater than that deduced from a direct observation. In all important respects it is similar to the discordance observed with the Cambridge Mural Circle, and described by me in the Cambridge Observations for 1833, 1834, and 1835. I have laid down the numbers of the above table in a graphical construction (with N.P.D. for abscissa and R—D for ordinate), and have drawn by hand a curve passing, as nearly as with a simple curve seemed practicable, through the points corresponding to the different groups, determining the proximity by the number of observations in each group. The curves for the two circles are very nearly similar; the mean of the ordinates is taken as a representation of the real value of R — D independent of errors of observation, applicable to both circles; and (in my ignorance of the cause of the discordance) I have considered, that half of this quantity is to be applied additively to the Direct-result, and half subtractively to the Reflexion-result. Thus the following table is formed.

Correction to be applied Algebraically to North Polar Distances, for the Discordance of Results of Direct and Reflected Observations.

N. P. D.	Correction to results of Direct Observations.	Correction to results of Reflected Observations.	N. P. D.	Correction to results of Direct Observations.	Correction to results of Reflected Observations.
°	"	"	°	"	"
−40	−0·05	+0·05	+ 50	+0·29	−0·29
−30	−0·15	+0·15	+ 60	+0·44	−0·44
−20	−0·24	+0·24	+ 70	+0·46	−0·46
−10	−0·35	+0·35	+ 80	+0·44	−0·44
0	−0·44	+0·44	+ 90	+0·38	−0·38
+10	−0·45	+0·45	+100	+0·24	−0·24
+20	−0·33	+0·33	+110	+0·16	−0·16
+30	−0·12	+0·12	+120	+0·05	−0·05
+40	+0·12	−0·12			

To investigate the correction to the latitude, the following process is employed. Twenty-nine stars are selected, of various N.P.D. not exceeding 36°, and which have been observed each several times above and below the pole. The direct-results by Troughton and those by Jones are arranged together, and a mean is taken, proportioning the weight to the number of observations: in like manner, the reflexion-results of Troughton and those of Jones are arranged together, and their mean is taken. These means occupy the fifth column of the subjoined table. In the sixth column, the means are corrected from the table above; and in the eighth column, the means are placed which are deduced from the direct and reflected observations (as reduced in the sixth column) giving weights proportional to the number of observations. These results I consider to be the best that the use of the circles can give. If the assumed co-latitude were correct, the algebraic sum of the quantities in column 8 for each star above and below the pole would be 0; if the co-latitude were increased by x, then $2x$ + that sum would $= 0$. The value of that sum, for each star, is given in the tenth column; the eleventh column contains the number representing the weight attributed to each star in the final determination. This weight has been determined (roughly) by the following considerations: First, when there are a observations above the pole and b below, the value is considered proportional to $\frac{ab}{a+b}$: Secondly, as there is a small uncertainty of refraction for stars at a distance from the pole, the value (as just found) is multiplied by 60 for Polaris, by 59 for δ Ursæ Minoris, by 58 for O^1 Camelopardali, and so on, till for the last star the multiplier is 32. The weights in the eleventh column are nearly proportional to the products thus formed. The twelfth column contains the products of the numbers in the tenth and eleventh columns.

Star's Name, Name of Circle, and Mode of Observation.	No. of Obs.	N.P.D. uncorrected.	No. of similar Obs.	Result of similar Observations.	Result corrected for Discordance.	No. of Obs.	Concluded N.P.D. on assumed Latitude.	No. of Obs.	Algebraic Sum of Determinations.	Weight.	Product.
		° ′ ″		″	″		″				
Polaris....... T. D.	25	1. 33. 55 ·09	52	54 ·87	54 ·43	72	54 ·43	179	− 1 ·82	40	−72 ·80
J. D.	27	54 ·65									
T. R.	10	54 ·10	20	54 ·03	54 ·47						
J. R.	10	53 ·95									
S. P. T. D.	36	− 1. 33. 55 ·88	83	−55 ·91	−56 ·34	107	−56 ·25				
S. P. J. D.	47	55 ·93									
S. P. T. R.	17	56 ·60	24	−56 ·35	−55 ·92						
S. P. J. R.	7	55 ·74									
δ Ursæ Minoris T. D.	6	3. 24. 38 ·17	10	38 ·24	37 ·80	16	37 ·46	21	− 1 ·73	4	− 6 ·92
J. D.	4	38 ·35									
T. R.	2	38 ·73	6	36 ·45	36 ·89						
J. R.	4	35 ·31									
S. P. T. D.	2	− 3. 24. 39 ·28	4	38 ·88	−39 ·29	5	−39 ·19				
S. P. J. D.	2	38 ·48									
S. P. T. R.	0	....	1	39 ·19	−38 ·78						
S. P. J. R.	1	39 ·19									
O^1 Camelopard. T. D.	2	5. 41. 23 ·70	4	24 ·45	24 ·00	4	24 ·00	10	− 0 ·96	2	− 1 ·92
J. D	2	25 ·21									
T. R.	0	....	0	....	.....						
J. R.	0	....									
S. P. T. D.	2	− 5. 41. 24 ·84	5	−24 ·64	−25 ·03	6	−24 ·96				
S. P. J. D.	3	24 ·51									
S. P. T. R.	1	25 ·02	1	−25 ·02	−24 ·63						
S. P. J. R.	0	.....									
O^2 Camelopard. T. D.	3	5. 41. 42 ·08	6	42 ·24	41 ·79	6	41 ·79	12	− 1 ·81	3	− 5 ·43
J. D.	3	42 ·40									
T. R.	0	.....	0	.....	.....						
J. R.	0	.....									
S. P. T. D.	2	− 5. 41. 42 ·90	5	−42 ·97	−43 ·36	6	−43 ·60				
S. P. J. D.	3	43 ·01									
S. P. T. R.	1	45 ·16	1	−45 ·16	−44 ·77						
S. P. J. R.	0	.....									

