

GREENWICH OBSERVATIONS,

1837.

INTRODUCTION.

I. *Personal Establishment and Arrangements.*

THE establishment of Assistants, and the division of the labours of the Observatory among them, remain in all respects in the same state as in the year 1836. I refer therefore to the statement in the Introduction to the volume for 1836 for the account of these particulars.

II. *Instruments.*

The instruments remain, in all respects, in the state described in the Introduction to the volume for 1836. The Zenith Tube, in its altered state, being not fully described in that Introduction, a more detailed account may with propriety be placed here.

The focal length of the vertical telescope is about 25 feet, and its aperture 5 inches. It turns horizontally upon a conical pivot at its lower end, and in a collar with steadying springs at nearly 5 feet from its upper end. This collar is carried by the upper extremity of a very large iron tube, within which the tube of the telescope revolves without touching it: the iron tube is supported by four curved iron legs diverging from its lower extremity, which is 4 feet 8 inches above the lower extremity of the telescope: the iron tube has no other support; and neither the iron tube nor its legs is connected with the walls of the building. At $3\frac{1}{2}$ inches below the object glass, the wire of the plumb-line is attached to a reel exterior to the telescope-tube (carried by the tube), and, passing over a screw, depends in the interior of the tube. The use of the screw is, to enable the observer to move the point of suspension laterally, either for the convenience of bringing the wire to the center of the field of the microscopes, or for

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the estimation of the relative values of the micrometers (to be mentioned hereafter). The wire in the greater part of its length passes within a small tube fixed within the telescope-tube: the plumb-bob hangs in a pot of water attached below the plate closing the lower end of the telescope-tube. At $5\frac{1}{2}$ inches below the screw, a micrometer-microscope is fixed on the same side of the tube, for observing the upper part of the wire: at the opposite side of the tube is an aperture with a reflector, for illuminating the microscope. At $1\frac{1}{2}$ inches above the lower end of the telescope, another micrometer-microscope is fixed on the opposite side of the tube, for observing the lower part of the wire. In the eye-piece of the telescope there are, carried by a fixed plate, ten pairs of wires arranged as acute crosses; and, carried by the moveable micrometer-plate, eleven single wires, whose intervals are not very different from those of the fixed crosses. This moveable plate is made to slide by a micrometer-screw acting in opposition to a spring in the usual way: its range is such as will carry any one of the moveable wires to touch the adjacent fixed wires on each side. The eye-piece is a four-glass eye-piece with a diagonal reflector: it is carried by a separate slider.

In the daily use of the Zenith Tube, it is reversed in azimuth after each observation.

III. *Subjects of Observation in the Year 1837.*

The Sun, Moon, and Planets have been observed at every practicable opportunity: except on Sundays, when the Moon only (with accompanying stars) is observed.

The stars observed with the meridional instruments, are those remaining on the lists for the observations of 1836, with the addition of a few stars required for the reduction of Sir John Herschel's observations of Halley's Comet (to be published in the Memoirs of the Royal Astronomical Society), and of an extensive catalogue circulated by Mr. Baily as requiring re-observation.

The observations of the Duration of Transit of the Moon's Diameter were made for the purpose of correcting Burckhardt's tabular semidiameter, which appears to be considerably too small.

IV. *Explanation of the Printed Observations.*

§ 1. *Transits as observed, and calculation of Apparent Right Ascensions*, page [1] to [143].

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.

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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 and λ 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.

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 of 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:

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For an equatoreal star.

<i>A</i>	+38 [·] 558
<i>B</i>	+25 [·] 672
<i>C</i>	+12 [·] 939
<i>D</i>	+ 0 [·] 046
<i>E</i>	−12 [·] 872
<i>F</i>	−25 [·] 749
<i>G</i>	−38 [·] 598

For Polaris, declination = $88^{\circ}.26' + n''$.

<i>A</i>	+23 [·] 32 [·] 80 + $n \times 0·254$
<i>B</i>	+15 [·] 39 [·] 72 + $n \times 0·169$
<i>C</i>	+ 7 [·] 53 [·] 37 + $n \times 0·085$
<i>D</i>	+ 1 [·] 67
<i>E</i>	− 7 [·] 50 [·] 90 − $n \times 0·084$
<i>F</i>	−15 [·] 42 [·] 55 − $n \times 0·169$
<i>G</i>	−23 [·] 34 [·] 07 − $n \times 0·254$

For δ Ursæ Minoris, declination = $86^{\circ}.34' + n''$.

<i>A</i>	+10 [·] 44 [·] 07 + $n \times 0·052$
<i>B</i>	+ 7 [·] 8 [·] 74 + $n \times 0·035$
<i>C</i>	+ 3 [·] 36 [·] 07 + $n \times 0·017$
<i>D</i>	+ 0 [·] 77
<i>E</i>	− 3 [·] 34 [·] 95 − $n \times 0·017$
<i>F</i>	− 7 [·] 10 [·] 03 − $n \times 0·035$
<i>G</i>	−10 [·] 44 [·] 66 − $n \times 0·052$

These numbers were derived from nineteen transits of Polaris ending with 1836, 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

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

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

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

where *I* is the increase (in seconds of time) of the Moon's A. R., for the transit over a

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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. For the measurement of the error of collimation, the following methods have been used. The use of the meridian marks at Blackwall and Chingford has been given up: the former being too broad for 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 in 1836 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 in 1836.

The value of one revolution of the micrometer-screw was found in 1836 to be $16''.266$.

The following are the details of the observations for the error of collimation in 1837.

Jan. 4. Mr. Main changed the position of the wire-plate, and then made the following observations:

Illuminated end East (1st Set).	<i>r</i>
Micrometer reading on coincidence with collimator (6 measures)	10.832
Illuminated end West (2nd Set).	
Micrometer reading on coincidence with collimator (6 measures)	9.518
Illuminated end East (3rd Set).	
Micrometer reading on coincidence with collimator (6 measures)	10.909

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Illuminated end West (4th Set).	<i>r</i>
Micrometer reading on coincidence with collimator (6 measures)	9·428
Illuminated end East (5th Set).	
Micrometer reading on coincidence with collimator (6 measures)	10·923
Illuminated end West (6th Set).	
Micrometer reading on coincidence with collimator (6 measures)	9·436
Hence reading for line of collimation by 1st and 2nd Sets	10·175
,, ,, by 3rd and 4th Sets	10·169
,, ,, by 5th and 6th Sets	10·179
Reading for true line of collimation	10·174
Micrometer reading on coincidence with <i>D</i> (6 measures)	10·191
Hence apparent error of collimation for <i>D</i>	0·017

The readings of the micrometer increase as the wire is moved from the illuminated end: hence (illuminated end West) stars above the pole pass the wire *D* later than they pass the line of collimation, or the error of collimation for *D* is negative, and equal to $-0^{\circ}017$, or $-0^{\circ}28$. Correcting this by the quantities $-0^{\circ}19$ for diurnal aberration, and $+0^{\circ}69$ for the distance of *D* for the mean of the seven wires, the error of collimation for the mean of the seven wires is $+0^{\circ}22$.

March 15. Observations by Mr. Main.

Illuminated end West (1st Set).	<i>r</i>
Micrometer reading on coincidence with collimator (8 measures)	12·897
Illuminated end East (2nd Set).	
Micrometer reading on coincidence with collimator (6 measures)	7·425
Reading for true line of collimation	10·161
Micrometer reading on coincidence with <i>D</i> (10 measures)	10·183
Hence apparent error of collimation for <i>D</i>	0·022

The wind was so high, that only two complete sets of measures could be obtained. They were sufficient to show that no particular change had taken place: but no further use was made of the result.

April 13. Observations by Mr. Main. The morning cloudy, and the circumstances generally favourable.

Illuminated end West (1st Set).	<i>r</i>
Micrometer reading on coincidence with collimator (6 measures)	12·172

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Illuminated end East (2nd Set).	<i>r</i>
Micrometer reading on coincidence with collimator (6 measures)	8·165
Illuminated end West (3rd Set).	
Micrometer reading on coincidence with collimator (6 measures)	12·172
Illuminated end East (4th Set).	
Micrometer reading on coincidence with collimator (6 measures)	8·172
Illuminated end West (5th Set).	
Micrometer reading on coincidence with collimator (6 measures).	12·196
Illuminated end East (6th Set).	
Micrometer reading on coincidence with collimator (6 measures).	8·176
Hence reading for line of collimation by 1st and 2nd Sets	10·168
,, ,, by 3rd and 4th Sets	10·172
,, ,, by 5th and 6th Sets	10·186
Reading for true line of collimation	10·175
Micrometer reading on coincidence with <i>D</i> (10 measures)	10·185
Hence apparent error of collimation for <i>D</i>	0·010

The value of this quantity is $-0''\cdot16$, which corrected as before gives for the error of collimation of the mean of the seven wires $+0''\cdot34$.

July 12. Observations by Mr. Main. The day still and cloudy.

Illuminated end West (1st Set).	<i>r</i>
Micrometer reading on coincidence with collimator (6 measures)	8·742
Illuminated end East (2nd Set).	
Micrometer reading on coincidence with collimator (6 measures).	11·622
Illuminated end West (3rd Set).	
Micrometer reading on coincidence with collimator (6 measures).	8·779
Illuminated end East (4th Set).	
Micrometer reading on coincidence with collimator (6 measures)	11·618
Illuminated end West (5th Set).	
Micrometer reading on coincidence with collimator (6 measures)	8·856
Illuminated end East (6th Set).	
Micrometer reading on coincidence with collimator (6 measures)	11·537
Hence reading for true line of collimation by 1st and 2nd Sets	10·182
,, ,, by 3rd and 4th Sets	10·199
,, ,, by 5th and 6th Sets	10·196
Reading for true line of collimation	10·192
Micrometer reading on coincidence with <i>D</i> (10 measures)	10·206
Hence apparent error of collimation for <i>D</i>	0·014

The value of this quantity is $-0''\cdot23$, and from this the error of collimation of the mean of the seven wires is found (as before) to be $+0''\cdot27$.

October 18. Observations by Mr. Main. Two sets of measures were rejected, the sun having suddenly broken out. It again became cloudy, and the following measures were taken under favourable circumstances.

Illuminated end West (1st Set).	<i>r</i>
Micrometer reading on coincidence with collimator (6 measures).....	7·609
Illuminated end East (2nd Set).	
Micrometer reading on coincidence with collimator (6 measures)	12·797
Illuminated end West (3rd Set).	
Micrometer reading on coincidence with collimator (6 measures).....	7·527
Illuminated end East (4th Set).	
Micrometer reading on coincidence with collimator (6 measures)	12·713
Illuminated end West (5th Set).	
Micrometer reading on coincidence with collimator (6 measures)	7·625
Illuminated end East (6th Set).	
Micrometer reading on coincidence with collimator (6 measures)	12·711
Hence reading for line of collimation by 1st and 2nd Sets	10·203
„ „ by 3rd and 4th Sets	10·120
„ „ by 5th and 6th Sets	10·168
Reading for true line of collimation	10·164
Micrometer reading on coincidence with <i>D</i> (10 measures).....	10·169
Hence apparent error of collimation for <i>D</i>	0·005

The value of this quantity is $-0''\cdot08$: whence the error of collimation of the mean of the seven wires is $+0''\cdot42$.

The error of collimation used on Jan. 1 and 2 is derived from the observations of 1836, Dec. 18.

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

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

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. The value of one division of the level-scales was ascertained in 1836 to be $1''\cdot086$.

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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,

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

On March 18, the pivots of the transit were carefully examined by Mr. Main and Mr. Henry, and found to be in excellent order. The level was applied, and its indications carefully noted in various positions of the transit-telescope; but no motion of the bubble could be observed.

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.

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

In a few instances, δ Ursæ Minoris has been used instead of Polaris.

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

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

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

March 14. The Chingford mark seen distinctly, but unsteady. Observations by Mr. Main.

Reading of micrometer for center of mark (mean of 16 contacts).....	10 ^{''} ·341
Reading for D	10 ^{''} ·538
Mark apparently nearer to the illuminated end than D (that is apparently W. of D)	0 ^{''} ·197
The value of this quantity is 3 ^{''} ·20.	

But the line of collimation was West of D about 0^{''}·28; therefore the image of the mark was West of the line of collimation by 2^{''}·92, or the mark was East of the line of collimation by 2^{''}·92.

But the azimuthal error, as determined on March 11, was + 4^{''}·27 (which is probably too great for March 14, the next determination being much less), and therefore, when directed to the North, the line of collimation was West of the meridian by 4^{''}·27, or a smaller quantity.

Consequently the mark is West of the meridian by 1^{''}·35, or a smaller quantity.

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 1837, Jan. 1, which in fact are used in these computations, and the constant alterations to the places of the Nautical Almanac.

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Star's Name.	Assumed Mean A.R. Jan. 1, 1837.	Correction to N.A.	Star's Name.	Assumed Mean A.R. Jan. 1, 1837.	Correction to N.A.
γ Pegasi.....	^h 0. ^m 4. ^s 51.01	— 0.07	Spica.....	^h 13. ^m 16. ^s 36.88	— 0.03
β Ceti.....	0. 35. 24.28	— 0.06	η Bootis.....	13. 46. 55.43	— 0.14
θ^1 Ceti.....	1. 15. 52.65	— 0.16	Arcturus.....	14. 8. 13.77	+ 0.01
α Arietis.....	1. 57. 59.94	+ 0.04	ϵ Bootis.....	14. 37. 52.13	0.00
γ Ceti.....	2. 34. 51.68	— 0.18	α^2 Libræ.....	14. 41. 52.38	— 0.14
α Ceti.....	2. 53. 45.93	— 0.04	β Libræ.....	15. 8. 14.62	— 0.14
η Tauri.....	3. 37. 48.50	+ 0.09	α Coronæ Borealis.	15. 27. 47.32	+ 0.04
γ^1 Eridani.....	3. 50. 25.65	+ 0.01	α Serpentis.....	15. 36. 14.65	+ 0.03
Aldebaran.....	4. 26. 34.52	+ 0.03	β^1 Scorpii.....	15. 55. 58.16	— 0.11
Rigel.....	5. 6. 42.45	— 0.01	δ Ophiuchi.....	16. 5. 48.59	— 0.03
β Tauri.....	5. 15. 59.60	— 0.01	Antares.....	16. 19. 25.47	— 0.03
δ Orionis.....	5. 23. 40.92	— 0.07	α Herculis.....	17. 7. 13.06	— 0.04
α Leporis.....	5. 25. 32.64	0.00	α Ophiuchi.....	17. 27. 22.29	+ 0.04
ϵ Orionis.....	5. 27. 56.71	— 0.03	μ^1 Sagittarii.....	18. 4. 0.96	— 0.18
α Orionis.....	5. 46. 20.98	0.00	α Lyræ.....	18. 31. 25.26	+ 0.11
μ Geminorum.....	6. 13. 5.97	+ 0.03	β Lyræ.....	18. 44. 3.81	— 0.05
Sirius.....	6. 37. 57.99	+ 0.17	ζ Aquilæ.....	18. 57. 55.12	— 0.06
δ Geminorum.....	7. 10. 23.01	— 0.04	δ Aquilæ.....	19. 17. 16.77	+ 0.10
Castor.....	7. 24. 11.41	— 0.08	γ Aquilæ.....	19. 38. 30.58	— 0.08
Procyon.....	7. 30. 45.92	— 0.18	α Aquilæ.....	19. 42. 49.72	— 0.12
Pollux.....	7. 35. 20.01	— 0.01	β Aquilæ.....	19. 47. 18.38	— 0.06
ϵ Argûs.....	8. 0. 36.40	+ 0.09	α^2 Capricorni.....	20. 9. 0.30	— 0.05
ϵ Hydræ.....	8. 38. 8.43	— 0.11	ζ Cygni.....	21. 6. 0.13	— 0.06
α Hydræ.....	9. 19. 34.68	— 0.04	β Aquarii.....	21. 22. 58.41	— 0.02
ϵ Leonis.....	9. 36. 35.25	— 0.07	ϵ Pegasi.....	21. 36. 10.83	— 0.06
Regulus.....	9. 59. 41.14	— 0.13	α Aquarii.....	21. 57. 24.61	— 0.07
δ Leonis.....	11. 5. 25.84	+ 0.09	ζ Pegasi.....	22. 33. 20.09	+ 0.04
δ Hydræ et Crateris	11. 11. 11.90	+ 0.08	Fomalhaut.....	22. 48. 37.67	— 0.07
β Leonis.....	11. 40. 44.50	0.00	α Pegasi.....	22. 56. 38.78	— 0.04
β Corvi.....	12. 25. 50.29	— 0.02	ϵ Piscium.....	23. 31. 34.15	+ 0.05
12 Canum Venat...	12. 48. 23.55	— 0.24	α Andromedæ.....	23. 59. 58.55	+ 0.04

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, 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 δ Ursæ Minoris, and Mean Right Ascensions of Stars observed in the Year 1837, page [128] to [143].*

The apparent right ascensions of Polaris and δ Ursæ Minoris 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 and δ Ursæ Minoris 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).

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

$$A a + B b + C c + C d$$

or

$$\frac{A}{15} \cos. A.R. \operatorname{cosec}. N.P.D. + \frac{B}{15} \sin. A.R. \operatorname{cosec}. N.P.D. + C \sin. A.R. \cotan. N.P.D. \times$$
$$n^{\circ} \log. 0.1259 + \frac{D}{15} \cos. A.R. \cotan. N.P.D. + C. \times n^{\circ} \log. 0.4869,$$

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 [141], &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).*

The position of each circle, as to the approximate coincidence of the curve 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.						
D A Y, 1837.	Object.	Transit by Graham 2.	Time by Hardy.	Sidereal Time.	Sec.of A.R.	Error.
January. . 7 ,,	α Arietis	^h 1. 57. 28. 25	^h 1. 57. 31. 02	^h 1. 57. 59. 91	59. 50	+ 0. 41
	γ Ceti	2. 34. 20. 03	2. 34. 22. 99	2. 34. 51. 91	51. 83	+ 0. 08
February . 24	Regulus	9. 58. 51. 56	9. 59. 27. 06	9. 59. 42. 58	42. 58	0. 00

TRANSITS FOR THE POSITION OF TROUGHTON'S CIRCLE— <i>continued</i> .						
DAY, 1837.	Object.	Transit by Graham 2.	Transit by Hardy.	Sidereal Time.	Sec. of A.R.	Error.
March... 18	Regulus	^h 9. 59. ^m 3.94	^h 9. 59. ^m 5.14	^h 9. 59. ^m 43.15	^s 42.58	+ 0.57
23	Pollux.	7. 34. 11.80	7. 34. 41.20	7. 35. 21.33	20.76	+ 0.57
April.... 26	α Hydræ.....	9. 18. 45.98	9. 18. 40.98	9. 19. 34.72	35.26	— 0.54
May..... 1	ϵ Leonis.....	9. 35. 48.06	9. 35. 41.76	9. 36. 37.19	36.22	+ 0.97
9	α Hydræ.....	9. 19. 10.10	9. 18. 37.20	9. 19. 35.10	35.09	+ 0.01
,,	β Leonis	11. 40. 22.23	11. 39. 48.54	11. 40. 46.49	45.88	+ 0.61
,,	γ Centauri.....	13. 36. 4.10	13. 35. 29.81	13. 36. 27.79	28.70	— 0.91
,,	δ Centauri.....	13. 42. 3.50	13. 41. 29.21	13. 42. 27.19	28.09	— 0.90
,,	Arcturus.....	14. 7. 52.88	14. 7. 18.38	14. 8. 16.36	15.64	+ 0.72
,,	α Libræ.....	14. 41. 30.70	14. 40. 56.15	14. 41. 54.14	54.25	— 0.11
10	Polaris S. P.	13. 0. 8.00	12. 59. 27.80	13. 0. 26.21	27.36	— 1.15
16	20 Libræ.....	14. 54. 45.05	14. 53. 33.75	14. 54. 34.71	34.73	— 0.02
,,	β Libræ.....	15. 8. 27.30	15. 7. 16.00	15. 8. 16.97	16.58	+ 0.39
17	β Leonis	11. 40. 57.46	11. 39. 45.01	11. 40. 46.09	45.80	+ 0.29
,,	β Corvi	12. 26. 2.83	12. 24. 50.29	12. 25. 51.38	51.53	— 0.15
,,	Spica.....	13. 16. 50.03	13. 15. 37.36	13. 16. 38.46	38.42	+ 0.04
23	ϵ Bootis.....	14. 38. 40.48	14. 36. 51.43	14. 37. 54.56	54.23	+ 0.33
26	α Ursæ Majoris...	10. 54. 39.95	10. 52. 35.55	10. 53. 40.49	38.63	+ 1.86
July..... 9	α Orionis.....	5. 46. 52.02	5. 45. 46.52	5. 46. 21.21	20.93	+ 0.28
10	Sirius	6. 38. 31.58	6. 37. 21.58	6. 37. 57.25	57.41	— 0.16
16	Sirius	6. 38. 46.80	6. 37. 18.42	6. 37. 57.88	57.51	+ 0.37
26	Sirius	6. 37. 57.23	6. 37. 12.03	6. 37. 58.23	57.68	+ 0.55
28	Procyon	7. 30. 47.50	7. 29. 58.70	7. 30. 46.34	46.21	+ 0.13
August.. 4	Sirius	6. 38. 31.30	6. 37. 6.60	6. 37. 57.89	57.86	+ 0.03
8	Sirius	6. 39. 9.64	6. 37. 3.64	6. 37. 57.98	57.94	+ 0.04
13	Sirius	6. 39. 27.92	6. 37. 0.42	6. 37. 58.22	58.06	+ 0.16
,,	Procyon.....	7. 31. 16.70	7. 29. 49.20	7. 30. 47.03	46.50	+ 0.53
,,	Pollux.....	7. 35. 51.20	7. 34. 23.70	7. 35. 21.53	20.63	+ 0.90
14	Pollux.....	7. 35. 56.50	7. 34. 22.80	7. 35. 21.63	20.66	+ 0.97
September 20	Polaris S. P.	13. 2. 22.00	13. 1. 7.50	13. 1. 27.66	53.64	— 25.98
22	Regulus	10. 0. 52.07	9. 59. 20.87	9. 59. 42.52	42.19	+ 0.33
25	Regulus	10. 1. 12.94	9. 59. 18.84	9. 59. 42.21	42.24	— 0.03
October.. 14	Arcturus	14. 8. 53.26	14. 7. 40.17	14. 8. 14.48	14.37	+ 0.11
,,	α Coronæ Borealis.	15. 28. 27.03	15. 27. 13.58	15. 27. 47.91	47.85	+ 0.06
TRANSITS FOR THE POSITION OF JONES'S CIRCLE.						
January.. 7	Polaris	1. 0. 35.00	1. 0. 37.45	1. 1. 6.29	2.22	+ 4.07
,,	α Arietis	1. 57. 27.60	1. 57. 30.40	1. 57. 59.29	59.50	— 0.21
,,	γ Ceti	2. 34. 19.50	2. 34. 22.50	2. 34. 51.42	51.83	— 0.41
April.... 22	ϵ Leonis.....	9. 35. 38.67	9. 35. 43.47	9. 36. 35.98	36.35	— 0.37

TRANSITS FOR THE POSITION OF THE CIRCLES.

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TRANSITS FOR THE POSITION OF JONES'S CIRCLE—continued.						
DAY, 1837.	Object.	Transit by Graham 2.	Transit by Hardy.	Sidereal Time.	Sec. of A.R.	Error.
May.....	9 β Leonis	^h 11. 40. 22 ^m 20 ^s	^h 11. 39. 48 ^m 51 ^s	^h 11. 40. 46 ^m 46 ^s	45 ^s 88	+ 0 ^s 58
	,, δ Centauri.....	13. 43. 30 ^m 00 ^s	13. 42. 55 ^m 71 ^s	13. 43. 53 ^m 69 ^s	52 ^s 61	+ 1 ^s 08
	,, Arcturus.....	14. 7. 53 ^m 30 ^s	14. 7. 18 ^m 80 ^s	14. 8. 16 ^m 78 ^s	15 ^s 64	+ 1 ^s 14
	,, α Libræ.....	14. 41. 31 ^m 30 ^s	14. 40. 56 ^m 75 ^s	14. 41. 54 ^m 74 ^s	54 ^s 25	+ 0 ^s 49
	10 Polaris S. P.....	13. 0. 37 ^m 00 ^s	12. 59. 56 ^m 80 ^s	13. 0. 55 ^m 21 ^s	27 ^s 36	+ 27 ^s 85
	12 Regulus.....	9. 59. 34 ^m 50 ^s	9. 58. 43 ^m 50 ^s	9. 59. 42 ^m 54 ^s	42 ^s 03	+ 0 ^s 51
	16 20 Libræ.....	14. 54. 45 ^m 60 ^s	14. 53. 34 ^m 30 ^s	14. 54. 35 ^m 26 ^s	34 ^s 73	+ 0 ^s 53
	,, β Libræ.....	15. 8. 27 ^m 00 ^s	15. 7. 15 ^m 70 ^s	15. 8. 16 ^m 67 ^s	16 ^s 58	+ 0 ^s 09
	17 β Corvi.....	12. 26. 3 ^m 60 ^s	12. 24. 51 ^m 06 ^s	12. 25. 52 ^m 15 ^s	51 ^s 53	+ 0 ^s 62
	26 Regulus.....	10. 0. 41 ^m 30 ^s	9. 58. 37 ^m 00 ^s	9. 59. 41 ^m 92 ^s	41 ^s 87	+ 0 ^s 05
	,, α Ursæ Majoris....	10. 54. 36 ^m 50 ^s	10. 52. 32 ^m 10 ^s	10. 53. 37 ^m 04 ^s	38 ^s 63	— 1 ^s 59
	,, ϵ Bootis.....	14. 38. 54 ^m 07 ^s	14. 36. 49 ^m 57 ^s	14. 37. 54 ^m 58 ^s	54 ^s 23	+ 0 ^s 35
July.....	9 α Orionis.....	5. 46. 52 ^m 00 ^s	5. 45. 46 ^m 50 ^s	5. 46. 21 ^m 19 ^s	20 ^s 93	+ 0 ^s 26
	10 Sirius.....	6. 38. 32 ^m 30 ^s	6. 37. 22 ^m 30 ^s	6. 37. 57 ^m 97 ^s	57 ^s 41	+ 0 ^s 56
	16 Sirius.....	6. 38. 47 ^m 07 ^s	6. 37. 18 ^m 69 ^s	6. 37. 58 ^m 15 ^s	57 ^s 51	+ 0 ^s 64
	24 Procyon.....	7. 30. 43 ^m 33 ^s	7. 30. 1 ^m 23 ^s	7. 30. 46 ^m 02 ^s	46 ^s 15	— 0 ^s 13
	26 Sirius.....	6. 37. 57 ^m 47 ^s	6. 37. 12 ^m 27 ^s	6. 37. 58 ^m 47 ^s	57 ^s 68	+ 0 ^s 79
	28 Procyon.....	7. 30. 47 ^m 80 ^s	7. 29. 59 ^m 00 ^s	7. 30. 46 ^m 64 ^s	46 ^s 21	+ 0 ^s 43
August ..	4 Sirius.....	6. 38. 31 ^m 87 ^s	6. 37. 7 ^m 17 ^s	6. 37. 58 ^m 46 ^s	57 ^s 86	+ 0 ^s 60
	8 Sirius.....	6. 39. 9 ^m 97 ^s	6. 37. 3 ^m 97 ^s	6. 37. 58 ^m 31 ^s	57 ^s 94	+ 0 ^s 37
	13 Sirius.....	6. 39. 28 ^m 40 ^s	6. 37. 0 ^m 90 ^s	6. 37. 58 ^m 70 ^s	58 ^s 06	+ 0 ^s 64
	,, Procyon.....	7. 31. 16 ^m 50 ^s	7. 29. 49 ^m 00 ^s	7. 30. 46 ^m 83 ^s	46 ^s 50	+ 0 ^s 33
	,, Pollux.....	7. 35. 50 ^m 80 ^s	7. 34. 23 ^m 30 ^s	7. 35. 21 ^m 13 ^s	20 ^s 63	+ 0 ^s 50
	14 Pollux.....	7. 35. 55 ^m 60 ^s	7. 34. 21 ^m 90 ^s	7. 35. 20 ^m 73 ^s	20 ^s 66	+ 0 ^s 07
September	20 Polaris S. P.....	13. 2. 40 ^m 50 ^s	13. 1. 26 ^m 00 ^s	13. 1. 46 ^m 16 ^s	53 ^s 64	— 7 ^s 45
	22 Regulus.....	10. 0. 52 ^m 07 ^s	9. 59. 20 ^m 87 ^s	9. 59. 42 ^m 52 ^s	42 ^s 19	+ 0 ^s 33
	25 Regulus.....	10. 1. 12 ^m 37 ^s	9. 59. 18 ^m 27 ^s	9. 59. 41 ^m 64 ^s	42 ^s 24	— 0 ^s 60
October. .	12 δ Leonis.....	11. 5. 59 ^m 40 ^s	11. 4. 54 ^m 50 ^s	11. 5. 28 ^m 32 ^s	26 ^s 90	+ 1 ^s 42
	13 δ Leonis.....	11. 6. 5 ^m 37 ^s	11. 4. 53 ^m 02 ^s	11. 5. 27 ^m 27 ^s	26 ^s 93	+ 0 ^s 34
	,, β Leonis.....	11. 41. 24 ^m 03 ^s	11. 40. 11 ^m 59 ^s	11. 40. 45 ^m 85 ^s	45 ^s 46	+ 0 ^s 39

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 generally 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, and in the Observations of 1836: the observer beginning with the northern horizontal microscope and passing the upper microscopes, the southern horizontal, and the lower ones, in the direction of the circle's circumference, reads them in the order A, C, E, B, D, F. These readings, in the observing books, are placed in the order A, C, E, B, D, F: 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.

It is the practice now, on every Monday, to examine three intervals on the limb with each microscope, and thus to ascertain the excess of reading of the micrometer in the position commonly used (namely, when the micrometer is turned in the direction increasing its readings, from its zero till the wire coincides with the next image of a division) above its reading for the image of a division on the other side of the zero. The quantity by which this exceeds $5'$ being taken for each microscope, the sum of these excesses with sign changed is given as a correction, in the *eleventh* column, called "Correction for Runs." This number is the correction when the micrometer-reading amounts to $5'$: a proportional part is to be taken for any other reading: and it is to be applied to the sum of the microscope readings before that sum is divided by 6. Occasionally, when the image of a division is very near the zero of the micrometer, the micrometer is turned in the opposite direction to coincide with that image: this is indicated by the mark † denoting "the micrometers placed on the next divisions." 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 1837.

ERRORS OF RUNS, FOR TROUGHTON'S CIRCLE.

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ERROR OF EACH MICROSCOPE OF TROUGHTON'S CIRCLE, FOR A READING OF 5'.								
Day.	Pointer Reading.	MICROSCOPES						Sum.
		A	B	C	D	E	F	
January.... 2	°	"	"	"	"	"	"	"
	50	— 0·8	— 1·4	— 1·8	— 2·3	— 2·2	— 1·4	— 9·9
	170	— 0·1	— 0·9	— 2·0	— 2·6	— 0·2	— 0·2	— 6·0
	290	— 0·4	— 0·6	— 0·1	— 2·9	— 0·5	— 0·4	— 4·9
	60	+ 0·8	— 0·1	— 0·2	+ 0·7	+ 1·4	— 0·7	+ 1·9
	180	+ 0·4	+ 0·8	+ 1·1	— 1·9	— 0·3	+ 0·2	+ 0·3
	300	+ 1·0	— 0·9	+ 0·5	— 1·3	+ 0·5	— 1·3	— 1·5
	70	— 0·2	— 0·2	— 0·1	— 1·4	— 0·1	— 3·3	— 5·3
	190	+ 1·6	— 0·5	— 1·1	— 0·2	— 0·6	— 1·8	— 2·6
	310	+ 1·1	— 1·8	+ 0·2	+ 0·1	— 1·1	— 0·9	— 2·4
	0	+ 1·3	— 2·0	— 0·7	+ 0·4	+ 0·1	+ 0·7	— 0·2
	120	+ 1·1	+ 0·8	— 0·5	+ 1·0	+ 2·2	— 1·7	+ 2·9
February... 7	240	+ 1·7	+ 1·0	+ 0·8	+ 0·5	— 1·1	— 1·3	+ 1·6
	0	+ 1·8	— 1·2	— 1·2	— 1·1	— 1·1	+ 0·7	— 2·1
	120	+ 0·2	— 0·2	+ 0·4	— 0·8	— 0·7	— 0·2	— 1·3
	240	+ 1·5	— 1·6	— 0·2	— 0·4	— 1·2	+ 0·6	— 1·3
	80	+ 0·9	— 0·9	— 1·8	— 0·8	— 0·3	— 0·7	— 3·6
	200	— 0·9	— 2·5	— 2·1	— 3·3	+ 2·6	— 2·1	— 8·3
	320	— 0·9	— 0·8	— 2·0	+ 0·3	+ 2·1	— 1·7	— 3·0
	20	— 0·6	— 0·7	— 2·0	— 0·2	— 0·9	+ 0·9	— 3·5
	140	+ 1·4	— 1·8	+ 0·4	— 0·6	— 0·4	— 0·4	— 1·4
	260	+ 0·4	— 0·3	— 0·2	— 2·5	— 1·6	— 0·3	— 4·5
	30	+ 1·2	— 0·1	— 1·3	— 2·2	+ 0·9	— 0·2	— 1·7
	150	+ 0·4	— 0·9	— 1·3	— 1·1	+ 1·4	+ 0·7	— 0·8
March..... 6	270	+ 1·2	— 0·5	+ 1·1	+ 2·1	— 0·9	— 0·2	— 1·4
	40	+ 1·5	— 1·4	— 1·7	— 0·2	— 0·2	— 0·1	— 2·1
	160	+ 0·9	— 1·7	— 1·1	— 0·6	— 0·3	+ 0·2	— 2·6
	280	+ 0·2	— 1·7	— 1·7	— 0·7	— 0·1	— 0·6	— 4·6
	50	— 0·3	— 1·0	— 1·4	— 2·6	— 1·4	— 2·1	— 8·8
	170	+ 0·9	— 1·4	— 0·7	— 0·8	— 2·1	— 1·4	— 5·5
	290	— 0·2	— 1·4	— 0·9	— 2·2	— 1·1	— 0·8	— 6·6
	290	+ 0·4	— 0·6	— 0·5	— 2·8	+ 1·4	+ 0·1	— 2·0
	202	+ 3·0	+ 0·4	— 0·5	— 2·0	+ 1·2	— 1·0	+ 1·1
	90	— 0·8	— 0·9	+ 0·7	+ 0·8	+ 0·5	+ 0·3	+ 0·6
	220	+ 2·1	+ 1·0	— 0·9	— 0·1	+ 1·3	+ 0·9	+ 4·3
	144	+ 2·8	+ 2·4	— 0·7	0·0	— 0·4	+ 1·0	+ 5·1
April..... 3	57	+ 1·4	+ 2·9	+ 1·2	— 1·1	0·0	— 2·0	+ 2·4