Star's Name, Name of Circle, and Mode of Observation.	No. of Obs.	N.P.D. uncorrected.	No. of similar Obs.	Result of similar Observations.	Result corrected for Discordance.	No. of Obs.	Concluded N.P.D. on assumed Latitude.	No. of Obs.	Algebraic Sum of Determinations.	Weight.	Product.
		° ′ ″		″	″						
κ Cephei ..... T. D.	8	12. 47. 8 ·59	13	8 ·72	8 ·34	24	8 ·30	45	— 1 ·88	10	—18 ·80
J. D.	5	8 ·92									
T. R.	4	7 ·56	11	7 ·83	8 ·25						
J. R.	7	7 ·98									
S. P. T. D.	6	—12. 47. 10 ·03	16	— 9 ·85	—10 ·17	21	—10 ·18				
S. P. J. D.	10	9 ·74									
S. P. T. R.	5	10 ·51	5	—10 ·51	—10 ·19						
S. P. J. R.	0	.....									
γ Cephei .... T. D.	10	13. 16. 56 ·55	20	56 ·86	56 ·45	34	56 ·33	72	— 2 ·14	15	—32 ·10
J. D.	10	57 ·18									
T. R.	7	55 ·69	14	55 ·75	56 ·16						
J. R.	7	55 ·81									
S. P. T. D.	16	—13. 16. 58 ·53	33	—58 ·39	—58 ·71	38	—58 ·47				
S. P. J. D.	17	58 ·25									
S. P. T. R.	3	56 ·89	5	—57 ·17	—56 ·86						
S. P. J. R.	2	57 ·59									
β Ursæ Minoris T. D.	13	15. 10. 27 ·22	23	27 ·31	26 ·92	36	26 ·82	68	— 1 ·87	14	—26 ·18
J. D.	10	27 ·43									
T. R.	5	26 ·18	13	26 ·24	26 ·63						
J. R.	8	26 ·27									
S. P. T. D.	12	—15. 10. 28 ·13	27	—28 ·36	—28 ·65	32	—28 ·69				
S. P. J. D.	15	28 ·55									
S. P. T. R.	4	28 ·98	5	—29 ·22	—28 ·93						
S. P. J. R.	1	30 ·16									
γ[2] Ursæ Minoris T. D.	3	17. 34. 57 ·36	6	56 ·99	56 ·63	10	56 ·39	16	— 1 ·93	3	— 5 ·79
J. D.	3	56 ·62									
T. R.	2	55 ·20	4	55 ·68	56 ·04						
J. R.	2	56 ·16									
S. P. T. D.	2	—17 ·34. 58 ·90	5	—57 ·91	—58 ·18	6	—58 ·32				
S. P. J. D.	3	57 ·25									
S. P. T. R.	1	59 ·33	1	—59 ·33	—59 ·06						
S. P. J. R.	0	.....									
κ Draconis ... T. D.	10	19. 18. 24 ·18	19	24 ·52	24 ·18	36	24 ·15	42	— 1 ·77	4	— 7 ·08
J. D.	9	24 ·90									
T. R.	8	23 ·78	17	23 ·77	24 ·11						
J. R.	9	23 ·77									
S. P. T. D.	2	—19. 18. 26 ·14	5	—25 ·73	—25 ·98	6	—25 ·92				
S. P. J. D.	3	25 ·46									
S. P. T. R.	1	25 ·85	1	—25 ·85	—25 ·60						
S. P. J. R.	0	.....									

Star's Name, Name of Circle, and Mode of Observation.	No. of Obs.	N.P.D. uncorrected.	No. of similar Obs.	Result of similar Observations.	Result corrected for Discordance.	No. of Obs.	Concluded N.P.D. on assumed Latitude.	No. of Obs.	Algebraic Sum of Determinations.	Weight.	Product.
		° ′ ″		″	″		″				
ξ Ursæ Minoris T. D.	5	19. 47. 45 ·80	10	45 ·89	45 ·56	10	45 ·56	18	− 2 ·19	4	− 8 ·76
J. D.	5	45 ·98									
T. R.	0	.....	0	.....	.....						
J. R.	0	.....									
S. P. T. D.	3	−19. 47. 47 ·71	7	−47 ·47	−47 ·71	8	−47 ·75				
S. P. J. D.	4	47 ·29									
S. P. T. R.	1	48 ·24	1	−48 ·24	−48 ·00						
S. P. J. R.	0	.....									
ε Draconis.... T. D.	7	20. 8. 59 ·26	11	58 ·99	58 ·66	14	58 ·60	29	− 1 ·87	6	−11 ·22
J. D.	4	58 ·53									
T. R.	0	.....	3	58 ·05	58 ·38						
J. R.	3	58 ·05									
S. P. T. D.	6	−20. 8. 59 ·92	13	−60 ·11	−60 ·35	15	−60 ·47				
S. P. J. D.	7	60 ·27									
S. P. T. R.	1	63 ·43	2	−61 ·51	−61 ·27						
S. P. J. R.	1	59 ·59									
β Cephei .... T. D.	9	20. 9. 29 ·50	20	29 ·20	28 ·87	30	29 ·04	60	− 1 ·40	11	−15 ·40
J. D.	11	28 ·96									
T. R.	6	29 ·36	10	29 ·04	29 ·37						
J. R.	4	28 ·55									
S. P. T. D.	13	−20. 9. 30 ·06	25	−30 ·22	−30 ·46	30	−30 ·44				
S. P. J. D.	12	30 ·39									
S. P. T. R.	2	31 ·57	5	−30 ·57	−30 ·33						
S. P. J. R.	3	29 ·90									
ι Cephei ..... T. D.	9	24 39. 38 ·30	17	38 ·60	38 ·37	28	38 ·29	54	− 2 ·00	10	−20 ·00
J. D.	8	38 ·94									
T. R.	5	37 ·37	11	37 ·94	38 ·17						
J. R.	6	38 ·42									
S. P. T. D.	11	−24. 39. 39 ·69	24	−40 ·17	−40 ·37	26	−40 ·29				
S. P. J. D.	13	40 ·58									
S. P. T. R.	2	39 ·50	2	−39 ·50	−39 ·30						
S. P. J. R.	0	.....									
ε Cassiopeiæ.. T. D.	2	27. 8. 29 ·26	4	29 ·93	29 ·75	8	29 ·62	12	− 1 ·38	2	− 2 ·76
J. D.	2	30 ·60									
T. R.	2	29 ·49	4	29 ·30	29 ·48						
J. R.	2	29 ·12									
S. P. T. D.	2	−27. 8. 29 ·97	4	−30 ·82	−31 ·00	4	−31 ·00				
S. P. J. D.	2	31 ·67									
S. P. T. R.	0	.....	0	.....	.....						
S. P. J. R.	0	.....									