d

TROUGHTON'S CIRCLE— <i>continued.</i>								
Day.	Pointer Reading.	MICROSCOPES						Sum.
		A	B	C	D	E	F	
	o	"	"	"	"	"	"	"
April..... 10	0	— 0·8	— 2·1	— 0·1	— 1·9	— 1·5	— 0·1	— 6·5
"	120	— 0·1	— 0·2	— 1·2	— 0·1	— 0·1	0·0	— 1·7
"	240	+ 0·9	— 2·3	— 0·5	— 1·7	— 0·7	+ 0·9	— 3·4
17	10	+ 0·1	+ 0·2	+ 1·2	+ 0·2	— 0·6	— 0·4	+ 0·7
"	130	+ 1·3	— 0·1	— 1·1	— 1·8	— 1·9	+ 1·2	— 2·4
"	250	— 0·2	— 0·5	— 0·1	— 0·9	— 0·3	+ 1·0	— 1·0
24	30	+ 1·3	— 0·6	— 0·9	0·0	+ 0·6	+ 0·3	+ 0·7
"	150	+ 1·6	+ 0·8	— 0·2	— 0·6	+ 0·6	0·0	+ 2·2
"	270	+ 1·8	+ 0·9	— 1·9	— 0·6	— 0·8	+ 0·4	— 0·2
May..... 1	40	+ 1·0	— 0·3	— 2·5	+ 1·8	+ 2·1	+ 1·3	+ 3·4
"	160	+ 1·5	+ 1·0	— 0·2	— 1·1	— 1·0	+ 1·9	+ 2·1
"	280	+ 1·6	— 0·2	— 0·4	— 0·4	+ 1·3	+ 0·9	+ 2·8
8	50	+ 0·5	— 1·8	— 2·2	+ 0·3	— 0·4	+ 0·4	— 3·2
"	170	— 0·8	— 1·0	— 0·3	— 1·6	— 1·3	+ 0·6	— 4·4
"	290	— 0·2	+ 1·4	+ 0·2	— 0·9	— 0·7	— 0·2	— 0·4
15	60	+ 0·4	— 0·1	+ 1·1	— 0·3	+ 1·5	+ 0·2	+ 2·8
"	180	+ 1·6	— 0·2	— 1·3	— 1·7	— 0·5	— 0·9	— 3·0
"	300	+ 1·6	— 1·2	+ 1·3	— 2·0	— 1·1	+ 0·2	— 1·2
22	300	+ 1·3	— 0·5	+ 0·7	— 1·5	— 0·9	— 0·4	— 1·3
"	180	+ 0·7	+ 0·3	— 1·2	— 0·5	— 0·1	+ 0·9	+ 0·1
"	60	+ 0·4	+ 0·6	+ 0·9	— 1·0	+ 1·0	— 0·3	+ 1·6
29	150	+ 1·7	— 1·5	— 0·8	— 0·5	— 0·2	— 0·5	— 1·8
"	270	— 0·6	+ 0·9	— 2·8	— 1·9	— 1·5	+ 0·2	— 5·7
"	60	+ 1·4	+ 2·1	+ 0·2	+ 0·4	+ 1·5	— 0·2	+ 5·4
June..... 5	160	+ 2·9	— 0·5	— 0·4	— 1·2	+ 0·2	— 0·3	+ 0·7
"	280	+ 0·8	+ 0·1	+ 0·8	— 1·2	+ 0·1	+ 0·5	+ 1·1
"	70	+ 1·7	— 0·8	— 0·5	+ 0·1	+ 0·6	+ 0·4	+ 1·5
12	170	+ 0·9	+ 1·0	+ 0·4	— 1·7	+ 0·1	+ 1·8	+ 2·5
"	290	+ 2·2	+ 0·1	+ 2·5	+ 0·1	— 0·5	+ 0·5	+ 4·9
"	80	+ 1·8	+ 1·1	— 0·2	— 0·7	— 0·7	— 0·4	+ 0·9
19	0	+ 4·5	+ 0·2	+ 2·1	+ 0·3	+ 1·9	+ 1·1	+ 10·1
"	120	+ 3·1	+ 1·7	+ 3·1	+ 0·8	+ 1·2	+ 2·7	+ 12·6
"	240	+ 3·8	+ 2·0	+ 1·1	+ 0·7	+ 2·5	+ 0·4	+ 10·5
26	0	+ 1·2	— 1·7	+ 0·5	— 0·6	+ 0·7	+ 0·5	+ 0·6
"	120	+ 1·9	— 0·8	+ 0·7	+ 0·6	+ 2·5	+ 0·2	+ 5·1
"	240	+ 2·1	— 0·9	— 0·4	— 1·3	— 1·2	+ 1·1	— 0·6

ERRORS OF RUNS, FOR TROUGHTON'S CIRCLE.

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TROUGHTON's CIRCLE—continued.										
Day.	Pointer Reading.	MICROSCOPES						Sum.		
		A	B	C	D	E	F			
July.....	°	"	"	"	"	"	"	"		
	20	+ 1.2	+ 0.8	— 0.7	— 1.1	— 0.3	+ 1.2	+ 1.1		
	140	+ 4.0	— 0.2	+ 0.5	— 1.1	+ 0.9	+ 0.5	+ 4.6		
	260	+ 1.2	+ 0.8	— 1.7	— 1.3	+ 0.6	+ 0.4	0.0		
	10	227	+ 4.0	+ 1.0	+ 1.9	— 2.2	+ 4.6	+ 1.6	+ 10.9	
	47	+ 4.0	+ 1.8	+ 0.5	— 0.5	+ 2.8	+ 1.1	+ 9.7		
	295	+ 1.6	+ 1.5	+ 1.3	+ 0.1	+ 2.9	— 0.2	+ 7.2		
	17	280	+ 3.8	— 0.8	+ 2.4	— 0.8	+ 1.5	+ 0.3	+ 6.4	
	160	+ 3.8	+ 2.3	+ 0.6	— 2.0	— 1.1	+ 3.8	+ 7.4		
	220	+ 2.6	+ 1.7	+ 1.3	— 0.8	+ 2.6	+ 0.8	+ 8.2		
	24	100	+ 3.2	— 0.5	+ 0.9	— 1.2	+ 1.6	— 0.7	+ 3.3	
	340	+ 4.7	+ 1.8	+ 3.3	— 2.0	+ 1.8	+ 1.9	+ 11.5		
	220	+ 3.8	+ 0.6	+ 1.6	— 2.3	+ 0.1	+ 1.7	+ 5.5		
	31	40	+ 4.4	+ 3.4	— 0.6	— 1.0	+ 2.8	+ 0.5	+ 9.5	
	160	+ 3.2	+ 2.1	+ 0.8	— 1.1	+ 1.0	+ 0.2	+ 6.2		
	280	+ 4.3	+ 0.8	+ 1.1	— 0.5	+ 2.0	+ 0.9	+ 8.6		
	August	7	90	+ 1.8	— 0.2	+ 2.8	— 0.3	+ 1.8	+ 1.3	+ 7.2
		210	+ 3.9	+ 3.3	+ 0.5	— 0.4	+ 1.6	+ 1.6	+ 10.5	
310		+ 2.5	+ 1.1	+ 0.7	— 1.0	+ 4.5	+ 2.1	+ 9.9		
14		240	+ 2.3	+ 2.0	+ 3.1	+ 2.8	0.0	+ 0.2	+ 10.4	
120		+ 5.0	+ 3.2	— 0.6	+ 1.3	+ 2.3	+ 2.6	+ 13.8		
0		+ 3.9	+ 2.9	+ 3.0	+ 0.9	+ 3.9	+ 1.8	+ 16.4		
21		0	+ 1.1	+ 0.2	+ 2.2	+ 0.2	+ 2.4	+ 0.6	+ 6.7	
120		+ 2.2	+ 0.3	+ 0.2	— 0.2	+ 2.8	+ 1.2	+ 6.5		
240		+ 2.2	0.0	+ 0.2	+ 0.2	+ 1.6	+ 1.6	+ 5.8		
28		100	+ 0.6	— 0.3	+ 0.1	+ 0.2	+ 1.3	+ 0.3	+ 2.2	
220		+ 1.9	— 1.0	+ 1.8	— 0.4	— 1.0	+ 1.1	+ 2.4		
340		+ 1.6	0.0	+ 0.9	— 0.2	— 0.4	+ 0.2	+ 2.1		
September .		4	110	+ 0.6	— 1.4	— 0.8	— 1.1	— 1.2	+ 1.2	— 2.7
		230	+ 1.4	— 0.2	— 0.6	— 2.4	— 0.9	— 0.4	— 3.1	
		350	+ 0.6	— 1.8	— 0.5	— 1.7	+ 0.5	— 0.6	— 3.5	
		11	0	+ 4.0	+ 2.5	0.0	— 1.0	— 0.6	— 0.1	+ 4.8
		240	+ 2.2	— 0.7	— 0.2	+ 0.3	+ 1.4	+ 0.8	+ 3.8	
		120	+ 2.9	+ 0.2	+ 1.9	— 0.1	+ 1.2	— 2.9	+ 3.2	
	18	60	+ 3.4	+ 2.7	+ 0.6	0.0	+ 0.4	+ 2.9	+ 10.0	
	120	+ 1.9	+ 3.6	+ 0.5	+ 2.4	+ 1.9	+ 2.4	+ 12.7		
	180	+ 0.4	+ 0.5	— 1.3	— 1.0	+ 1.0	+ 1.7	+ 1.3		

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INTRODUCTION TO GREENWICH OBSERVATIONS, 1837.

TROUGHTON'S CIRCLE—continued.								
Day.	Pointer Reading.	MICROSCOPES						Sum.
		A	B	C	D	E	F	
	°	"	"	"	"	"	"	"
September . 25	330	+ 1.5	— 0.1	— 0.4	— 2.7	+ 2.8	+ 2.1	+ 3.2
„	210	+ 3.2	+ 3.2	0.0	— 0.2	+ 0.1	+ 1.5	+ 7.8
„	92	+ 1.4	+ 0.5	+ 0.7	+ 0.9	+ 1.9	+ 3.0	+ 8.4
October.... 2	0	+ 3.6	+ 0.2	0.0	+ 0.7	+ 1.9	— 0.4	+ 6.0
„	120	+ 3.9	+ 1.9	+ 1.4	+ 1.0	+ 2.2	+ 1.6	+ 12.0
„	260	+ 4.7	+ 1.2	+ 1.9	+ 1.1	— 2.0	+ 0.6	+ 7.5
9	50	+ 1.3	0.0	— 0.4	— 1.1	— 0.2	— 0.1	— 0.5
„	170	+ 1.0	— 0.5	+ 0.6	— 2.1	+ 0.4	— 0.2	— 0.8
„	290	+ 1.4	— 0.1	+ 0.4	— 1.9	— 1.8	— 0.2	— 2.2
16	60	+ 0.2	+ 0.9	— 0.4	+ 0.3	+ 1.2	+ 1.1	+ 3.3
„	180	+ 0.9	+ 0.5	+ 1.8	+ 0.5	— 0.7	+ 1.9	+ 4.9
„	300	+ 2.3	+ 0.7	+ 1.3	+ 0.1	+ 0.8	+ 0.9	+ 6.1
23	90	+ 1.8	— 0.1	+ 0.1	— 0.4	+ 0.7	— 0.1	+ 2.0
„	210	+ 1.9	+ 0.2	+ 0.3	+ 1.6	— 0.2	+ 0.9	+ 4.7
„	330	+ 1.8	+ 0.4	+ 0.9	— 1.7	+ 1.1	+ 0.9	+ 3.4
30	110	— 0.6	— 0.9	+ 0.5	+ 2.2	+ 1.1	+ 0.7	+ 3.0
„	230	+ 2.0	— 0.1	+ 0.9	— 1.1	+ 0.3	— 0.4	+ 1.6
„	350	+ 1.2	— 0.8	+ 0.1	— 1.4	+ 1.5	+ 0.2	+ 0.8
November.. 6	0	+ 2.6	— 0.8	+ 0.2	— 0.5	+ 0.8	— 0.4	+ 1.9
„	120	+ 2.7	+ 1.6	+ 0.1	+ 0.1	+ 0.8	+ 0.4	+ 5.7
„	240	+ 2.7	+ 0.6	— 0.2	— 1.1	— 2.3	+ 1.8	+ 1.5
13	10	+ 1.9	+ 3.8	+ 0.2	0.0	+ 2.4	+ 1.7	+ 10.0
„	130	+ 2.2	+ 1.5	+ 1.6	+ 1.2	+ 0.9	+ 1.0	+ 8.4
„	250	+ 3.3	+ 1.5	+ 1.2	+ 1.7	— 0.2	+ 1.0	+ 8.5
18	100			+ 0.7	+ 0.4	— 0.6	+ 0.7	+ 1.2
„	220			— 0.3	— 0.7	— 1.2	+ 0.9	— 1.3
„	340			+ 1.3	— 0.5	+ 1.2	+ 1.1	+ 3.1
23	0			+ 0.4	— 2.3	+ 0.9	+ 0.5	— 0.5
„	120			+ 1.9	+ 0.8	+ 0.6	+ 0.7	+ 4.0
„	240			+ 1.7	— 0.3	— 0.9	+ 0.9	+ 1.4
27	10			+ 1.8	— 1.6	— 1.3	— 1.6	— 2.7
„	130			+ 2.4	— 1.2	+ 1.8	— 0.1	+ 2.9
„	250			+ 1.8	— 2.2	+ 1.9	+ 0.4	+ 1.9
December.. 4	50			— 2.9	— 2.3	— 2.4	— 0.7	— 8.3
„	170			— 0.3	— 0.9	— 1.8	+ 0.4	— 2.6
„	290			+ 0.6	— 2.1	— 0.6	— 0.9	— 3.0

ERRORS OF RUNS, FOR JONES'S CIRCLE.

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TROUGHTON'S CIRCLE—concluded.								
Day.	Pointer Reading.	MICROSCOPES						Sum.
		A	B	C	D	E	F	
	°	"	"	"	"	"	"	"
December... 11	230			— 0.1	— 3.4	+ 0.9	— 0.4	— 3.0
"	110			+ 1.8	— 1.0	+ 0.5	+ 1.1	+ 2.4
"	350			— 1.1	— 1.3	— 0.2	+ 1.5	— 1.1
18	100			+ 0.8	— 0.9	+ 0.6	+ 1.9	+ 2.4
"	220			+ 3.1	— 2.9	— 0.4	+ 1.1	+ 0.9
"	340			+ 2.7	— 1.2	— 0.8	+ 1.3	+ 2.0
26	130			+ 0.9	— 1.0	— 0.4	+ 1.1	+ 0.6
"	250			+ 2.8	— 1.7	+ 0.2	+ 1.8	+ 3.1
"	10			+ 1.5	— 0.6	+ 0.2	+ 2.2	+ 3.3
ERROR OF EACH MICROSCOPE OF JONES'S CIRCLE, FOR A READING OF 5'.								
January.... 2	295	— 2.9	— 1.5	— 1.9	— 0.8	— 1.6	— 1.0	— 9.7
"	56	— 1.5	— 2.0	— 0.7	— 2.1	— 0.9	— 2.1	— 9.3
"	120	— 2.0	— 0.9	— 2.3	— 0.9	+ 0.1	— 1.6	— 7.6
9	150	— 1.0	— 2.7	+ 1.2	+ 0.2	— 0.9	+ 0.1	— 3.1
"	270	— 0.5	— 2.0	+ 1.1	+ 0.8	— 0.7	— 0.6	— 1.9
"	30	— 1.4	— 2.0	+ 0.5	— 0.1	— 1.0	— 1.7	— 5.7
16	150	— 1.5	— 2.0	+ 0.2	— 0.7	— 0.3	— 0.8	— 5.1
"	270	— 0.4	— 2.8	+ 0.8	+ 0.2	— 1.0	— 1.6	— 4.8
"	30	— 0.2	— 2.1	+ 1.1	— 1.0	— 0.2	— 2.3	— 4.7
30	0	— 1.6	— 2.4	— 0.2	— 2.1	— 1.1	— 2.2	— 9.6
"	120	— 1.9	— 0.6	— 0.2	— 2.1	— 1.2	— 1.4	— 7.4
"	240	— 2.6	— 2.4	— 0.8	— 0.2	— 1.2	— 0.6	— 7.8
February... 6	80	— 2.1	— 2.6	— 0.5	— 0.6	— 3.3	— 2.2	— 11.3
"	200	— 1.9	— 0.8	— 1.8	— 0.7	— 1.8	— 2.4	— 9.4
"	320	— 1.1	— 0.7	— 0.3	— 1.6	— 3.1	— 2.7	— 9.5
13	300	0.0	+ 0.4	+ 0.8	— 0.9	+ 0.7	— 0.7	+ 0.3
"	130	— 1.9	— 0.2	— 0.2	— 0.1	— 1.1	+ 1.0	— 2.5
"	50	— 0.3	— 0.7	+ 1.3	+ 0.3	— 0.8	— 0.2	— 0.4
20	0	— 1.1	— 3.2	— 2.3	— 2.2	— 1.7	— 1.1	— 11.6
"	120	— 2.0	— 3.0	— 2.3	— 1.5	— 1.6	— 2.0	— 12.4
"	240	— 0.1	— 2.3	— 1.5	— 1.6	— 1.5	— 1.0	— 8.0