Star's Name, Name of Circle, and Mode of Observation.	No. of Obs.	N.P.D. uncorrected.	No. of similar Obs.	Result of similar Observations.	Result corrected for Discordance.	No. of Obs.	Concluded N.P.D. on assumed Latitude.	No. of Obs.	Algebraic Sum of Determinations.	Weight.	Product.
		° ′ ″		″	″		″				
α Ursæ Majoris T. D.	9	27. 21. 55. 64	18	55 ·30	55 ·12	32	55 ·16	52	− 1 ·51	8	−12 ·08
J. D.	9	54 ·95									
T. R.	7	54 ·87	14	55 ·04	55 ·22						
J. R.	7	55 ·21									
S. P. T. D.	9	−27. 21. 55 ·83	18	−56 ·65	−56 ·83	20	−56 ·67				
S. P. J. D.	9	57 ·46									
S. P. T. R.	1	55 ·24	2	−55 ·39	−55 ·21						
S. P. J. R.	1	55 ·55									
θ Cephei .... T. D.	9	27. 33. 18 ·62	17	18 ·94	18 ·76	26	18 ·70	42	− 2 ·13	7	−14 ·91
J. D.	8	19 ·31									
T. R.	4	18 ·23	9	18 ·42	18 ·60						
J. R.	5	18 ·58									
S. P. T. D.	5	−27. 33. 20 ·36	12	−20 ·38	−20 ·56	16	−20 ·83				
S. P. J. D.	7	20 ·40									
S. P. T. R.	3	21 ·94	4	−21 ·82	−21 ·64						
S. P. J. R.	1	21 ·45									
α Cephei..... T. D.	12	28. 6. 25 ·21	18	25 ·73	25 ·57	34	25 ·55	68	− 1 ·93	12	−23 ·16
J. D.	6	26 ·76									
T. R.	5	26 ·41	16	25 ·37	25 ·53						
J. R.	11	24 ·89									
S. P. T. D.	13	−28. 6. 27 ·32	27	−27 ·16	−27 ·33	34	−27 ·48				
S. P. J. D.	14	27 ·00									
S. P. T. R.	4	28 ·27	7	−28 ·21	−28 ·04						
S. P. J. R.	3	28 ·14									
η Cephei..... T. D.	7	28. 47. 44 ·75	13	45 ·43	45 ·28	22	45 ·62	42	− 2 ·40	7	−16 ·80
J. D.	6	46 ·23									
T. R.	4	46 ·85	9	45 ·97	46 ·12						
J. R.	5	45 ·27									
S. P. T. D.	8	−28. 47. 47 ·99	17	−47 ·73	−47 ·89	20	48 ·02				
S. P. J. D.	9	47 ·49									
S. P. T. R.	2	48 ·88	3	−48 ·93	−48 ·77						
S. P. J. R.	1	49 ·03									
υ Ursæ Majoris T. D.	4	30. 11. 40 ·25	14	40 ·27	40 ·15	26	40 ·19	46	− 1 ·87	7	−13 ·09
J. D.	10	40 ·28									
T. R.	9	40 ·03	12	40 ·11	40 ·23						
J. R.	3	40 ·34									
S. P. T. D.	9	−30. 11. 41 ·85	19	−42 ·13	−42 ·28	20	−42 ·06				
S. P. J. D.	10	42 ·38									
S. P. T. R.	1	38 ·11	1	−38 ·11	−37 ·96						
S. P. J. R.	0	.....									