JONES's CIRCLE— <i>continued.</i>								
Day.	Pointer Reading.	MICROSCOPES						Sum.
		A	B	C	D	E	F	
	°	"	"	"	"	"	"	"
February... 27	160	— 0·8	— 3·0	+ 0·2	— 0·3	— 2·0	— 0·6	— 6·5
„	280	— 0·9	— 3·7	— 0·5	— 1·0	— 1·7	+ 0·1	— 7·7
„	40	— 2·0	— 3·2	— 1·5	— 1·0	— 1·0	— 1·0	— 9·7
March..... 6	20	— 2·0	— 0·3	— 3·0	+ 0·3	— 1·4	— 1·0	— 7·4
„	250	— 0·9	— 0·9	— 0·8	— 1·2	+ 0·5	+ 0·9	— 2·4
„	148	— 2·2	— 1·9	— 2·4	— 0·7	— 1·0	— 1·1	— 9·3
13	310	— 1·7	— 0·7	— 0·2	0·0	— 0·5	— 2·1	— 5·2
„	200	— 1·1	— 1·7	+ 0·3	— 1·2	+ 0·4	+ 0·9	— 2·4
„	80	— 1·4	— 1·8	— 0·4	+ 0·1	— 1·1	— 2·8	— 7·4
20	0	— 0·8	— 1·6	+ 0·3	— 0·8	— 1·7	0·0	— 4·6
„	240	— 0·9	— 0·5	+ 1·8	— 1·0	0·0	— 2·0	— 2·6
„	120	— 1·8	— 1·0	— 0·2	— 0·9	— 1·2	— 1·2	— 6·3
27	185	— 2·9	— 3·4	+ 0·6	— 1·0	— 1·5	0·0	— 8·2
„	305	— 0·5	— 3·2	+ 1·2	+ 0·2	— 2·7	— 2·7	— 7·7
„	65	— 1·1	— 3·2	+ 0·1	— 2·4	— 1·3	— 1·7	— 9·6
April..... 3	150	— 1·8	— 2·6	+ 2·0	— 0·1	— 1·5	— 0·6	— 4·6
„	270	— 1·4	— 3·2	+ 1·5	— 0·7	— 2·2	— 1·8	— 7·8
„	30	— 0·6	— 2·7	— 1·0	— 0·8	— 2·3	— 2·4	— 9·8
10	200	— 2·5	— 3·1	— 0·8	— 0·9	— 2·6	— 1·0	— 10·9
„	320	— 2·1	— 1·9	— 1·0	— 0·4	— 3·3	— 0·4	— 9·1
„	80	— 2·0	— 2·5	+ 0·2	— 1·2	— 1·6	— 1·8	— 8·9
17	200	— 2·0	— 2·2	— 0·3	— 1·4	— 2·2	— 2·0	— 10·1
„	320	— 2·0	— 2·0	— 0·8	— 1·0	— 2·4	— 1·1	— 9·3
„	80	— 2·4	— 2·8	— 0·5	— 0·6	— 2·4	— 1·7	— 10·4
24	0	— 0·9	— 1·1	+ 0·3	— 0·2	— 1·8	— 2·5	— 6·2
„	260	+ 0·1	+ 0·4	— 1·0	— 1·6	— 1·3	— 1·9	— 5·3
„	160	0·0	— 1·5	— 1·1	— 1·6	— 3·0	— 0·6	— 7·8
May..... 1	190	— 2·1	— 1·6	+ 1·1	— 0·6	— 0·3	— 0·4	— 3·9
„	310	— 1·1	— 1·0	+ 1·6	— 0·4	— 1·2	— 1·7	— 3·8
„	70	— 1·0	— 2·0	+ 0·8	— 0·5	— 0·1	— 1·0	— 3·8
8	56.45	— 1·9	— 0·2	+ 1·7	— 0·1	— 1·9	+ 0·9	— 1·5
„	118.55	— 2·5	+ 0·7	+ 3·8	+ 1·0	— 3·0	— 1·7	— 1·7
„	191.45	+ 0·2	+ 0·3	+ 1·5	— 1·9	+ 0·7	— 1·3	— 0·5
15	0	— 1·6	+ 0·4	+ 1·7	+ 0·4	— 2·7	— 1·4	— 3·2
„	240	+ 0·1	0·0	+ 1·5	+ 1·9	— 0·9	— 0·1	+ 2·5
„	120	— 2·0	+ 0·1	0·0	+ 0·6	+ 0·1	— 1·3	— 2·5

ERRORS OF RUNS, FOR JONES'S CIRCLE.

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JONES'S CIRCLE—continued.								
Day.	Pointer Reading.	MICROSCOPES						Sum.
		A	B	C	D	E	F	
	°	"	"	"	"	"	"	"
May..... 22	20	— 0.2	0.0	+ 0.5	— 0.2	— 2.1	— 5.1	— 7.1
,, 240		+ 0.5	— 0.2	+ 1.0	— 2.0	— 1.6	— 3.0	— 5.3
,, 140		— 1.2	— 1.0	+ 1.9	— 0.6	— 2.1	— 1.1	— 4.1
29	30	+ 0.4	— 1.0	+ 0.3	— 1.3	+ 0.4	— 0.5	— 1.7
,, 150		— 1.3	— 2.2	+ 0.5	— 0.8	— 0.2	— 0.8	— 4.8
,, 270		— 0.8	— 2.4	+ 2.0	— 0.8	— 0.1	— 0.4	— 2.5
June..... 5	40	— 0.9	+ 0.6	+ 1.5	+ 0.4	— 0.2	0.0	+ 1.4
,, 160		— 0.7	0.0	+ 1.0	— 0.2	+ 0.8	— 0.5	+ 0.4
,, 280		0.0	— 1.5	+ 0.9	— 0.6	— 0.2	— 1.7	— 3.1
12	300	— 0.2	+ 0.4	+ 0.7	— 0.9	+ 0.8	+ 0.1	+ 0.9
,, 200		+ 0.6	+ 0.1	+ 1.5	— 0.1	+ 0.3	+ 1.1	+ 3.5
,, 100		— 1.1	— 0.9	0.0	— 0.1	+ 0.6	— 2.1	— 3.6
19	20	— 0.6	— 0.8	+ 0.7	— 0.6	+ 0.2	— 0.2	— 1.3
,, 140		— 1.5	— 1.2	+ 0.7	— 0.5	— 0.3	— 1.0	— 3.8
,, 260		— 1.8	— 1.4	+ 1.6	— 0.5	+ 0.9	— 0.4	— 1.6
26	30	— 0.1	+ 0.1	+ 0.9	— 0.6	+ 0.5	— 0.2	+ 0.6
,, 150		— 1.5	— 2.2	— 0.2	+ 0.2	0.0	+ 0.6	— 3.1
,, 270		+ 0.3	— 1.6	+ 0.7	+ 0.6	— 0.9	+ 0.4	— 0.5
July..... 3	40	— 0.5	— 1.4	+ 1.4	— 0.2	+ 1.2	— 0.7	— 0.2
,, 160		— 0.6	— 1.0	+ 0.6	0.0	0.0	— 1.1	— 2.1
,, 280		+ 0.3	— 1.2	+ 1.0	0.0	— 0.6	— 1.6	— 2.1
10	0	+ 0.1	— 0.4	+ 0.7	+ 0.8	+ 0.7	— 0.5	+ 1.4
,, 120		+ 0.7	— 0.4	+ 0.2	— 0.1	— 0.9	+ 1.8	+ 1.3
,, 240		+ 0.4	— 0.8	+ 0.4	— 0.5	+ 0.3	+ 1.1	+ 0.9
17	20	— 1.0	— 1.2	+ 0.8	— 1.1	— 1.2	— 0.4	— 4.1
,, 240		— 1.4	— 0.6	+ 1.7	+ 0.2	+ 0.4	— 0.6	— 0.3
,, 130		+ 0.4	— 0.6	+ 2.5	— 0.6	— 1.0	— 1.9	— 1.2
24	100	— 0.9	— 1.8	+ 0.6	— 0.1	— 0.5	— 0.7	— 3.4
,, 220		— 1.1	— 1.1	+ 0.2	+ 0.1	— 0.4	— 0.4	— 2.7
,, 340		— 0.9	— 1.2	+ 1.5	+ 0.6	— 1.0	— 0.7	— 1.7
31	50	— 1.6	— 2.1	— 0.6	— 0.8	— 0.9	— 1.4	— 7.4
,, 170		— 2.3	— 0.1	— 2.0	— 1.3	— 1.9	— 0.0	— 7.6
,, 290		— 1.7	— 1.5	— 0.6	— 0.3	— 0.6	— 0.1	— 4.8
August 7	60	— 0.6	— 1.3	— 0.1	— 0.1	— 0.1	— 0.4	— 2.6
,, 180		— 0.4	— 2.2	— 1.1	— 0.1	— 0.6	— 1.1	— 5.5
,, 300		— 0.3	— 1.4	0.0	— 0.2	— 0.7	— 0.4	— 3.0

JONES's CIRCLE— <i>continued.</i>								
Day.	Pointer Reading.	MICROSCOPES						Sum.
		A	B	C	D	E	F	
	o	"	"	"	"	"	"	"
August 14	70	-- 0.2	-- 1.3	-- 0.6	-- 0.2	-- 0.5	+ 0.6	-- 2.2
"	190	-- 0.3	-- 1.2	+ 0.4	-- 0.2	-- 0.1	-- 0.6	-- 2.0
"	310	-- 1.6	-- 0.7	-- 0.2	+ 0.7	-- 1.6	-- 0.4	-- 3.8
21	30	-- 0.2	-- 1.4	+ 1.3	+ 0.6	-- 0.2	-- 0.5	-- 0.4
"	150	-- 1.5	-- 2.0	0.0	+ 0.2	+ 0.7	-- 0.2	-- 2.8
"	270	+ 0.2	-- 0.9	+ 0.4	+ 1.2	-- 0.4	-- 0.7	-- 0.2
28	40	-- 1.4	-- 1.0	0.0	+ 0.3	+ 0.2	-- 0.9	-- 2.8
"	160	-- 2.0	+ 0.1	-- 1.0	-- 0.4	+ 1.3	-- 0.7	-- 2.7
"	280	-- 1.8	-- 0.5	-- 1.0	0.0	-- 1.6	-- 0.3	-- 5.2
September.. 4	40	-- 1.9	-- 0.2	-- 0.5	-- 0.4	-- 0.6	-- 0.2	-- 3.4
"	160	-- 2.1	-- 1.6	-- 0.9	-- 0.2	-- 0.9	-- 1.3	-- 7.0
"	280	-- 2.7	-- 0.7	-- 0.4	-- 0.3	-- 1.7	-- 1.8	-- 7.6
11	50	-- 1.0	-- 0.5	-- 0.4	+ 0.1	+ 0.2	-- 0.8	-- 2.4
"	170	-- 0.9	-- 1.7	0.0	+ 0.6	-- 1.8	-- 1.0	-- 4.8
"	290	-- 1.2	-- 0.9	-- 0.6	-- 0.2	-- 0.8	-- 0.5	-- 4.2
18	60	-- 0.8	+ 0.5	+ 0.9	+ 1.7	+ 0.1	+ 0.8	+ 3.2
"	180	-- 1.3	-- 0.6	+ 1.6	+ 1.0	-- 1.1	+ 0.2	-- 0.2
"	300	-- 1.1	+ 0.6	+ 0.2	+ 2.1	-- 0.7	+ 0.9	+ 2.0
25	70	0.0	-- 0.5	-- 0.2	-- 0.4	-- 0.7	+ 0.2	-- 1.6
"	190	-- 1.0	-- 0.8	-- 0.1	+ 1.0	-- 0.4	-- 0.2	-- 1.5
"	310	-- 1.8	-- 0.8	-- 0.2	+ 0.7	-- 1.6	0.0	-- 3.7
October.... 2	50	-- 0.2	-- 2.6	+ 1.0	+ 2.7	+ 0.9	-- 0.6	+ 1.2
"	170	-- 0.3	-- 2.5	0.0	+ 0.1	-- 0.4	-- 1.2	-- 4.3
"	290	-- 1.0	-- 2.2	-- 0.6	+ 0.4	+ 0.2	+ 0.3	-- 2.9
9	70	-- 0.4	-- 2.8	+ 1.0	+ 0.6	-- 1.3	-- 0.2	-- 3.1
"	190	-- 1.9	-- 2.8	-- 0.2	-- 0.3	-- 1.0	-- 0.6	-- 6.8
"	310	-- 2.3	-- 1.7	+ 0.6	+ 0.3	-- 0.1	-- 0.3	-- 3.5
16	50	-- 1.6	-- 3.0	-- 0.6	+ 0.2	-- 0.2	-- 0.8	-- 6.0
"	170	-- 1.7	-- 2.3	-- 0.4	0.0	-- 0.3	-- 0.6	-- 5.3
"	290	-- 2.2	-- 2.6	-- 0.3	-- 0.3	+ 0.9	-- 0.3	-- 4.8
23	30	-- 0.9	-- 3.8	0.0	-- 0.5	-- 0.4	-- 0.8	-- 6.4
"	150	-- 2.0	-- 2.7	0.0	+ 0.4	+ 0.5	-- 0.7	-- 4.5
"	270	-- 1.3	-- 2.6	-- 0.3	+ 0.9	-- 0.4	+ 0.5	-- 3.2
30	50	-- 2.0	-- 2.8	-- 0.5	-- 0.3	-- 1.0	-- 0.9	-- 7.5
"	170	-- 1.2	-- 2.7	-- 0.4	0.0	-- 1.9	-- 1.5	-- 7.7
"	290	-- 0.9	-- 3.0	-- 0.2	-- 0.7	0.0	-- 1.2	-- 6.0

ERRORS OF RUNS FOR JONES'S CIRCLE.

XXV

JONES'S CIRCLE — <i>concluded.</i>								
Day.	Pointer Reading.	MICROSCOPES						Sum.
		A	B	C	D	E	F	
	°	"	"	"	"	"	"	"
November 6	0	+ 0.1	— 2.0	— 1.6	— 2.7	— 1.8	— 2.3	— 10.3
, ,	120	— 0.2	— 0.2	+ 0.9	— 0.1	+ 0.1	+ 0.3	+ 0.8
, ,	240	+ 0.6	— 0.3	— 0.6	— 0.6	— 0.3	— 0.9	— 2.1
13	45	— 1.2	— 1.2	+ 1.4	+ 0.5	— 1.0	+ 1.2	— 0.3
, ,	165	— 0.8	— 1.6	+ 0.2	— 0.3	— 1.0	0.0	— 3.5
, ,	285	— 1.5	— 0.9	+ 1.1	+ 0.6	— 0.9	+ 0.5	— 1.1
20	55	— 1.8	— 1.3	+ 0.2	+ 0.6	— 1.4	+ 0.8	— 2.9
, ,	175	— 1.4	— 1.0	— 1.3	0.0	— 0.9	+ 2.4	— 2.2
, ,	295	— 1.6	— 1.0	+ 0.1	— 1.0	0.0	+ 0.5	— 3.0
27	20	— 1.2	— 1.9	— 1.1	— 1.9	— 1.1	+ 1.6	— 5.6
, ,	140	— 2.4	— 2.4	— 0.6	— 3.5	— 1.0	0.0	— 9.9
, ,	260	— 1.4	— 1.0	— 0.6	— 0.6	— 0.1	+ 0.9	— 2.8
December 4	300	— 0.8	+ 0.1	— 0.9	+ 0.2	— 3.3	+ 0.3	— 4.4
, ,	128	— 1.5	— 0.4	0.0	— 0.5	— 2.2	— 0.4	— 5.0
, ,	0	— 0.2	— 0.5	+ 0.1	— 1.6	— 3.3	— 2.0	— 7.5
11	60	— 1.1	— 3.0	— 0.6	0.0	— 0.2	+ 0.1	— 4.8
, ,	180	— 0.5	— 1.3	— 0.5	+ 0.9	— 1.4	— 0.4	— 3.2
, ,	300	— 1.0	— 1.4	— 1.0	— 1.0	— 0.8	— 0.3	— 5.5
18	65	— 0.8	— 1.2	— 0.5	— 0.3	— 1.9	+ 0.7	— 4.0
, ,	185	— 0.7	— 1.1	— 0.5	+ 0.4	— 1.3	+ 0.5	— 2.7
, ,	305	0.0	— 2.5	— 0.2	+ 0.9	— 3.5	+ 1.0	— 4.3
26	50	— 1.0	— 1.5	+ 0.2	+ 0.4	— 1.7	— 0.5	— 4.1
, ,	170	— 1.0	— 1.8	— 0.5	+ 1.2	— 1.4	— 0.5	— 4.0
, ,	290	0.0	— 1.4	— 0.8	0.0	— 1.0	+ 1.2	— 2.0

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

The *twelfth* 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 coin-

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cidence-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 *thirteenth* column contains the value, in minutes and seconds, of the arc measured with the micrometer. The value of one revolution of the micrometer of Troughton was found in 1836 to be $53''.56$, and that of the micrometer of Jones to be $40''.26$.

The *fourteenth* column contains the number of the vertical wire at which the object was seen when the observation with the horizontal wire was made. The telescope of 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° equatoreal, and that of Jones's wires 21° .

The *fifteenth* column contains the correction to be applied to the circle-reading in consequence of the object not having been observed when passing the middle wire. It consists of two parts, one due to the body's change of N.P.D., 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 $10''$ (from Nautical Almanac) $\times$ sec. declination $\times \frac{3600 + I}{3600} \times n^\circ$. (log. = 8.523) $\times$ number of intervals of wires: where I has the same meaning as in page iv. The latter is calculated by this formula: $\tan.$ declination $\times n^\circ$. (log. = 9.350) $\times$ (number of intervals of wires)². The two numbers are combined together to form the number in the fifteenth column.

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

The *seventeenth* column contains the reading for the Zenith Point, as ascertained by a process subsequently to be described.

The *eighteenth* 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 cor-

responding 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. 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 $\times$ 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 the readings of these thermometers having excited a suspicion of the propriety of their situations, the formerly interior thermometer was in the month of July mounted on the outside of the building in a tin case, at the distance of four feet nearly from the north wall, with its bulb quite free to the current of air, but protected from radiation; and a small thermometer was suspended between the two circle piers. The readings of these thermometers are given, for the remainder of the year, as the readings of the exterior and interior thermometer.

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

The *ninth* column contains the parallax. This is computed on the supposition that the earth's ellipticity is $\frac{1}{300}$. For the planets the formula is, $\log. \text{parallax} = \log. \sin. (\text{zen. dist.} - 11'.12'') + \text{ar. co. log. distance} + 0.9325$. 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: $\log. \text{seconds of parallax} = \log. \text{seconds of corrected horizontal equatoreal parallax} + \log. \sin. (\text{zen. dist.} - 11'.12'')$
 $+ 9.9991136 + \log. \frac{\sin.}{\text{arc}} (\text{for hor. par.}) + \log. \frac{\text{arc}}{\sin.} (\text{for parallax.})$

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 $1 + \cos. \theta$, 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 $38^{\circ}.31'.21''$.