Star's Name, Name of Circle, and Mode of Observation.	No. of Obs.	N.P.D. uncorrected.	No. of similar Obs.	Result of similar Observations.	Result corrected for Discordance.	No. of Obs.	Concluded N.P.D. on assumed Latitude.	No. of Obs.	Algebraic Sum of Determinations.	Weight.	Product.
		° ′ ″		″	″		″				
θ Draconis ... T. D.	5	30. 59. 40 ·75	13	40 ·72	40 ·62	22	40 ·38				
J. D.	8	40 ·70									
T. R.	6	40 ·22	9	39 ·94	40 ·04						
J. R.	3	39 ·38									
S. P. T. D.	7	−30. 59. 42 ·03	13	−41 ·67	−41 ·81	13	−41 ·81	35	− 1 ·43	5	− 7 ·15
S. P. J. D.	6	41 ·24									
S. P. T. R.	0	.....	0	.....	.....						
S. P. J. R.	0	.....									
β Cassiopeiæ.. T. D.	7	31. 45. 17 ·23	14	17 ·24	17 ·15	20	17 ·21				
J. D.	7	17 ·24									
T. R.	3	17 ·92	6	17 ·28	17 ·36						
J. R.	3	16 ·64									
S. P. T. D.	15	−31. 45. 18 ·76	31	−18 ·46	−18 ·59	32	−18 ·59	52	− 1 ·38	7	− 9 ·66
S. P. J. D.	16	18 ·17									
S. P. T. R.	1	18 ·58	1	−18 ·58	−18 ·45						
S. P. J. R.	0	.....									
δ Ursæ Majoris T. D.	13	32. 3. 19 ·56	29	20 ·10	20 ·03	52	20 ·11				
J. D.	16	20 ·52									
T. R.	13	20 ·28	23	20 ·12	20 ·19						
J. R.	10	19 ·92									
S. P. T. D.	9	−32. 3. 22 ·11	16	−21 ·87	−22 ·00	18	−21 ·95	70	− 1 ·84	8	−14 ·72
S. P. J. D.	7	21 ·57									
S. P. T. R.	0	.....	2	−21 ·65	−21 ·52						
S. P. J. R.	2	21 ·65									
δ² Cephei .... T. D.	6	32. 25. 20 ·41	16	20 ·41	20 ·35	24	20 ·46				
J. D.	10	20 ·41									
T. R.	6	20 ·93	8	20 ·63	20 ·69						
J. R.	2	19 ·72									
S. P. T. D.	13	−32. 25. 22 ·28	27	−22 ·46	−22 ·59	28	−22 ·51	52	− 2 ·05	8	−16 ·40
S. P. J. D.	14	22 ·63									
S. P. T. R.	1	20 ·94	1	−20 ·94	−20 ·81						
S. P. J. R.	0	.....									
β Ursæ Majoris T. D.	1	32. 44. 24 ·31	8	25 ·12	25 ·06	16	24 ·77				
J. D.	7	25 ·24									
T. R.	7	24 ·55	8	24 ·42	24 ·48						
J. R.	1	23 ·52									
S. P. T. D.	7	−32. 44. 26 ·08	14	−26 ·13	−26 ·25	14	−26 ·25	30	− 1 ·48	4	− 5 ·92
S. P. J. D.	7	26 ·19									
S. P. T. R.	0	.....	0	.....	.....						
S. P. J. R.	0	.....									

Star's Name, Name of Circle, and Mode of Observation.	No. of Obs.	N.P.D. uncorrected.	No. of similar Obs.	Result of similar Observations.	Result corrected for Discordance.	No. of Obs.	Concluded N.P.D. on assumed Latitude.	No. of Obs.	Algebraic Sum of Determinations.	Weight.	Product
		° ′ ″		″	″		″				
η Cassiopeiæ.. T. D.	2	33. 3. 23·40	6	22·85	22·80	12	23·00	28	— 1·03	4	— 4·12
J. D.	4	22·58									
T. R.	4	23·32	6	23·15	23·20						
J. R.	2	22·80									
S. P. T. D.	8	—33. 3. 23·56	16	—23·91	—24·03	16	—24·03				
S. P. J. D.	8	24·26									
S. P. T. R.	0	.. ..	0	.....	.....						
S. P. J. R.	0	.. ..									
ε Ursæ Majoris T. D.	6	33. 8. 55·20	16	54·65	54·60	22	54·44	26	— 1·25	2	— 2·50
J. D.	10	54·32									
T. R.	5	53·89	6	53·96	54·01						
J. R.	1	54·32									
S. P. T. D.	2	—33. 8. 55·96	3	—56·01	—56·13	4	—55. 69				
S. P. J. D.	1	56·10									
S. P. T. R.	0	.. ..	1	—54·48	—54·36						
S. P. J. R.	1	54·48									
ζ Ursæ Majoris T. D.	14	34. 12. 56·88	29	57·32	57·30	36	57·35	73	— 2·52	10	—25·20
J. D.	15	57·73									
T. R.	4	57·41	7	57·51	57·53						
J. R.	3	57·65									
S. P. T. D.	18	—34. 12. 59·66	36	—59·80	—59·91	37	—59·87				
S. P. J. D.	18	59·95									
S. P. T. R.	0	.. ..	1	—58·65	—58·54						
S. P. J. R.	1	58·65									
α Cassiopeiæ.. T. D.	8	34. 21. 46·41	14	46·62	46·60	21	46·30	50	— 1·93	6	—11·58
J. D.	6	46·89									
T. R.	3	45·94	7	45·67	45·69						
J. R.	4	45·46									
S. P. T. D.	14	—34. 21. 48·04	29	—48·12	—48·23	29	—48·23				
S. P. J. D.	15	48·20									
S. P. T. R.	0	.. ..	0	.....	.....						
S. P. J. R.	0	.. ..									
γ Ursæ Majoris T. D.	10	35. 23. 35·72	26	36·01	36·01	42	35·88	62	— 1·90	6	—11·40
J. D.	16	36·19									
T. R.	11	35·81	16	35·66	35·66						
J. R.	5	35·32									
S. P. T. D.	10	—35. 23. 37·90	20	—37·68	—37·78	20	—37·78				
S. P. J. D.	10	37·46									
S. P. T. R.	0	.. ..	0	.....	.....						
S. P. J. R.	0	.. ..									

It appears from these numbers, that the mean of the refractions employed (Bessel's) is consistent with circumpolar observations (though not, for that reason, necessarily correct) as far as 74° zenith distance. The first five stars (N.P.D. 1°.33′ to 12°.47′) give for $2\,x$, 1″·79; the next six (13°.17′ to 20°.8′) give 1″·98; the six following (20°.9′ to 28°.6′) give 1″·77; the six next in order (28°.47′ to 32°.25′) give 1″·85; and the last six (32°.44′ to 35°.21′) give 1″·90. The final result is 1″·85, or the correction to the co-latitude + 0″·93. The assumed co-latitude is 38°.31′.21″; thus the true co-latitude appears to be 38°.31′.21″·93, or the true latitude 51°.28′.38″·07. I think there is good reason to believe that this value is not one-tenth of a second in error. The whole number of observations immediately employed is 1366.

Combining the correction + 0″·93 for the increase of co-latitude with the correction previously given for the discordance of Direct and Reflexion-observations, the following table is formed.

Correction to be applied algebraically to North Polar Distances, for the Discordance of Direct and Reflexion Results, and for the Error of the assumed Latitude.

N.P.D.	Correction to Results of Direct Observation.	Correction to Results of Reflexion Observation.	N.P.D.	Correction to Results of Direct Observation.	Correction to Results of Reflexion Observation.
°	″	″	°	″	″
−40	+0·88	+0·98	+ 50	+1·22	+0·64
−30	+0·78	+1·08	+ 60	+1·37	+0·49
−20	+0·69	+1·17	+ 70	+1·39	+0·47
−10	+0·58	+1·28	+ 80	+1·37	+0·49
0	+0·49	+1·37	+ 90	+1·31	+0·55
+10	+0·48	+1·38	+100	+1·17	+0·69
+20	+0·60	+1·26	+110	+1·09	+0·77
+30	+0·81	+1·05	+120	+0·98	+0·88
+40	+1·05	+0·81			

This table is to be used for the correction of every result in the two last columns throughout the section of *Calculation of Geocentric North Polar Distances*, &c.

The catalogue of concluded mean N.P.D. of stars contains the results affected with the corrections given by the last table. The annual variations are taken from the Nautical Almanac or the Astronomical Society's Catalogue, or are computed by the same formula. In regard to nomenclature, the same rules are followed as in the Catalogue of Concluded A.R.: Baily's edition of Flamsteed's British Catalogue being considered as the only authority for the letters attached to the unnamed stars.

§ 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,* (page 92 *to* 112.)

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 or Meridian Ephemeris. The excess of the latter over the former is set down as the Error of the Nautical Almanac. The mean of all the values is — $0^s \cdot 17$.

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 formed by doubling the semidiameter of the Nautical Almanac. The mean of all the values of the errors is — $1'' \cdot 50$.

For the duration 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 A.R. 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 × versed sine of θ. The corrections on Jan. 3, July 27, and September 24, are respectively $0^s \cdot 00$, + $0^s \cdot 06$, and – $0^s \cdot 02$. The mean of the values of errors is — $0^s \cdot 41$.

The Moon's vertical diameter is found in the same manner as the Sun's: (the correction for defective illumination having been already applied.) The mean of the values of errors, found by giving the weights 1, 2, 1, 2, 2, 2, 2, 1, to the eight determinations respectively (the weights depending principally on the number of observations in each) is — $6'' \cdot 23$. From the agreement of this determination with the preceding, there appears little doubt that the semidiameter of the Moon in Burckhardt's tables is too small by three seconds.

The vertical diameters of Venus are found by doubling the semidiameters given in the section of *North Polar Distances, &c.* and therefore are not imperfect diameters, as observed in the first instance. The vertical diameters of the other planets are merely the measures given in the section of *Observations with the Mural Circles.* In all cases, when measures have been made with both circles, the mean is taken. The duration of passage of the planet's diameter is formed as for the Sun, &c.

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 at 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. $3^s\cdot00$ — seconds of Sid. Time + solar equiv. for seconds.

Small tables of the 3rd, 4th, and 5th quantities are prepared, 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 or the Meridian Ephemeris.

The Right Ascensions of the Sun are transcribed from those in the ***Transits, &c.*** with no alteration, except that when the first limb only has been observed the correction + $0^s\cdot08$ is applied, and when the second limb only has been observed, the correction — $0^s\cdot08$. The days on which these corrections are applied, are Jan. 15, 26, 30; Feb. 1, 12, 18; March 11; April 2; May 14, 19, 26; June 4; July 7, 14, 27; Aug. 5, Sept. 1, and Oct. 4. The North Polar Distances of the Sun are taken from those in the ***North Polar Distances, &c.*** the correction for discordance of direct and reflexion results and for error of latitude being applied, and the correction + $0''\cdot75$ for the observation of the North limb only on Feb. 18. The tabular places are taken from the Nautical Almanac or the Meridian Ephemeris.

The Right Ascensions of the Moon are taken from the ***Transits,*** the correction + $0^s\cdot20$ being applied when the first limb was observed, and — $0^s\cdot20$ when the second limb was observed. When both were observed, the mean is taken. The Tabular Right Ascension is found by applying to the right ascension of limb (given in the section Moon Culminating stars of the Nautical Almanac,) the time of passage of semidiameter (given in the same.) The North Polar Distances are taken from those in the ***North Polar Distances, &c.***, applying the correction for error of latitude, &c., and the quantity + $3'\cdot12$ when the north limb only was observed, and − 3″·12 when the south limb only was observed. When both limbs were observed, the mean is taken. On Jan. 6 and 7 an extraordinary correction is applied. No observations for determining the zenith point had been made for some days, and the determination nearest in respect of time was adopted for Jan. 6 and 7. It appears, however, that the places of the stars observed at the same time and reduced with the same zenith point are in error, as compared with unexceptionable results, by the following quantities nearly: λ Leonis − 6″·27, γ Leonis − 4″·52, Regulus − 3″·48, χ Leonis − 7″·07. Adopting the weights 2, 3, 4, 1, the mean is − 4″·71. The correction + 4″·71 is therefore applied to the Moon's N.P.D. on Jan. 6 and 7. The tabular N.P.D. are interpolated from the hourly ephemeris of the Nautical Almanac, with second differences.