§ 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, 1837, 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 $A \sin. N.P.D. \times (n^{\circ}. \log. = 9.6375) - A. \sin. A.R. \cos. N.P.D. + B. \cos. A.R. \cos. N.P.D. + C. \cos. A.R. \times n^{\circ}. (\log. = 1.3020) - D. \sin. A.R.$

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.		Name.	N. P. D.	R — D.	No. of Obs.	
			D.	R.				D.	R.
	o / "					o / "			
ν Cephei S. P.	—29. 38	+1.70	1	1	η Cassiopeiā.....	+33. 3	—0.72	1	1
α Cephei S. P.	—28. 6	—0.39	9	6	ε Ursæ Majoris	33. 9	+0.42	4	1
θ Cephei S. P.	—27. 33	—0.82	8	2	ε Cephei '....	33. 46	—0.65	3	6
δ Draconis S. P. ...	—22. 37	—0.41	2	1	ζ ¹ Ursæ Majoris....	34. 13	—1.13	17	8
β Cephei S. P.	—20. 9	+0.13	8	1	ζ ² Ursæ Majoris....	34. 13	+0.18	9	5
γ Cephei S. P.	—13. 17	+0.87	2	2	α Cassiopeiā.....	34. 21	—0.34	4	2
κ Cephei S. P.	—12. 46	+1.68	7	6	γ Ursæ Majoris....	35. 24	—0.03	19	1
δ Ursæ Minoris S. P.	— 3. 25	—0.34	5	1	17 ¹ Draconis.....	36. 45	—0.19	4	1
*Cephei S. P. (51Hév.)	— 2. 44	—2.47	3	2	16 Draconis.....	36. 46	—1.93	4	1
Polaris S. P.	— 1. 34	—0.02	36	13	ι Ursæ Majoris.....	41. 19	+1.08	7	2
λ Ursæ Minoris.....	+ 1. 10	—0.41	6	5	ι Bootis.....	41. 42	+0.62	3	2
Polaris.....	1. 34	+0.36	9	6	δ Persei.....	42. 44	+0.38	1	2
* Cephei (51 Hév.).	2. 44	—4.40	1	1	τ Herculis.....	43. 18	—0.71	2	2
δ Ursæ Minoris....	3. 25	+0.17	4	4	ι Herculis.....	43. 54	+0.44	4	3
ε Ursæ Minoris....	7. 42	—1.08	7	1	Capella.....	44. 11	—1.35	7	9
ζ Ursæ Minoris....	11. 42	+1.36	4	2	ψ Ursæ Majoris....	44. 37	—1.55	4	3
γ Cephei.....	13. 17	—0.15	2	4	β Aurigæ.....	45. 5	—1.35	2	2
5 Ursæ Minoris....	13. 35	+0.15	4	3	δ Cygni.....	45. 16	—0.94	4	5
β Ursæ Minoris....	15. 11	—0.79	16	9	α Cygni.....	45. 18	+0.19	1	4
11 Ursæ Minoris...	17. 35	—0.11	1	2	λ Ursæ Majoris....	46. 16	+0.30	7	4
γ Ursæ Minoris....	17. 35	+0.26	3	5	γ ¹ Andromedæ.....	48. 27	+0.49	3	1
κ Draconis.....	19. 19	+0.52	2	2	64 Aurigæ.....	48. 50	—2.41	2	1
A. R. 14 ^h . 9 ^m	19. 48	—0.77	4	3	β Bootis.....	48. 58	—0.96	3	1
β Cephei.....	20. 9	+1.14	2	1	10 Canum Venaticūm	49. 50	+1.00	4	1
ε Draconis.....	20. 9	+0.34	3	3	12 ¹ Canum Venaticūm	50. 48	+0.08	2	2
δ Draconis.....	22. 37	—0.55	2	3	12 ² Canum Venaticūm	50. 48	+1.12	2	2
ι Draconis.....	24. 28	—2.36	2	1	α Lyræ.....	51. 22	—0.30	13	8
ι Cephei.....	24. 39	—1.05	2	4	61 ¹ Cygni.....	52. 3	—1.19	4	2
α Draconis.....	24. 51	—1.47	7	4	κ Lyræ.....	54. 0	—2.39	2	1
α Ursæ Minoris....	27. 22	—1.05	14	6	β Andromedæ.....	55. 15	+1.33	7	3
κ Cassiopeiā.....	27. 58	+0.40	2	2	σ ¹ Coronæ Borealis..	55. 43	+0.67	3	2
η Draconis.....	28. 7	+0.95	20	2	β ¹ Lyræ.....	56. 49	—0.32	10	2
ν Ursæ Majoris....	30. 12	—0.49	6	6	π ¹ Pegasi.....	57. 37	+0.88	3	2
ι Draconis.....	30. 28	—0.60	3	1	π ² Pegasi.....	57. 37	+0.68	3	2
θ Draconis.....	31. 0	—1.01	3	1	Castor.....	57. 46	+1.53	4	1
δ Ursæ Majoris....	32. 4	—1.20	8	5	ζ Cygni.....	60. 26	+0.91	6	4
δ ² Cephei.....	32. 25	+0.21	1	3	2 Cygni.....	60. 42	+3.05	4	1
β Ursæ Majoris....	+32. 45	+0.32	6	5	β Tauri.....	+61. 32	+3.56	1	1

DISCORDANCE OF DIRECT AND REFLEXION RESULTS.

xxx1

TROUGHTON — <i>continued.</i>									
Name.	N.P.D.	R—D.	No. of Obs.		Name.	N.P.D.	R—D.	No. of Obs.	
			D.	R.				D.	R.
Pollux.....	+61.35	+0.99	8	2	α Leonis.....	+79.22	+0.69	2	1
α Andromedæ.....	61.49	+2.89	3	2	ζ Pegasi.....	80.1	+0.66	8	7
C Tauri.....	62.26	+0.96	1	1	f^2 Ophiuchi.....	80.18	—0.28	5	1
α Coronæ Borealis..	62.44	+0.26	10	1	ϵ Pegasi.....	80.52	+0.82	7	8
ϵ Geminorum.....	64.43	—0.22	1	2	α Aquilæ.....	81.33	—0.11	3	1
79 Herculis.....	65.35	+0.82	4	1	θ Piscium.....	84.31	—0.24	5	3
λ Leonis.....	66.19	+1.14	1	1	4 Equulei.....	84.41	+0.27	3	2
28 Vulpeculæ.....	66.27	+0.93	3	2	δ Aquilæ.....	87.12	+2.96	3	1
A. S. C. 2153.....	66.31	—1.63	1	3	10 Ceti.....	90.57	—0.44	4	1
73 Herculis.....	66.53	+1.41	2	3	e Serpentis.....	91.7	—0.10	3	2
γ Leonis.....	69.20	+2.82	2	1	α Aquarii.....	91.7	+0.02	12	5
η Arietis.....	69.33	+3.60	1	1	d Aquilæ.....	91.11	—0.97	1	1
Arcturus.....	69.58	+1.28	15	9	θ Virginis.....	94.40	—0.99	2	1
* A. R. 19 ^b . 17 ^m	73.21	+1.52	4	1	β Aquarii.....	96.17	—0.53	6	5
Aldebaran.....	73.49	+2.21	2	3	β Libræ.....	98.47	—1.55	6	2
A. S. C. 2034.....	73.58	+1.46	1	1	ψ^1 Aquarii.....	99.58	+0.76	5	1
101 Virginis.....	73.59	+0.47	4	1	Spica.....	100.18	—1.44	5	2
κ Leonis.....	74.57	+0.36	1	1	λ Virginis.....	102.37	—3.65	1	1
α Pegasi.....	75.40	+2.38	10	5	ι Aquarii.....	104.39	—3.51	1	1
γ Pegasi.....	75.43	+1.62	2	2	49 Libræ.....	106.3	—5.21	2	3
ζ Aquilæ.....	76.22	+0.98	3	6	Sirius.....	106.30	+0.17	58	6
Regulus.....	77.14	+2.83	3	2	η Capricorni.....	110.30	—0.35	2	1
66 Herculis.....	+78.57	+0.49	5	2	Antares.....	+116.4	—0.46	2	3

JONES.									
Name.	N.P.D.	R—D.	No. of Obs.		Name.	N.P.D.	R—D.	No. of Obs.	
			D.	R.				D.	R.
ζ^1 Ursæ Majoris S. P.	—34.13	—2.58	2	1	5 Ursæ Minoris....	+13.35	—0.21	5	2
ϵ Ursæ Majoris S. P.	—33.9	—2.38	3	1	β Ursæ Minoris....	15.11	—1.83	15	10
ν Cephei S. P.	—29.38	—1.21	1	1	11 Ursæ Minoris...	17.35	—0.52	2	1
α Cephei S. P.	—28.6	—2.77	14	3	γ Ursæ Minoris...	17.35	—0.41	5	3
θ Cephei S. P.	—27.33	—1.57	8	1	* A. R. 14 ^b . 9 ^m	19.48	—0.71	6	1
β Cephei S. P.	—20.9	+2.08	9	2	ϵ Draconis.....	20.9	—0.83	3	3
γ Ursæ Minoris S. P.	—17.35	+1.13	1	1	δ Draconis.....	22.37	—2.90	3	2
κ Cephei S. P.	—12.46	+0.37	11	4	i Draconis.....	24.28	+0.17	2	1
δ Ursæ Minoris S. P.	—3.25	—1.87	8	2	ι Cephei.....	24.39	—0.66	4	2
* Cephei(51Hev.)S. P.	—2.44	—1.12	2	3	α Draconis.....	24.51	—1.62	6	5
Polaris S. P.	—1.34	—1.41	33	16	α Ursæ Majoris....	27.22	—1.30	7	13
λ Ursæ Minoris.....	+1.10	—1.39	6	5	κ Cassiopeiæ.....	27.58	—2.42	2	2
Polaris.....	1.34	—2.08	11	4	α Cephei.....	28.6	—4.12	1	1
δ Ursæ Minoris....	3.25	—1.45	4	4	η Draconis.....	28.7	—2.50	11	11
ϵ Ursæ Minoris....	7.42	—0.84	3	5	γ Cassiopeiæ.....	30.10	—0.58	2	1
ζ Ursæ Minoris....	11.42	—0.42	5	1	ν Ursæ Majoris....	30.12	—1.42	7	5
γ Cephei.....	+13.17	—0.97	4	2	ι Draconis.....	+30.28	—0.64	1	3

JONES—continued.									
Name.	N.P.D.	R—D.	No. of Obs.		Name.	N.P.D.	R—D.	No. of Obs.	
	° ' "		D.	R.		° ' "		D.	R.
θ Draconis	+31. 0	—0·86	2	2	ϵ Geminorum	+ 64. 43	+0·13	2	1
β Cassiopeiæ	31. 45	—1·15	1	1	γ Herculis	65. 35	+0·93	3	2
δ Ursæ Majoris	32. 4	+0·11	10	3	δ Vulpeculæ	66. 27	—0·73	4	1
β Ursæ Majoris	32. 45	+0·14	6	5	α Tauri	68. 5	+0·61	1	1
ϵ Ursæ Majoris	33. 9	+0·25	3	2	A^1 Tauri	68. 22	+1·48	1	1
ϵ Cephei	33. 46	+0·04	6	3	δ Leonis	68. 35	—0·04	4	2
ζ^1 Ursæ Majoris	34. 13	—0·02	15	10	Arcturus	69. 58	+1·45	10	14
ζ^2 Ursæ Majoris	34. 13	+0·60	7	7	* A. R. 19 ^b . 17 ^m	73. 21	+1·74	1	3
α Cassiopeiæ	34. 21	+0·09	5	1	Aldebaran	73. 49	+1·38	4	1
γ Ursæ Majoris	35. 24	—0·34	15	5	A. S. C. 2034	73. 58	—0·47	1	1
ι Ursæ Majoris	41. 19	+1·11	4	5	β Leonis	74. 31	+0·97	2	1
δ Persei	42. 44	+0·38	3	2	α Pegasi	75. 40	+0·65	7	8
τ Herculis	43. 18	+2·03	3	1	γ Pegasi	75. 43	+0·52	3	1
ι Herculis	43. 54	+2·50	4	3	A. S. C. 701	75. 54	+0·49	3	1
Capella	44. 11	+1·89	12	6	ζ Aquilæ	76. 22	+0·08	6	3
ψ Ursæ Majoris	44. 37	+0·18	4	3	δ Herculis	78. 57	+0·94	5	2
β Aurigæ	45. 5	—0·45	4	2	ζ Pegasi	80. 1	—1·49	14	1
δ Cygni	45. 16	+0·53	5	4	f^2 Ophiuchi	80. 18	—0·64	5	1
α Cygni	45. 18	+0·85	5	2	ϵ Pegasi	80. 52	—0·68	13	2
λ Ursæ Majoris	46. 16	+0·25	4	6	Procyon	84. 22	—0·01	5	1
ϵ Aurigæ	46. 26	—2·17	5	1	θ Piscium	84. 31	+0·78	4	4
γ^1 Andromedæ	48. 27	0·00	2	2	4 Equulei	84. 41	+1·41	3	2
γ^2 Andromedæ	48. 27	+1·32	1	1	ι Equulei	85. 15	+0·35	6	3
δ Aurigæ	48. 50	+1·40	2	3	ζ Virginis	89. 46	+1·99	1	1
β Bootis	48. 58	+1·21	1	3	10 Ceti	90. 57	+1·29	4	1
10 Canum Venaticum	49. 50	+1·49	2	3	e Serpentis	91. 7	+0·88	4	1
δ Aurigæ	50. 25	+1·10	1	3	α Aquarii	91. 7	+0·99	14	3
12 ¹ Canum Venaticum	50. 48	+0·63	2	2	d Aquilæ	91. 11	+0·88	1	1
12 ² Canum Venaticum	50. 48	+1·70	2	2	* A. R. 19 ^b . 11 ^m	91. 14	—1·08	1	1
α Lyrae	51. 22	+1·38	15	9	58 Ceti	92. 51	—2·53	1	1
δ Cygni	52. 3	—0·35	5	1	27 Piscium	94. 28	+0·02	4	1
κ Lyrae	54. 0	+1·52	1	2	A. S. C. 617	98. 21	+1·48	1	1
β Andromedæ	55. 15	+1·38	5	5	λ Aquarii	98. 27	+0·36	1	1
β^1 Lyrae	56. 49	+0·17	4	8	θ^1 Ceti	99. 2	+1·26	6	1
* A. R. 6 ^b . 22 ^m . 45 ^s	56. 52	+1·21	1	1	Spica	100. 18	—0·83	4	3
π^1 Pegasi	57. 37	+1·15	4	1	σ Aquarii	101. 31	—0·35	2	1
π^2 Pegasi	57. 37	+0·39	4	1	α^1 Capricorni	103. 0	+1·13	4	1
Castor	57. 46	—0·20	5	2	α^2 Capricorni	103. 3	+0·05	5	1
ζ Cygni	60. 26	+0·70	8	2	A. S. C. 2264	104. 52	—0·92	3	1
2 Cygni	60. 42	+2·02	3	2	A. S. C. 2262	105. 22	—0·84	3	1
β Tauri	61. 32	—1·16	1	1	49 Libræ	106. 3	+4·13	4	1
Pollux	61. 35	+0·39	9	5	Sirius	106. 30	+0·31	61	6
α Andromedæ	61. 49	+0·80	3	2	β^1 Scorpii	109. 21	+0·40	3	1
α Coronæ Borealis	+62. 44	+0·18	10	1	Antares	+116. 4	—0·28	4	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

DISCORDANCE OF DIRECT AND REFLEXION RESULTS.

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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.
ν Cephei S.P. to θ Cephei S.P.	9	28. 7	—0.25	ζ Urs. Maj. S.P. to θ Cephei S.P.	7	29. 50	—2.29
δ Draconis S.P. to β Cephei S.P.	2	21. 23	—0.14	β Cephei S.P. to κ Cephei S.P.	7	15. 34	+0.97
γ Cephei S.P. to κ Cephei S.P.	8	12. 54	+1.48	δ Urs. Min. S.P. to δ Urs. Min.	33	0. 21	—1.50
δ Urs. Min. S.P. to δ Urs. Min.	32	0. 4	—0.29	ϵ Ursæ Min. to β Ursæ Min.	18	13. 21	—1.31
ϵ Ursæ Min. to β Ursæ Min.	17	13. 50	—0.31	11 Ursæ Minoris to α Draconis	10	19. 35	—1.08
11 Ursæ Minoris to ϵ Draconis	13	19. 9	+0.12	i Draconis to α Draconis	8	24. 45	—1.16
δ Draconis to α Draconis	9	24. 6	—1.27	α Ursæ Majoris to η Draconis	21	27. 51	—2.16
α Ursæ Majoris to η Draconis	10	27. 13	—0.36	γ Cassiopeiæ to δ Ursæ Majoris	13	30. 54	—0.84
ν Ursæ Majoris to ϵ Ursæ Majoris	21	31. 41	—0.43	β Ursæ Maj. to γ Ursæ Maj.	33	34. 4	+0.11
ϵ Cephei to 16 Draconis	21	34. 28	—0.62	i Ursæ Majoris to Capella	16	43. 11	+1.63
i Ursæ Maj. to λ Ursæ Majoris	31	44. 15	—0.50	ψ Ursæ Majoris to ϵ Aurigæ	16	46. 27	+0.14
γ^1 Andromedæ to 61 ¹ Cygni	18	50. 48	—0.25	γ^1 Androm. to 10 Can. Venat.	8	48. 59	+1.03
κ Lyrae to Castor	13	56. 23	+0.53	63 Aurigæ to 61 ¹ Cygni	15	51. 12	+1.19
ζ Cygni to α Coronæ Borealis	12	61. 20	+1.60	κ Lyrae to Castor	15	56. 21	+0.76
ϵ Geminorum to 73 Herculis	8	66. 14	+0.60	ζ Cygni to α Coronæ Borealis	13	61. 23	+0.62
γ Leonis to Arcturus	11	69. 53	+1.63	ϵ Geminorum to δ Leonis	8	67. 0	+0.41
* A.R. 19 ^b . 17 ^m to ζ Aquilæ	16	75. 10	+1.64	Arcturus	10	69. 58	+1.45
Regulus to α Aquilæ	21	79. 39	+0.82	* A.R. 19 ^b . 17 ^m to ζ Aquilæ	16	75. 23	+0.59
θ Piscium to δ Aquilæ	6	85. 0	+0.46	66 Herculis to ϵ Pegasi	6	80. 0	—0.27
10 Ceti to θ Virginis	10	91. 28	—0.25	Procyon to i Equulei	10	84. 49	+0.70
β Aquarii to λ Virginis	11	98. 23	—1.07	ζ Virginis to 58 Ceti	9	91. 10	+0.49
i Aquarii to Sirius	9	106. 12	—1.03	27 Piscium to σ Aquarii	8	99. 5	+0.04
η Capricorni to Antares	3	114. 13	—0.42	α^1 Capricorni to Sirius	11	105. 35	+0.49
				β^1 Scorpii to Antares	2	112. 42	+0.06

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 generally 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 however are not identical, and it has therefore appeared best to use each for the reduction of observations with the circle to which it belongs. $R - D$ being taken from each curve for every 10° of N. P. D., half of this quantity is considered as a correction

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additive to the Direct-result, and half subtractive from the Reflexion-result. Thus the following table is formed.