In addition to the usual column of Errors of Tables, there is one exhibiting the effect of altering the coefficient of parallax (the number being $\frac{1}{1000}$ part of the parallax actually used,) and one exhibiting the effect of the earth's oblateness. The latter is found by separately computing the parallax, considering the geocentric zenith-distance as equal to the astronomical zenith-distance, and the geocentric radius as equal to the equatoreal radius, and taking the difference between this parallax and the parallax actually used.

For all other objects, the Right Ascensions are extracted without alteration from the *Transits, &c.*, and the North Polar Distances from the *North Polar Distances, &c.*, without any correction except for error of latitude, &c. As the semidiameter of Venus used in correcting the Right Ascensions is taken from the Ephemeris, while that used for the N.P.D. is deduced immediately from observations, it is thought necessary to mention the limb observed in A.R., but not that observed in N.P.D. The tabular places are taken entirely from the Meridian Ephemeris.

The investigation of the position of the Ecliptic is conducted in the same manner as the investigations from observations at Cambridge Observatory, given in the Astronomical Society's Memoirs, Vols. 8, 9, and 10. The mean of all the errors in each month, for A.R. 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 A.R. and for N.P.D., an alteration of a unit 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 present volume. Assuming these errors to arise from an erroneous position of the ecliptic assumed in the Nautical Almanac, they may be expressed by the formula $x \times \cos. \odot$ longitude $+ y \times \sin. \odot$ 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.

For the ***Errors in the Tabular Geocentric Places of the Sun and Planets***, the errors in A.R. are increased by $0^{s}{\cdot}01$, as it appears, from a comparison of the assumed A.R. of the principal clock-stars with those used in the Cambridge Observations, that the errors thus altered, will correspond to the same equinox with those in a memoir in the 10th volume of the Royal Astronomical Society's Transactions: to which therefore these calculations may be considered as a continuation. The errors in longitude and E.P.D. are formed by the use of the numbers P, Q, R, S, in the Appendix to this volume. For Vesta, Juno, Pallas, and Ceres, whose latitude exceeded the limits of those tables, the longitude and E.P.D. were computed, 1st, from the A.R. and N.P.D. of the Meridian Ephemeris; 2nd, from these quantities affected with the errors in A.R. 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 Heliocentric 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

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

$$+ \frac{\text{tan.}\,(\lambda - L)}{R \times \text{cos. hel. lat.} \times \text{sin. } 1''} \times \text{error of projection of radius vector.}$$

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

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

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

For the other planets, the following are used:

$$\text{Error of Hel. long.} = \frac{\Delta}{R \times \text{cos.}\,(\lambda - L)} \times \text{error of geocen. long.}$$

$$+ \frac{\text{tan.}\,(\lambda - L)}{R \times \text{sin. } 1''} \times \text{error of projection of radius vector.}$$

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

The Geocentric Longitudes and Latitudes were extracted from the Connaissance des Temps, except for the small planets, for which they are calculated in the preceding operations.

The Weight for Heliocentric Longitude is computed by the formula

$$\sqrt{\text{n}^{\text{o}}\text{. of obs. of A.R.}} \times \frac{1}{\text{coeff. of error of geoc. long.}}$$

And the Weight for Heliocentric Latitude by the formula

$$\sqrt{\text{n}^{\text{o}}\text{. of obs. of N.P.D.}} \times \frac{1}{\text{coeff. of error of geoc. lat.}}$$

§ 7. *Transits of Jupiter and his Fourth Satellite, &c.* (page 114 to 121.)

The comparisons of the clock, Arnold 1, with the Transit Clock, are given in detail, on account of the irregular rate of the former.

With respect to the observations, it seems necessary to mention only that the telescope was not moved in the time embraced by the observations included between the black lines.

The light equation was computed by the formula $493^{s}{\cdot}09$ × Jupiter's distance from the earth.

The application of these observations to the determination of Jupiter's mass will be found in the 10th volume of the Memoirs of the Royal Astronomical Society.

§ 8. *Differences of Right Ascension and of North Polar Distance between Saturn and neighbouring Stars, and between Venus and neighbouring Stars, &c.* (page 124.)

Before commencing these observations, it was supposed that the Eastern Equatoreal was in pretty good adjustment. The discordances however in the apparent absolute polar distances led me to suspect errors of adjustment; and from a series of observations of N.P.D. of stars at different hour-angles (made by Mr. Main) duly corrected for refraction, it appeared that the elevation of the pole was nearly correct, but that in the meridian of 6^{h} and 18^{h} its position was nearly 8′ in error. This however would produce no sensible effect on the following results. No examination of the other adjustments was made.

A more serious cause of possible error is the looseness of the clamps. It was the belief of the observers, that the instrument admitted of a small motion when the clamping-screws on both circles were firmly pressed. I endeavoured to verify this remark by observations of a day-mark, but I could not find with certainty that the telescope had any motion except that allowed by the spring of materials. The clamps, however, admitted of being made more tight (by driving the screws, on whose conical points the universal-joint-motion takes place, for the small play necessary to the slow-motion-screw,) and this was done in the month of August. At the same time a counterpoise on the upper bearing of the polar axis was removed.

In a few instances only of the observations here given, the graduations of the declination-circle have been employed. These graduations are upon brass, and in some parts of the circle are nearly effaced. I think it probable also, from the occurrence of irregularities in the attempt to investigate the errors of runs of the micrometer-microscopes, that the division is not very good: but I have not expressly examined into this matter. The interval of divisions is 10′.

From the irregularities above mentioned, it was impossible to ascertain exactly the correction for runs. It appeared however to be small, and I have therefore thought that it might without imprudence be neglected.

The values of the micrometer-revolutions have been ascertained from observation of a day-mark (reading the circle with its microscopes when the micrometer-wires were placed in different positions and brought upon the mark:) these observations have been several times repeated. The examination of coincidences has also been several times repeated. It therefore appears unnecessary to give the details.

The transits, when incomplete, have been completed by ascertaining the intervals with other transits of the same object on the same day. When the first and third wire have been used, their mean is assumed to coincide with the second, but the order has, in successive series, been so interchanged, that the mean will not be affected by any error in this assumption.

The refractions have been computed by the following formula. 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 A.R. $= \frac{57^s}{15} \times \frac{\text{tan. } ZQ}{\text{sin. } PS. \text{ cos. } (PS - PQ)}$. Tables are prepared, containing the values of P Q and tan. Z Q for different values of the hour-angle: and the computation for each instance is then very easy.

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

The star's assumed place is brought up from Mr. Pond's Catalogue of 1112 stars, with the corrections of the Astronomical Society's Catalogue and the Nautical Almanac.

The time by Arnold 1 or Arnold 2, is converted into Sidereal Time by means of comparisons with the Transit Clock, which are here wholly suppressed. It is to be remarked, that comparisons of the clocks have usually been made immediately after the observations of each night, and these have been used for the computation of the Clock Error: but the clocks have also been regularly compared once in every week, and by the weekly comparisons the others have been checked. It is presumed therefore, that there is little chance of constant error in the sidereal times.

The conversion of Sidereal into Mean Solar Time, and the interpolation from the Nautical Almanac with Second Differences, are made in the usual way.

§ 9. *Observations of the Solar Eclipse of* 1836, *May* 15; *with the Equations deduced from the Micrometrical Measures.*

The observations and reductions for the beginning and end of the Eclipse require no particular comment. The observation of the beginning is extremely doubtful, as the Sun was nearly hidden by clouds.

The rest of the observations consist entirely of Micrometrical Measures of differences of North Polar Distances of cusps, limbs, or cusp and limb. They were carried on with both instruments with little interruption during the whole eclipse, except that during the middle of the eclipse the sun was concealed from the Eastern Equatoreal by the Great Room of the Observatory. The objects of observation were previously arranged, in order to secure as far as possible the means of correcting all the elements (difference of right ascension of centers, difference of north polar distance of centers, and semidiameters) affecting the phenomenon.

The observations with the Western Equatoreal were made by Mr. Main, the numbers being written down by Mr. Richardson: and those with the Eastern Equatoreal by Mr. Glaisher, the numbers being written down by Mr. Ellis.

There appear to be in the results of observation some traces of the unsteadiness of the Eastern Equatoreal whose suspected existence has been already mentioned. In a few instances there is little doubt that an error of one revolution of the micrometer-screw has been committed: others suggest the notion, that the screws are, in different parts of their length, unequal; but observations made in the year 837, on day-marks, do not give any decided support to this opinion.

1 In the table of Geocentric Quantities, the right ascension and north polar distance of the Sun and Moon, and the Moon's semidiameter and equatoreal horizontal parallax, have been interpolated with second differences from the Nautical Almanac.

For the table of Apparent Quantities, the Sun's right ascension and north polar distance have been corrected for parallax, in the manner described above for Saturn and Venus (with sign changed.) The Moon's apparent right ascension has been computed by the tentative formula.

$$\text{Log. sin. }(\theta-\theta') = 9{\cdot}7952487 + \text{log. sin. } P + \text{log. sin. } \theta + \text{log. sin. } \delta'.$$

The Moon's apparent north polar distance has been computed by the formula,

$$2 \text{ log. sin. } \psi = 9{\cdot}8913926 + \text{log. sin. } P - \text{Log. cos. } \delta'.$$

$$\text{log. cot. } \delta = \text{log. sin. } \theta - \text{log. sin. } \theta' + \text{log. cot. } \delta' + 2 \text{ log. cos. } \psi.$$

(The constant numbers are the logarithms of the equatoreal and polar coordinates of Greenwich.)

The Moon's apparent semidiameter by the formula,

$$\text{log. } s = \text{log. } s' + \text{log. sin. } \theta - \text{log. sin } \theta' + \text{log. sin. } \delta - \text{log. sin. } \delta'.$$

These calculations have been made independently for every 10^m, and the results then examined by differences.

For further computations, the values were interpolated to every minute with second differences (by addition of differences,) assuming,

$$\text{2nd difference for } 1^m = \frac{1}{100} \text{ mean of adjacent 2nd differences for } 10^m.$$

$$\text{1st difference for } 1^m = \frac{1}{10} \text{ 1st difference for } 10^m.$$

$$- \frac{45}{10} \text{ 2nd difference for } 1^m.$$

For fractions of a minute, the interpolation was further made with first differences only.

For the Micrometrical Observations with the Eastern Equatoreal, the Time by the Transit Clock has been obtained, supposing that at $4^h.50^s$ sidereal, Arnold 1 was fast on the Transit Clock $1^m.12^s{\cdot}45$, and at $8^h.26^m$ sidereal, it was fast $1^m.13^s{\cdot}25$. The time by Transit Clock was reduced to Sidereal Time by the error and rate in the section of Transits, and this was converted into Mean Solar Time in the usual manner.

The micrometer-reading was converted into arc by multiplying the reading of *a* by $31''{\cdot}471$, and that of *b* by $31''{\cdot}588$, and taking their sum. These values are the mean of several determinations about that time: the coincidence, as examined on May 17, appeared to be at $0^r{\cdot}000$.

To correct this for the effects of refraction, the refraction in N.P.D. was computed for several hour-angles through the eclipse, and for the polar distances $70^\circ.30'$ and $71^\circ.30'$. The difference of these numbers gave the effect of refraction on a measured arc of 1° of N.P.D., and a proportionate part was taken as a correction for the arc actually measured.