Corrections to N. P. D. independent of Latitude-Correction (to be applied algebraically.)

N. P. D.	Troughton.		N. P. D.	Jones.	
	D.	R.		D.	R.
— 50°	“00	“00	— 50°	“00	“00
— 40	— ‘02	+ ‘02	— 40	— ‘06	+ ‘06
— 30	— ‘04	+ ‘04	— 30	— ‘17	+ ‘17
— 20	— ‘08	+ ‘08	— 20	— ‘32	+ ‘32
— 10	— ‘11	+ ‘11	— 10	— ‘50	+ ‘50
0	— ‘14	+ ‘14	0	— ‘67	+ ‘67
+ 10	— ‘16	+ ‘16	+ 10	— ‘80	+ ‘80
+ 20	— ‘24	+ ‘24	+ 20	— ‘76	+ ‘76
+ 30	— ‘32	+ ‘32	+ 30	— ‘41	+ ‘41
+ 40	— ‘30	+ ‘30	+ 40	+ ‘39	— ‘39
+ 50	— ‘06	+ ‘06	+ 50	+ ‘54	— ‘54
+ 60	+ ‘44	— ‘44	+ 60	+ ‘44	— ‘44
+ 70	+ ‘66	— ‘66	+ 70	+ ‘36	— ‘36
+ 80	+ ‘44	— ‘44	+ 80	+ ‘24	— ‘24
+ 90	“00	“00	+ 90	+ ‘20	— ‘20
+ 100	— ‘40	+ ‘40	+ 100	+ ‘12	— ‘12
+ 110	— ‘40	+ ‘40	+ 110	+ ‘08	— ‘08
+ 120	— ‘10	+ ‘10	+ 120	+ ‘03	— ‘03
+ 130	“00	“00	+ 130	“00	“00

To investigate the correction for latitude, the following process is employed. Twenty-eight stars are selected, of various N. P. D. not exceeding 37° , and which have been observed each several times above and below the pole. The results from Troughton by direct vision, Troughton by reflexion, Jones by direct vision, Jones by reflexion, are separately corrected from the table above, and the corrected numbers are placed in the fifth column of the subjoined table. Taking the means of these, giving a weight to each determination proportioned to the number of the observations, the numbers in the seventh column are found. The algebraical sum of this number for any star above the pole with the corresponding number for the same star below the pole ought to be zero, if the assumed co-latitude were correct: if the co-latitude require the correction z , then the sum of those numbers $+ 2z = 0$. The ninth column contains the algebraical sum for each star. The weight in the tenth column has been determined (nearly) by the following formula: if there are a observations and b below, the fraction $\frac{a b}{a + b}$ is formed; and this is multiplied by 60 for Polaris, 59 for δ Cephei, 58 for δ Ursæ Minoris, and so on, ending with 33 for 16 Draconis. The eleventh column contains the products of the numbers in the ninth and tenth columns.

CORRECTION OF ASSUMED LATITUDE.

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Star's Name, Name of Circle, and Mode of Observation.	No. of Obs.	N. P. D. uncorrected.	Correc- tion.	N. P. D. corrected.	No. of Obs.	Concluded N. P. D. on assumed Latitude.	No. of Obs.	Algebraic Sum of Determi- nations.	Weight.	Product.
		° ' "	" "	" "		" "		" "		
Polaris T. D.	9	1. 33. 34.70	— .14	34.56	30	34.80	128	—1.64	30	—49.20
T. R.	6	35.06	+ .14	35.20						
J. D.	11	35.66	— .69	34.97						
J. R.	4	33.58	+ .69	34.27						
S. P. T. D.	36	— 1. 33. 36.57	— .14	—36.71	98	—36.44				
T. R.	13	36.59	+ .14	36.45						
J. D.	33	35.55	— .64	36.19						
J. R.	16	36.96	+ .64	36.32						
51Cephei (Hev.) T. D.	1	2. 44. 7.55	— .14	7.41	4	6.18	14	—4.27	4	—17.08
T. R.	1	3.15	+ .14	3.29						
J. D.	2	7.72	— .70	7.02						
J. R.		....	..	....						
S. P. T. D.	3	— 2. 44. 9.99	— .13	—10.12	10	—10.45				
T. R.	2	12.46	+ .13	12.33						
J. D.	2	9.35	— .63	9.98						
J. R.	3	10.47	+ .63	9.84						
δ Ursæ Minoris T. D.	4	3. 24. 35.85	— .15	35.70	16	35.83	32	—0.96	10	— 9.60
T. R.	4	36.02	+ .15	36.17						
J. D.	4	36.46	— .71	35.75						
J. R.	4	35.01	+ .71	35.72						
S. P. T. D.	5	— 3. 24. 36.92	— .13	—37.05	16	—36.79				
T. R.	1	37.26	+ .13	37.13						
J. D.	8	35.88	— .61	36.49						
J. R.	2	37.75	+ .61	37.14						
ε Ursæ Minoris T. D.	7	7. 42. 21.86	— .16	21.70	16	22.32	20	—1.22	4	— 4.88
T. R.	1	20.78	+ .16	20.94						
J. D.	3	23.36	— .77	22.59						
J. R.	5	22.52	+ .77	23.29						
S. P. T. D.		— 7. 42.	..		4	—23.54				
T. R.	2	23.75	+ .11	—23.64						
J. D.	2	22.91	— .54	23.45						
J. R.		....	..	....						
γ Cephei T. D.	2	13. 16. 36.17	— .19	35.98	12	35.89	20	—2.62	6	—15.72
T. R.	4	36.02	+ .19	36.21						
J. D.	4	36.23	— .79	35.44						
J. R.	2	35.26	+ .79	36.05						
S. P. T. D.	2	—13. 16. 38.65	— .10	—38.75	8	—38.51				
T. R.	2	37.78	+ .10	37.68						
J. D.	4	38.37	— .44	38.81						
J. R.		....	..	....						

Star's Name, Name of Circle, and Mode of Observation.	No. of Obs.	N. P. D. uncorrected.	Correc- tion.	N. P. D. corrected.	No. of Obs.	Concluded N. P. D. on assumed Latitude.	No. of Obs.	Algebraic Sum of Determi- nations.	Weight.	Product.
β Ursæ Minoris T. D. 16		15. 10. 41.45	— .20	41.25						
T. R. 9		40.66	+ .20	40.86						
J. D. 15		42.54	— .78	41.76	50	41.38				
J. R. 10		40.71	+ .78	41.49						
S. P. T. D. 2		—15. 10. 42.33	— .09	—42.42			54	—1.46	5	— 7.30
T. R.			..							
J. D. 2		42.86	— .41	43.27	4	—42.84				
J. R.			..							
ξ U. Min. (Bode) T. D. 4		19. 48. 2.40	— .24	2.16						
T. R. 3		1.63	+ .24	1.87	14	2.44				
J. D. 6		3.48	— .76	2.72			16	—2.88	2	— 5.76
J. R. 1		2.77	+ .76	3.53						
S. P. T. D. 1		—19. 48. 5.66	— .08	— 5.74						
T. R.			..							
J. D. 1		4.58	— .32	4.90	2	— 5.32				
J. R.			..							
ϵ Draconis. T. D. 3		20. 8. 49.05	— .24	48.81						
T. R. 3		49.39	+ .24	49.63	12	49.52				
J. D. 3		50.23	— .76	49.47			24	—1.71	7	—11.97
J. R. 3		49.40	+ .76	50.16						
S. P. T. D. 6		—20. 8. 51.01	— .08	—51.09						
T. R.			..							
J. D. 6		51.04	— .32	51.36	12	—51.23				
J. R.			..							
β Cephei. T. D. 2		20. 9. 14.03	— .24	13.79						
T. R. 1		15.17	+ .24	15.41	6	13.68				
J. D. 3		13.80	— .76	13.04			26	—0.71	5	— 3.55
J. R.			..							
S. P. T. D. 9		—20. 9. 14.32	— .08	—14.40						
T. R.			..							
J. D. 9		14.54	— .32	14.86	20	—14.39				
J. R. 2		12.46	+ .32	12.14						
δ Draconis. T. D. 2		22. 37. 29.88	— .26	29.62						
T. R. 3		29.33	+ .26	29.59	10	29.52				
J. D. 3		30.73	— .67	30.06			16	—0.90	4	— 3.60
J. R. 2		27.83	+ .67	28.50						
S. P. T. D. 2		—22. 37. 29.88	— .07	—29.95						
T. R. 1		29.47	+ .07	29.40	6	—30.42				
J. D. 3		30.80	— .28	31.08						
J. R.			..							

CORRECTION OF ASSUMED LATITUDE.

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Star's Name, Name of Circle, and Mode of Observation.	No. of Obs.	N. P. D. uncorrected.	Correc- tion.	N. P. D. corrected.	No. of Obs.	Concluded N. P. D. on assumed Latitude.	No. of Obs.	Algebraic Sum of Determi- nations.	Weight.	Product.
δ Cephei T. D.	2	24. 39. 19.80	- .28	19.52	12	19.18	16	-2.78	3	- 8.34
T. R.	4	18.75	+ .28	19.03						
J. D.	4	19.58	- .59	18.99						
J. R.	2	18.92	+ .59	19.51						
S. P. T. D.	2	-24. 39. 21.97	- .06	22.03	4	-21.96				
T. R.		....	..	....						
J. D.	2	21.65	- .25	21.90						
J. R.		....	..	....						
κ Cassiopeiæ T. D.	2	27. 58. 7.15	- .30	6.85	8	7.44	14	-0.27	4	- 1.08
T. R.	2	7.55	+ .30	7.85						
J. D.	2	8.74	- .48	8.26						
J. R.	2	6.32	+ .48	6.80						
S. P. T. D.	3	-27. 58. 7.31	- .04	7.35	6	- 7.71				
T. R.		....	..	....						
J. D.	3	7.88	- .20	8.08						
J. R.		....	..	....						
α Cephei T. D.	2	28. 6. 11.25	- .30	10.95	4	11.74	36	-0.73	2	- 2.92
T. R.		....	..	....						
J. D.	1	14.60	- .48	14.12						
J. R.	1	10.48	+ .48	10.96						
S. P. T. D.	9	-28. 6. 12.29	- .04	12.33	32	-12.47				
T. R.	6	12.68	+ .04	12.64						
J. D.	14	11.86	- .20	12.06						
J. R.	3	14.63	+ .20	14.43						
η Draconis T. D.	20	28. 6. 55.09	- .30	54.79	44	54.69	46	-2.31	4	- 4.62
T. R.	2	56.04	+ .30	56.34						
J. D.	11	55.70	- .48	55.22						
J. R.	11	53.21	+ .48	53.69						
S. P. T. D.	1	-28. 6. 57.10	- .04	57.14	2	-57.00				
T. R.		....	..	....						
J. D.	1	56.67	- .20	56.87						
J. R.		....	..	....						
θ Draconis T. D.	3	30. 59. 51.06	- .32	50.74	8	49.95	12	-0.88	3	- 2.64
T. R.	1	50.05	+ .32	50.37						
J. D.	2	49.68	- .33	49.35						
J. R.	2	48.82	+ .33	49.15						
S. P. T. D.	2	-30. 59. 50.48	- .04	50.52	4	-50.83				
T. R.		....	..	....						
J. D.	2	50.98	- .16	51.14						
J. R.		....	..	....						

Star's Name, Name of Circle, and Mode of Observation.	No. of Obs.	N. P. D. uncorrected.	Correc- tion.	N. P. D. corrected.	No. of Obs.	Concluded N. P. D. on assumed Latitude.	No. of Obs.	Algebraic Sum of Determi- nation.	Weight.	Product.
β Cassiopeiæ . . . T. D.	2	31. 44. 57. 65	— .32	57. 33		"		"		
T. R.		....	..	....						
J. D.	1	58. 65	— .28	58. 37	4	57. 70				
J. R.	1	57. 50	+ .28	57. 78						
S. P. T. D.	4	—31. 44. 59. 10	— .04	59. 14			12	—1. 33	3	— 3. 99
T. R.		....	..	....						
J. D.	4	58. 78	— .15	58. 93	8	—59. 03				
J. R.		....	..	....						
δ Ursæ Majoris T. D.	8	32. 3. 40. 55	— .32	40. 23						
T. R.	5	39. 35	+ .32	39. 67						
J. D.	10	40. 12	— .25	39. 87	26	40. 01				
J. R.	3	40. 23	+ .25	40. 48			30	—1. 13	3	— 3. 39
S. P. T. D.	2	—32. 3. 40. 74	— .04	40. 78						
T. R.		....	..	....						
J. D.	2	41. 36	— .14	41. 50	4	—41. 14				
J. R.		....	..	....						
δ^2 Cephei T. D.	1	32. 25. 0. 94	— .32	0. 62						
T. R.	3	1. 15	+ .32	1. 47						
J. D.	4	2. 62	— .21	2. 41	8	1. 83				
J. R.		....	..	....			14	—2. 18	3	— 6. 54
S. P. T. D.	3	—32. 25. 4. 01	— .04	4. 05						
T. R.		....	..	....						
J. D.	3	3. 84	— .14	3. 98	6	— 4. 01				
J. R.		....	..	....						
δ^1 Cephei T. D.	1	32. 25. 41. 17	— .32	40. 85						
T. R.		....	..	....						
J. D.	1	44. 61	— .21	44. 40	2	42. 62				
J. R.		....	..	....			4	—1. 67	1	— 1. 67
S. P. T. D.	1	—32. 25. 45. 24	— .04	45. 28						
T. R.		....	..	....						
J. D.	1	43. 17	— .14	43. 31	2	—44. 29				
J. R.		....	..	....						
β Ursæ Majoris T. D.	6	32. 44. 43. 76	— .32	43. 44						
T. R.	5	44. 08	+ .32	44. 40						
J. D.	6	43. 23	— .20	43. 03	22	43. 58				
J. R.	5	43. 37	+ .20	43. 57			26	—2. 32	3	— 6. 96
S. P. T. D.	2	—32. 44. 46. 14	— .03	46. 17						
T. R.			..							
J. D.	2	45. 50	— .14	45. 64	4	—45. 90				
J. R.			..							

CORRECTION OF ASSUMED LATITUDE.

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Star's Name, Name of Circle, and Mode of Observation.	No. of Obs.	N. P. D. uncorrected.	Correc- tion.	N. P. D. corrected.	No. of Obs.	Concluded N. P. D. on assumed Latitude.	No. of Obs.	Algebraic Sum of Determi- nations.	Weight.	Product.
η Cassiopeia... T. D.	1	33. 3. 4.20	— .32	3.88						
T. R.	1	3.48	+ .32	3.80						
J. D.	2	4.83	— .17	4.66	4	4.25				
J. R.		..	..	....			6	—1.74	1	— 1.74
S. P. T. D.	1	—33. 3. 5.08	— .04	5.12						
T. R.		....	..	....						
J. D.	1	6.74	— .13	6.87	2	— 5.99				
J. R.		....	..	....						
ϵ Ursæ Majoris T. D.	4	33. 9. 13.70	— .32	13.38						
T. R.	1	14.12	+ .32	14.44						
J. D.	3	13.90	— .17	13.73	10	13.78				
J. R.	2	14.15	+ .17	14.32			18	—0.85	4	— 3.40
S. P. T. D.	4	—33. 9. 14.00	— .04	14.04						
T. R.		....	..	....						
J. D.	3	14.57	— .13	14.70	8	—14.63				
J. R.	1	16.95	+ .13	16.82						
ϵ Cephei T. D.	3	33. 46. 1.66	— .31	1.35						
T. R.	6	1.01	+ .31	1.32						
J. D.	6	2.27	— .13	2.14	18	1.78				
J. R.	3	2.31	+ .13	2.44			22	—1.60	3	— 4.80
S. P. T. D.	2	—33. 46. 3.01	— .03	3.04						
T. R.		....	..	....						
J. D.	2	3.60	— .12	3.72	4	— 3.38				
J. R.		....	..	....						
ζ^1 Ursæ Majoris T. D.	17	34. 13. 17.76	— .31	17.45						
T. R.	8	16.63	+ .31	16.94						
J. D.	15	17.07	— .07	17.00	50	17.17				
J. R.	10	17.05	+ .07	17.12			56	—1.32	4	— 5.28
S. P. T. D.	3	—34. 13. 19.04	— .03	19.07						
T. R.		....	..	....						
J. D.	2	17.01	— .12	17.13	6	—18.49				
J. R.	1	19.59	+ .12	19.47						
α Cassiopeia... T. D.	4	34. 21. 26.80	— .31	26.49						
T. R.	2	26.46	+ .31	26.77						
J. D.	5	27.03	— .07	26.96	12	26.79				
J. R.	1	27.12	+ .07	27.19			18	—1.58	3	— 4.74
S. P. T. D.	3	—34. 21. 27.41	— .03	27.44						
T. R.		....	..	....						
J. D.	3	29.18	— .12	29.30	6	—28.37				
J. R.		....	..	....						

INTRODUCTION TO GREENWICH OBSERVATIONS, 1837.

Star's Name, Name of Circle, and Mode of Observation.	No. of Obs.	N. P. D. uncorrected.	Correc- tion.	N. P. D. corrected.	No. of Obs.	Concluded N. P. D. on assumed Latitude.	No. of Obs.	Algebraic Sum of Determi- nation.	Weight.	Product.
γ Ursæ Majoris T. D.	19	35. 23. 55.41	— .31	55.10		"		"		
T. R.	1	55.38	+ .31	55.69						
J. D.	15	55.58	.00	55.58	40	55.31				
J. R.	5	55.24	.00	55.24			44	— 0.30	3	— 0.90
S. P. T. D.	2	— 35. 23. 55.82	— .03	55.85						
T. R.		....	..	....						
J. D.	2	55.26	— .11	55.37	4	— 55.61				
J. R.		....	..	....						
17 ¹ Draconis... T. D.	4	36. 44. 41.70	— .31	41.39						
T. R.	1	41.51	+ .31	41.82						
J. D.	5	43.18	+ .12	43.30	10	42.39				
J. R.		....	..	....			13	— 1.22	2	— 2.44
S. P. T. D.	1	— 36. 44. 44.16	— .03	44.19						
T. R.		....	..	....						
J. D.	2	43.22	— .10	43.32	3	— 43.61				
J. R.		....	..	....						
16 Draconis... T. D.	4	36. 46. 10.08	— .31	9.77						
T. R.	1	8.15	+ .31	8.46						
J. D.	5	10.07	+ .12	10.19	10	9.85				
J. R.		....	..	....			13	— 0.88	2	— 1.76
S. P. T. D.	1	— 36. 46. 11.90	— .03	11.93						
T. R.		....	..	....						
J. D.	2	10.03	— .10	10.13	3	— 10.73				
J. R.		....	..	....						

Dividing the sum of the products in the last column by the sum of the weights, the value of $2z$ is found from 750 observations to be $+1''.53$, or the correction to the assumed co-latitude $+0''.77$. The correction found from 1366 observations in the year 1836 is $+0''.93$. I prefer the result of 1836, not merely because the observations were more numerous, but also because in a part of 1837 the observations of stars were too much confined to the south side of the zenith, and an error may have thence arisen in regard to the determination of $R-D$.

Using the quantity $+0''.93$ therefore, in conjunction with the numbers of the table on page xxxiv, 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.	TROUGHTON.		JONES.		N. P. D.
	Correction to Results of Direct Observation.	Correction to Results of Reflexion Observation.	Correction to Results of Direct Observation.	Correction to Results of Reflexion Observation.	
°	"	"	"	"	°
— 50	+ 0·93	+ 0·93	+ 0·93	+ 0·93	— 50
— 40	+ 0·91	+ 0·95	+ 0·87	+ 0·99	— 40
— 30	+ 0·89	+ 0·97	+ 0·76	+ 1·10	— 30
— 20	+ 0·85	+ 1·01	+ 0·61	+ 1·25	— 20
— 10	+ 0·82	+ 1·04	+ 0·43	+ 1·43	— 10
0	+ 0·79	+ 1·07	+ 0·26	+ 1·60	0
+ 10	+ 0·77	+ 1·09	+ 0·13	+ 1·73	+ 10
+ 20	+ 0·69	+ 1·17	+ 0·17	+ 1·69	+ 20
+ 30	+ 0·61	+ 1·25	+ 0·52	+ 1·34	+ 30
+ 40	+ 0·63	+ 1·23	+ 1·32	+ 0·54	+ 40
+ 50	+ 0·87	+ 0·99	+ 1·47	+ 0·39	+ 50
+ 60	+ 1·37	+ 0·49	+ 1·37	+ 0·49	+ 60
+ 70	+ 1·59	+ 0·27	+ 1·29	+ 0·57	+ 70
+ 80	+ 1·37	+ 0·49	+ 1·17	+ 0·69	+ 80
+ 90	+ 0·93	+ 0·93	+ 1·13	+ 0·73	+ 90
+ 100	+ 0·53	+ 1·33	+ 1·05	+ 0·81	+ 100
+ 110	+ 0·53	+ 1·33	+ 1·01	+ 0·85	+ 110
+ 120	+ 0·83	+ 1·03	+ 0·96	+ 0·90	+ 120
+ 130	+ 0·93	+ 0·93	+ 0·93	+ 0·93	+ 130

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 adopted seconds of N. P. D. are found by taking the mean of the results of all the groups, giving each a weight proportional to its number of observations. For the stars whose N. P. D. does not exceed 15°, the observations above and below the pole are considered equally good: from N. P. D. 15° to N. P. D. 36°, those below have the weight $\frac{2}{3}$ for each observation: from N. P. D. 36° to N. P. D. 41°, those below have the weight $\frac{1}{2}$: beyond 41° N. P. D. the observations are not combined. The annual variations are taken from the Nautical Almanac 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 114.)*

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 — $0^{\circ}18$.

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 — $1''85$.

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 $\times$ versed sine of θ . The correction on April 20 is — $0^{\circ}03$. The apparent error of the diameter for that day is — $0^{\circ}38$.

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 seven values of errors is — $5''94$. From the agreement of this result with the preceding, as well as with those of the year 1836, and with those deduced from the Cambridge Observations, there appears little doubt that Burckhardt's tabular semidiameter is $3''$ too small.

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. $3^m.47^s.00$ — hours of Sid. Time + solar equiv. for hours.
4. $10^s.00$ — minutes of Sid. Time + solar equiv. for minutes.
5. $3^s.00$ — seconds of Sid. Time + solar equiv. for seconds.

Small tables of the 3rd, 4th, and 5th quantities are prepared, 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 + $0^s.09$ is applied, and when the second limb only has been observed, the correction — $0^s.09$. The days on which these corrections are applied, are Jan. 6, 14; Feb. 24; Mar. 21, 23; April 6, 8; May 13, 16, 17, 30, 31; June 9, 17, 21; July 4, 7, 22; Aug. 4, 17; Sept. 12, 13; Oct. 4, 13, 17; Nov. 2, 3, 14. 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 + $0''.92$ on May 10; June 15; Aug. 19. 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 + $0^s.20$ being applied when the first limb was observed, and — $0^s.20$ 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 + $3''.05$ when the north limb only was observed, and — $3''.05$ when the south limb only was observed. When both limbs were observed, the mean is taken. An additional correction is applied for the error of parallax. From Mr. Henderson's researches, it appears that Burckhardt's tabular parallax is too small by about $\frac{1}{26000}$ part, and a correction to this amount is applied in forming the N. P. D. from observation as here exhibited. 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 observation, 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 Greenwich Observations, 1836. Assuming these errors to arise from an erroneous position of the ecliptic assumed in the Nautical Almanac, they may be expressed by the formula $x \times \cos. \odot \text{ longitude} + y \times \sin. \odot \text{ longitude} + z$. 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 $0^{\circ}.03$, 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 the Greenwich Observations, 1836. 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

$$\begin{aligned} \text{Error of Hel. longitude} &= \frac{\Delta \times \cos. \text{geocen. lat.}}{R \times \cos. \text{hel. lat.} \times \cos. (\lambda - L)} \times \text{error of geocen. long.} \\ &+ \frac{\tan. (\lambda - L)}{R \times \cos. \text{hel. lat.} \times \sin. 1''} \times \text{error of projection of radius vector.} \end{aligned}$$

$$\begin{aligned} \text{Error of Hel. E. P. D.} &= \frac{\Delta \times \cos. \text{hel. lat.}}{R \times \cos. \text{geoc. lat.}} \times \text{error of geocen. E. P. D.} \\ &- \sin. \text{hel. lat.} \times \cos. \text{hel. lat.} \times \tan. (\lambda - L) \times \text{error of geocen. long.} \\ &- \frac{r \times \tan. \text{geoc. lat.} \times \cos. (\lambda - l)}{R^2 \times \cos. (\lambda - L) \times \sin. 1''} \times \text{error of projection of radius vector.} \end{aligned}$$

For the other planets, the following are used :

$$\begin{aligned} \text{Error of Hel. long.} &= \frac{\Delta}{R \times \cos. (\lambda - L)} \times \text{error of geocen. long.} \\ &+ \frac{\tan. (\lambda - L)}{R \times \sin. 1''} \times \text{error of projection of radius vector.} \end{aligned}$$

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

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

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

And the Weight for Heliocentric E. P. D. by the formula

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

The errors of the tabular Longitude and Ecliptic Polar Distance of the Moon are deduced from the errors of Tabular Right Ascension and North Polar Distance, by use of the numbers P, Q, R, S. The errors of Tabular Right Ascension are previously* affected with the correction + 0^h.03, to reduce them to the same equinox as that adopted for the planets.

* In the Observations of 1836, the tabular Errors of the Moon were in like manner reduced to the same equinox as the tabular errors of the Planets.

§ 7. *Observations of γ Draconis with the Zenith Tube, and Reduction of the Observations,*
(page 116 to 123.)

Referring to the commencement of this Introduction for the description of the instrument, it will readily be seen that the deduction of Zenith Distance from an observation consists of these parts. If the axis of the tube be exactly vertical, and the wire of the Grand Micrometer be brought on the star, the reading of the Micrometer will give the Zenith Distance, provided that we know the reading corresponding to a star in the true zenith. The latter reading however can be found only by observing the actual star, at the same zenith distance, with the instrument in reversed position: the micrometer's distance from its zenithal position will now be the same as before, but on the opposite side: and the position intermediate to the two will be the zenithal position. This supposes that the actual star has the same zenith distance in the two observations: if the zenith distance has changed, the amount of this change must be obtained from theoretical computations, and one of the observations must be reduced so as to exhibit the result which it would have exhibited if the star's declination had not changed. Then the zenithal-reading is found, and the true zenith distance is deduced for each observation.

But if the tube be not vertical, each observation can still be made available, by reducing it to what it would have been if the tube had been vertical. This will be done by means of the micrometer-microscopes with which the position of the plumb-line is observed. For if their readings are the same when the Zenith Tube is reversed, it is clear that the axis is vertical: if they are not the same, their difference gives the means of ascertaining the error of verticality. In practice it is more convenient, not to take the difference between the plumb-line-micrometer readings in the different positions, but to reduce each reading for the value of its whole reading from the zero (real or imaginary) of the micrometer. A large imaginary quantity is thus introduced into the value deduced from each observation: the same quantity therefore occurs in the deduced zenithal-reading, and therefore it disappears entirely from the zenith-distance obtained from their difference.

If the plumb-line were suspended from a point rigorously fixed, a single microscope near the bottom would ascertain the error of verticality. But as no dependence can be placed on the fixity of any suspension, a micrometer near the top is necessary to ascertain the variations of the point of suspension.

A little consideration of these points will show that the reduction of any observation will be effected by converting the readings of the Grand Micrometer and the two plumb-line micrometers into arc, the readings of each being reckoned from some fixed zeros, real or imaginary: that their sums may be additive or subtractive according to the position of the micrometer: and that the result thus obtained will contain a constant (which will be invariable so long as the relation of the upper plumb-line micrometer to the object-glass,

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and that of the lower plumb-line micrometer to the Grand Micrometer, shall continue invariable,) which constant will be eliminated by observation in reversed positions of the Tubes. It is only necessary to add, that, in the present position of the micrometers, the results are all additive for zenith distance North when the eye-piece is West. The first step now must be, to ascertain the values necessary for converting the micrometer-readings into arc.

Observations for the Values of the Micrometers of the Zenith Tube.

1st. To find the intervals between the wires of the Grand Micrometer, in terms of revolutions of its screw.

The moveable plate of the Grand Micrometer contains eleven straight wires, which are called, 0, I, II, III, IV, V, VI, VII, VIII, IX, X, reckoning in succession from left to right when the observer is in front of the diagonal eye-piece. The fixed plate contains ten crosses, which are called I, II, III, &c. to X, in the same order. The intervals of the crosses are nearly the same as the intervals of the straight wires: and the range of the micrometer-screw is sufficient to carry each fixed wire from coincidence with one fork to coincidence with the next.

The following intervals were found, by bringing successively wire 0 and wire I to coincide with cross I: bringing wire I and wire II to coincide with cross II, &c.

Day of Observation. 1836.	Intervals in Revolutions of the Screw of the Grand Micrometer.										Observer.
	Wire 0 to Wire I.	Wire I. to II.	Wire II. to III.	Wire III. to IV.	Wire IV. to V.	Wire V. to VI.	Wire VI. to VII.	Wire VII. to VIII.	Wire VIII. to IX.	Wire IX. to X.	
Nov. 10	r 50·007	r 49·997	r 49·973	r 49·999	r 49·950	r 49·993	r 49·993	r 49·996	r 49·994	r 49·967	G
10	50·047	50·005	49·957	49·991	49·949	49·997	49·971	49·989	49·992	49·960	M
12	50·004	49·997	49·967	50·000	49·937	49·993	49·990	49·978	49·991	49·971	G
14	50·016		49·980	50·002	49·950	49·990	49·975	49·980	49·993	49·969	G
14		50·005									G
14		49·983									G
14		50·000									G
Mean....	50·019	49·998	49·969	49·998	49·947	49·993	49·982	49·986	49·993	49·967	

2nd. To find the intervals between the wires from transits of γ Draconis.

The instrument was turned with its eye-piece North till Nov. 23, and South in the succeeding observations, and the transits of γ Draconis were observed. In the observations to Nov. 23, the star passed the wires in the order X, IX, VIII, &c., and in the later series it passed in the order I, II, &c.

The following intervals of time were thus obtained.

Day of Observation, 1836.	Intervals expressed by the time occupied by the passage of γ Draconis.										Observer.
	Wire 0. to Wire I.	Wire I. to II.	Wire II. to III.	Wire III. to IV.	Wire IV. to V.	Wire V. to VI.	Wire VI. to VII.	Wire VII. to VIII.	Wire VIII. to IX.	Wire IX. to X.	
Nov. 14	"	35.1	36.5	36.1	"	"	"	"	"	"	G
15	36.1	36.0	35.8	35.3							G
18		35.7	36.1	36.1	35.6	36.3	35.7	36.0	36.1	36.0	G
23		35.9	35.6	36.0	35.7	36.2	35.9	35.8	36.3	35.8	G
Dec. 13					36.1	36.0	35.8	35.8	36.3		G
15	35.7	36.0	36.0	36.1	35.6	35.7	36.1	35.9	36.3		G
16	35.9	36.0	35.9	36.1	35.8	36.1	36.1	35.7	36.0		M
Mean . . .	35.90	35.78	35.98	35.95	35.76	36.06	35.92	35.84	36.20	35.90	

3rd. To find the value of one revolution of the screw of the Grand Micrometer.

Observing that the tangent of the star's distance from the meridian increases very nearly uniformly, and therefore that a scale of equal parts in the micrometer will correspond very nearly to equal times, and considering the N. P. D. of γ Draconis as $38^{\circ}.29'.30''$, the following results are obtained.

Value of one revolution of the Grand Micrometer.

By the observations of the interval from Wire 0. to Wire I.	6".701
Wire I. to Wire II.	6.681
Wire II. to Wire III.	6.722
Wire III. to Wire IV.	6.713
Wire IV. to Wire V.	6.684
Wire V. to Wire VI.	6.734
Wire VI. to Wire VII.	6.710
Wire VII. to Wire VIII.	6.694
Wire VIII. to Wire IX.	6.760
Wire IX. to Wire X.	6.708

The mean of all is $6''.711$.

4th. To find the proportion between the values of a revolution of the micrometer of the upper plumb-line microscope, and a revolution of the micrometer of the lower plumb-line microscope.

Let x be the value of one revolution of the lower microscope.

y " " " of the upper "

and let m and n be the number of revolutions read off, when the micrometer-crosses bisect the plumb-line.

Then if, upon inclining the tube and shifting the point of suspension, the upper

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micrometer still bisects the plumb-line, the inclination will be expressed by $x \times \delta m$: if the lower micrometer still bisects the plumb-line, the inclination will be $y \times \delta n$: if neither of them remains in coincidence, the inclination will be $x \times \delta m + y \times \delta n$. Therefore if, without altering the inclination of the tube, the place of suspension be shifted, and the values of m and n be changed in consequence,

$$x \times \delta m + y \times \delta n = 0.$$

The following were the readings of the microscopes on shifting the point of suspension :—

No. of Reference.	Day. 1836.	Reading of Lower Plumb-line Micrometer.	Number of Observations.	Observer.	Reading of Upper Plumb-line Micrometer.	Number of Observations.	Observer.
1	Nov. 9	107·994	6	M	89·974	5	G
2		93·866	6	M	107·687	5	G
3		93·897	10	M	107·746	10	G
4		106·318	10	M	92·126	10	G
5	Nov. 10	106·426	10	M	92·090	10	G
6		94·033	10	M	107·724	10	G
7		105·806	10	M	92·850	10	G
8		94·177	10	M	107·493	10	G

The equations $x \times \delta m + y \times \delta n = 0$, formed from the successive pairs, are as follows :—

$$\text{From Nos. 1 and 2, } x \times 14·128 - y \times 17·713 = 0$$

$$\text{From Nos. 3 and 4, } x \times 12·421 - y \times 15·620 = 0$$

$$\text{From Nos. 5 and 6, } x \times 12·393 - y \times 15·634 = 0$$

$$\text{From Nos. 7 and 8, } x \times 11·629 - y \times 14·643 = 0$$

The values of $\frac{y}{x}$ found from these equations are + 0·798, + 0·795, + 0·793, + 0·794. The mean is + 0·795.