The computation of tabular N.P.D. of a limb (consisting only of the addition of interpolated N.P.D. of center to interpolated semidiameter,) requires no further remark. That of N.P.D. of a cusp was done by a tentative process. Putting x for the N.P.D. of a cusp, the equations to be satisfied are,

$$Z^2 = \frac{S^2 - (\Delta - x)^2}{\sin.\ \Delta\ \sin.\ x}$$

$$z^2 = \frac{s^2 - (\delta - x)^2}{\sin.\ \delta\ \sin.\ x}$$

$$Z + z = a$$

These equations, though not strictly accurate, are never erroneous to the amount of $0''{\cdot}01$.

The co-efficients of small errors of elements are computed by the following formulæ:

$$Q = \frac{\Delta - x}{Z\ \sin.\ \Delta\ \sin.\ x}$$

$$q = \frac{\delta - x}{z\ \sin.\ \delta\ \sin.\ x}$$

$$\text{Co-efficient of d } a = \frac{1}{Q + q}$$

$$\text{Co-efficient of d } S = -\frac{S}{Z\ \sin.\ \Delta\ \sin.\ x\ (Q + q)}$$

$$\text{Co-efficient of d } s = -\frac{s}{z\ \sin.\ \delta\ \sin.\ x\ (Q + q)}$$

$$\text{Co-efficient of d } \Delta = \frac{Q}{Q + q}$$

$$\text{Co-efficient of d } \delta = \frac{q}{Q + q}$$

These expressions are found by differentiating the equations above, neglecting the variation of x in the denominator; they are not therefore accurate, but their error is insensible. For the Observations with the Western Equatoreal, the same remarks apply with the following alterations. At $4^h.\ 54^m$ sidereal, Arnold 2 was slow on the Transit clock $24^s{\cdot}5$, and at $8^h.16^m$ it was slow $24^s{\cdot}3$. The reading of one micrometer, when its wire coincided with the wire of the other in the zero position, was found $= 0^r{\cdot}004$: this quantity is therefore subtracted from the reading, and the remainder is multiplied by $118''{\cdot}18$ for A and $117''{\cdot}94$ for B.

The equations given by the observations have not been solved, as I have not yet had leisure for examining the cases which appear to require alteration or to merit rejection.

§ 10. *Eclipses, &c. of Jupiter's Satellites, and Occultations of Stars by the Moon: with the Equations deduced from the Occultations.*

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 Computation 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. The hor. eq. parallax is then corrected by a quantity taken from the following Table, depending on the zenith-distance (Z), and the angle from the vertical (on the Moon's limb,) as seen in an inverting telescope, at which the occultation takes place, (V.) The investigation from which this table is formed, is given in the Cambridge Observations, 1831, Introduction.

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

Z is found by means of a celestial globe: *V* is taken from the Nautical Almanac. The eq. hor. parallax thus corrected is applicable to the point of the limb at which the occultation happens.

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 relation of these numbers to the numbers used in the solar eclipse will be immediately seen.)

Then, putting θ for the apparent hour-angle of the point of occultation = star's hour-angle,

δ for the apparent N.P.D. of the point of occultation = star's N.P.D.

θ' and δ' for the geocentric hour-angle and N.P.D. of the corresponding point on the Moon's surface, (namely, the point of contact of a line drawn from the Earth's center in the vertical plane passing through the point of occultation,)

the following equations are solved by successive trials:

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

$$+ \log.\ \frac{\text{arc}}{\text{sine}}\ \text{for}\ (\theta - \theta)$$

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

$$+ \log.\ \frac{\text{arc}}{\text{sine}}\ \text{for}\ (\delta - \delta') - \log.\ \text{sine}\ \tfrac{1}{2}\ (\theta + \theta')$$

$$\log.\ 2^{\text{d}}\ \text{n}^{\circ} = \log.\ \tfrac{1}{2}\ (\theta - \theta')\ \text{in seconds} + \log.\ \frac{\text{tan.}}{\text{arc}}\ \text{for}\ \tfrac{1}{2}\ (\theta - \theta')$$

$$+ \log.\ \sin.\ (\delta + \delta' - 180) + \log.\ \cot.\ \tfrac{1}{2}\ (\theta + \theta') + \log.\ \frac{\text{arc}}{\text{sine}}\ \text{for}\ (\delta - \delta')$$

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

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:

log. tan. ψ = log. diff. A.R. of Moon's center and corresponding point + $\tfrac{1}{2}$ log. sin. N.P.D. of Moon's center + $\tfrac{1}{2}$ 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. A.R. + $\tfrac{1}{2}$ log. sin. N.P.D. of center + $\tfrac{1}{2}$ 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. A.R. + log. sine (sum of N.P.D.) — log. dist. + 4·0835.

log. 2^{d} n° = log. diff. N.P.D.— log. distance.

Co-efficient of variation of greater N.P.D. = 1^{st} n° + 2^{d} n°.

Co-efficient of variation of smaller N.P.D. = 1^{st} n° – 2^{d} n°.

Log. co-efficient of variation of diff. A.R. =

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

And the variation of the A.R. of the corresponding point is found by applying $e'' + \frac{m}{1000} \times$ parallax in A.R.: that of the A.R. of the moon's center by applying $x'' + t \times$ change of A.R. in 1^{s}: that of the N.P.D. of corresponding point, by applying $f'' + \frac{m}{1000} \times$ parallax in N.P.D.: that of the N.P.D. of the moon's center by applying $y'' + t \times$ change of N.P.D. in 1″: and that of the moon's semidiameter by applying $\frac{n}{1000} \times$ semidiameter. The semidiameter affected with the last correction, is made equal to the distance affected with the sum of the products of the preceding variations by their proper co-efficients: and thus the final equation is formed.

§ 11. *Meteorological Observations on the Days of the Equinoxes and Solstices.*

These observations were made in conformity with a recommendation of Sir John Herschel, extensively circulated in this country. The observations are given without any correction.