5th. To find the absolute values of the revolutions of the two plumb-line micrometers.

By means of the foot-screws which shift the lower support of the zenith-tube, the foot of the tube was shifted alternately N. and S. as far as was practicable. The place of suspension was shifted at the same time (in some instances further than was desirable, but not so far, it is apprehended, as to injure the results). In each of these positions γ Draconis was observed. The eye-piece was west during the whole of this process: in this position the readings of the grand micrometer increase as the zenith distance north increases, or as the declination increases.

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For the reduction, the revolutions of the lower micrometer are converted into revolutions of the upper micrometer by means of the proportion given above: the readings of the grand micrometer are converted into arc by means of the value found in No. 3, and the declinations are taken from the Nautical Almanac. The constant (which may be conceived as an index-error) is eliminated in taking the difference of two successive determinations. There remains, therefore, an equation in which only one unknown quantity is involved. The accuracy of the Nautical Almanac is assumed only for the difference of declinations at the times of the two observations compared.

The following are the observations :—

No. for Reference.	Day of Observation. 1837.	Reading of Upper Plumb-line Micrometer.	Reading of Lower Plumb-line Micrometer.	Its value in Terms of Upper Plumb-line Micrometer.	Reading of Grand Micro-meter.	Its value in Arc.	Observer.	Declination from Nautical Almanac.
1	Feb. 7	114·840	85·693	107·790	48·587	326''·07	M	51° 30' 16''·21
2	Feb. 16	93·101	112·223	141·161	40·408	271·18	M	14·24
3	Mar. 13	114·106	86·643	108·985	47·063	315·84	M	11·22
4	Mar. 20	91·528	115·429	145·194	38·503	258·39	M	11·12
5	May 9	112·175	84·895	106·786	50·358	337·95	M	18·60
6	May 16	91·271	116·805	146·924	38·818	260·51	M	20·55

The wire V was used for all the observations.

Adding together the reading for the upper micrometer and the equivalent for the reading of the lower micrometer, we have these equations :—

$$\begin{aligned}
 \text{No. 1.} \dots 222\cdot630 \times y + 326\cdot07 + c &= 51^{\circ} 30' 16''\cdot21 \\
 2. \dots 234\cdot262 \times y + 271\cdot18 + c &= 51.30.14\cdot24 \\
 3. \dots 223\cdot091 \times y + 315\cdot84 + c &= 51.30.11\cdot22 \\
 4. \dots 236\cdot722 \times y + 258\cdot39 + c &= 51.30.11\cdot12 \\
 5. \dots 218\cdot961 \times y + 337\cdot95 + c &= 51.30.18\cdot60 \\
 6. \dots 238\cdot195 \times y + 260\cdot51 + c &= 51.30.20\cdot55
 \end{aligned}$$

Combining Nos. 1 and 2, we find $y = + 4''\cdot549$: combining Nos. 3 and 4, $y = + 4''\cdot207$: combining Nos. 5 and 6, $y = + 4''\cdot128$. The difference between the first of these values and the others being very considerable, the following observation was made in 1838. The eye-piece was east, and the readings increase with the increase of N.P.D.

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No. for Reference.	Day of Observation. 1838.	Reading of Upper Plumb-line Micrometer.	Reading of Lower Plumb-line Micrometer.	Its value in Terms of Upper Plumb-line Micrometer.	Reading of Grand Micro-meter.	Its value in Arc.	Observer.	N. P. D. from Nautical Almanac.
7	June 6	99.909	100.028	125.821	16.782	112.63	W R	38. 29. 34.8
8	June 12	107.389	105.922	133.235	7.230	48.52	A	38. 29. 32.8

From these we obtain the equations,

$$\text{No. 7.} \dots 225.730 \times y + 112.63 + c' = 38.29.34.8$$

$$\text{No. 8.} \dots 240.624 \times y + 48.52 + c' = 38.29.32.8$$

Combining these, we find $y = + 4''.170$.

I have no doubt that the discordance in the value of y deduced from the first pair of equations arises from an error of one revolution in the reading of one of the plumb-line microscopes, and probably in the upper, which required greater care than the others: (this assumption would reconcile the determinations very closely.) Rejecting the first, the mean of the other values gives $y = + 4''.168$, whence $x = + 5''.243$.

With these values, and the value of the grand micrometer-screw $6''.711$, the whole of the observations are reduced. It will be observed that the products of the number of revolutions by the values of one revolution are all to be added together; and the sum represents Declination or Zenith Distance North, altered by a constant, when the eye-piece is west; and North Polar Distance or Zenith Distance South, altered by a different constant, when the eye-piece is east.

The reduction of the observations has been effected in the following manner. The principle assumes the correctness of the change only of declination in the Nautical Almanac, in the first instance: but any error even in this quantity is nearly or wholly eliminated in the subsequent process. Let z_w be the star's zenith-distance north at the time of an observation when the eye-piece was west, and z_e its zenith-distance north at the time of another observation when the eye-piece was east: (it is indifferent whether this observation was before or after the other.) Let d_w and d_e be the seconds of the star's tabular declination for those times; and s_w and s_e the respective sums, for the two observations, of the equivalents for the micrometer readings.

$$\text{Then} \quad z_w = s_w + c$$

$$z_e = s_e - c$$

$$\text{Therefore} \quad z_w - z_e = s_w + s_e + 2c$$

$$\text{Or} \quad c = \frac{z_w - z_e}{2} - \frac{s_w + s_e}{2}$$

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But $z_w - z_e$ is evidently equal to $d_w - d_e$

$$\text{Therefore} \quad c = \frac{d_w - d_e}{2} - \frac{s_w + s_e}{2}$$

In this manner, the instrument being reversed after each observation, every pair of consecutive observations gives a value of c . With regard to the mode of adopting a value to apply to the reduction of several observations, or even of a single observation, no general rule can be given.

As long as the tabular declination of the star increases uniformly, and the observations are equivalent in time, the successive values of $d_w - d_e$ will be alternately positive and negative, and with equal values. Thus the mean of two successive values of c would be wholly independent of the tabular change of declination. And even with any changes of declination and any intervals of time, and deducing the adopted value of c in any manner which makes use of every value of c found, the mutual destruction of positive and negative quantities will always render the dependence on the tables insignificantly small.

The reduction of the apparent place to the mean place for Jan. 1, 1837, is performed with the corrections of the Nautical Almanac.

The particulars already given are sufficient for the elucidation of the process represented in the printed observations. With regard to the readings of the plumb-line micrometers at contact with the plumb-line, it is only proper to remark that the image of the plumb-line is so large that the observation of its center cannot be safely made, and its sides are therefore always observed.

§ 8. *Observations of the Duration of Transit of the Moon's Diameter, with the Eastern Equatoreal, (page 126 and 127.)*

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

During each transit of a diameter, the Equatoreal is fixed relatively to the earth. Suppose, then, the Moon to stand still in space, while the earth and the equatoreal telescope which is firmly attached to it move round. The axis of the telescope produced (or rather the plane of its meridional wire) will come in contact successively with one side and with the other side of the Moon. Produce these touching positions of the plane backwards till they intersect. Their intersection will be in a line parallel to the earth's axis: when the Moon is near the meridian, the intersection will be nearly as distant from

the place of observation as the earth's axis is ; when the Moon is near the six-hour angle, their intersection will be near the place of observation : and generally their intersection will be at the place determined by drawing a perpendicular from the earth's axis upon the plane of the meridional wire. Consequently, the angle which the earth and telescope must describe that the plane may pass the Moon's diameter, will be found by dividing the Moon's diameter by the Moon's distance from the perpendicular dropped from the earth's axis upon the meridional plane passing through the Moon. Now, the Moon's distance here spoken of is the same as the Moon's distance from the earth's axis multiplied by the cosine of the parallax in right ascension. When the Moon is on the meridian the cosine of the parallax in right ascension is 1. Therefore the time in which the plane passes the Moon's diameter (that is, the duration of transit of the Moon's diameter) in any hour-angle, is to the duration of transit on the meridian, as unity to the cosine of the parallax in right ascension. As that parallax cannot exceed $40'$, whose cosine is 0.9999323 , the duration of transit cannot differ from that on the meridian by the time of transit $\times 0.0000677$: a quantity wholly insensible. The Moon's motion in right ascension produces the same effect in all cases as if the velocity of the earth's rotation were altered in a certain proportion. The duration of transit is therefore sensibly the same at all hour-angles as if the Moon were on the meridian of the place.

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

§ 9. *Observations of Mars and Stars near him, with the Eastern Equatoreal, and Reduction of the Observations, (page 130—141.)*

The eye-piece affixed to the Equatoreal for the observations of Mars, &c., is not the same as that used in 1836. It carries a quadrant and spirit-level for the approximate determination of zenith-distance and angle made by the vertical with the star's meridian (which, however, has not been used), and it is made to rotate round the axis of the telescope by a screw-motion. In this respect it is firmer than the other eye-piece, whose rotation was effected by a pinion. The value of one revolution of the micrometer a , as ascertained

by repeated observations of a day-mark on Feb. 22, is $32^{\circ}.042$: and that of b is $30^{\circ}.721$. When the graduated face of the declination-circle is East, the head of micrometer a is above, and its readings increase as the wire is carried upwards.

On the two first days of observation, one limb only of the planet was observed: and it was necessary to ascertain the value of its semidiameter. A comparison of all the measured diameters, from series 21 to 58, with those of the Nautical Almanac, gave for correction to the semidiameter of the Nautical Almanac $+ 6''.73$. This has been applied to form the assumed semidiameter on Feb. 6 and 14.

The following explanations of the tabular part appear to be sufficient:

As there is no fixed wire in the micrometer, whenever a wire fulfilling the office of a fixed wire was thought convenient, the micrometer not in actual use was set to its own zero, and was not moved during the series of observations. The reading of the other micrometer at coincidence with this having been found, the observation with the so fixed wire has been represented as if made with the moveable wire at that coincidence-reading.

The refractions and parallaxes in N.P.D. are computed by the formula given in the Introduction to the Observations, 1836, page lxiv.

The star's assumed N.P.D. is taken from the Ephemeris in the Nautical Almanac, 1837, page 474, &c.

The interpolated N.P.D. of Mars is formed by interpolation with second differences between the places in the daily Ephemeris of Mars, page 291, &c.

§ 10. *Eclipses, Occultations, and Transits of Jupiter's Satellites, and Occultations of Stars by the Moon, with the Equations deduced from the Occultations, (page 144—152.)*

The tabular statement of observations appears to require no remark, except that the clocks were always compared (by setting an adjustable 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.

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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	+0.05	+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:

$$F = \log. \sin. \text{star's hour-angle} + \log. \text{seconds of corrected eq. hor. parallax} + 9.4942187.$$

$$G = \log. \sin. \text{star's N.P.D.} + \log. \sin. \text{star's hour-angle} + \log. \text{seconds of corrected eq. hor. parallax} + 9.8913921.$$

(The former constant is the logarithm of half the distance of Greenwich from the earth's axis, and the latter is the logarithm of the distance of Greenwich from the plane of the equator.)

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 :

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

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

$$\begin{aligned} \log. 2^{\text{d}} n^{\circ} &= \log. \frac{1}{2} (\theta - \theta') \text{ in seconds} + \log. \frac{\tan.}{\text{arc}} \text{ for } \frac{1}{2} (\theta - \theta') \\ &+ \log. \sin. (\delta + \delta' - 180^{\circ}) + \log. \cot. \frac{1}{2} (\theta + \theta') + \log. \frac{\text{arc}}{\sin.} \text{ for } (\delta - \delta') \\ \delta - \delta' &= 1^{\text{st}} n^{\circ} + 2^{\text{d}} n^{\circ}. \end{aligned}$$

In the first trials the $\log. \frac{\text{arc}}{\sin.}$, &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 :

$$\begin{aligned} \log. \tan. \psi &= \log. \text{diff. A. R. of Moon's center and corresponding point} + \frac{1}{2} \log. \sin. \\ &\quad \text{N. P. D. of Moon's center} + \frac{1}{2} \log. \sin. \delta' - \log. \text{diff. N. P. D. of} \\ &\quad \text{Moon's center and corresponding point.} \\ \log. \text{dist.} &= \log. \text{diff. N. P. D.} - \log. \cos. \psi. \\ \text{or} &= \log. \text{diff. A. R.} + \frac{1}{2} \log. \sin. \text{N. P. D. of center} + \frac{1}{2} \log. \sin. \delta' - \log. \sin. \psi. \end{aligned}$$

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,

$$\begin{aligned} \log. 1^{\text{st}} n^{\circ} &= 2 \log. \text{diff. A. R.} + \log. \sin. (\text{sum of N. P. D.}) - \log. \text{dist.} + 4.0835. \\ \log. 2^{\text{d}} n^{\circ} &= \log. \text{diff. N. P. D.} - \log. \text{distance.} \end{aligned}$$

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

Co-efficient of variation of smaller N. P. D. = $1^{\text{st}} n^{\circ} - 2^{\text{d}} n^{\circ}$.

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

$$\log. \text{diff. A. R.} + \log. \sin. \delta' + \log. \sin. \text{Moon's N. P. D.} - \log. \text{distance.}$$

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

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

2nd. The alteration of the horizontal equatoreal parallax in the proportion of

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

3rd. The alteration in the position of the Moon with regard to the meridian, depending on the alteration of time t , will introduce an alteration in the correction for parallax. (This term was omitted in the reduction of the occultations observed at Cambridge, as well as in those observed at Greenwich in 1836: for the latter it will be supplied in the supplement to this Introduction.) It is computed by the following formula; in which P is the horizontal parallax, and l is the geocentric latitude of Greenwich.

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

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

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

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

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

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

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

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

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

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

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

§ 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.

SUPPLEMENT TO THE INTRODUCTION.

I. In the volume for 1836, page 83, &c. the mean N. P. D. of the stars are given as deduced from each circle and in each mode of observation, but the results of each circle and mode are not combined. The following concluded N. P. D. have been furnished by Mr. Glaisher; they are formed according to the rule described in page xli., the weight $\frac{1}{2}$ being given, however, to stars at any polar distance beyond 36° .

CATALOGUE OF MEAN NORTH POLAR DISTANCES,

From the Greenwich Observations for 1836.

No.	Star's Name.	Mean N. P. D. Jan. 1, 1836.	Annual Variation.	No. of Obs.	
				Above Pole.	Below Pole.
1	β Cassiopeiaë.....	31. 45. 17.89	—20.043	20	32
2	12 Cassiopeiaë.....	29. 4. 42.77	19.994	10	
3	44 Piscium.....	88. 58. 8.56	19.990	6	
4	κ Cassiopeiaë.....	27. 58. 27.32	19.938	12	
5	α Cassiopeiaë.....	34. 21. 47.27	19.861	21	29
6	η Cassiopeiaë.....	33. 3. 23.53	19.035	12	16
7	δ Piscium.....	83. 18. 32.64	19.740	2	
8	Piazzi 0 ^b . 209.....	29. 46. 35.89	19.685	10	
9	20 Ceti.....	92. 2. 10.67	19.669	2	
10	γ Cassiopeiaë.....	30. 10. 22.35	19.632		2
11	α App. Sculptoris ...	120. 14. 41.49	19.560	10	
12	ϵ Piscium.....	82. 59. 40.31	19.486	2	
13	μ Cassiopeiaë.....	35. 53. 14.60	19.422	10	
14	e Piscium.....	85. 13. 10.10	19.368	2	
15	Polaris.....	1. 33. 55.34	19.345	72	107
16	ψ Cassiopeiaë.....	22. 43. 44.35	19.006	4	
17	θ Ceti.....	99. 1. 55.69	18.964	1	
18	μ Piscium.....	84. 42. 16.36	18.795	2	
19	χ Cassiopeiaë.....	31. 36. 46.26	18.734	10	
20	51 Andromedæ.....	42. 12. 20.46	18.596	2	
21	Piazzi I. 139.....	30. 17. 2.00	18.463	10	
22	ν Piscium.....	85. 20. 43.11	18.429	3	
23	44 Cassiopeiaë.....	30. 16. 45.68	—18.429	10	

CATALOGUE OF MEAN N. P. D. FROM OBSERVATIONS OF 1836.

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No.	Star's Name.	Mean N. P. D. Jan. 1, 1836.	Annual Variation.	No. of Obs.	
				Above Pole.	Below Pole.
24	♂ Piscium	81. 40. 11.64	-18.295	2	
25	3 Arietis	73. 24. 42.26	18.250	10	
26	ε Cassiopeiae	27. 8. 30.42	18.081	8	4
27	ξ Piscium	87. 37. 30.82	17.985	2	
28	58 Ceti	92. 51. 46.10	17.789	4	
29	53 Cassiopeiae	26. 24. 24.04	17.737	10	
30	γ ¹ Andromedæ	48. 27. 40.55	17.635	12	
31	α Arietis	67. 19. 0.59	17.461	13	
32	55 Cassiopeiae	24. 14. 58.67	17.280	10	
33	ξ ¹ Ceti	81. 55. 34.82	17.180	3	
34	θ Persei	41. 28. 13.98	15.760	6	
35	γ Ceti	87. 27. 35.23	15.658	11	
36	38 Arietis	78. 14. 56.01	15.593	8	
37	* A. R. 2 ^b . 36 ^m	73. 9. 12.18	15.574	2	
38	π Arietis	73. 13. 21.94	15.364	2	
39	α Ceti	86. 33. 30.41	14.575	13	
40	12 Eridani	119. 38. 17.43	14.689	6	
41	Piazzi III. 7	24. 57. 21.61	13.825	10	
42	α Persei	40. 43. 46.17	13.397	18	6
43	δ Persei	42. 44. 38.99	12.142	20	2
44	Piazzi III. 105	27. 10. 54.37	12.087	9	
45	η Tauri	66. 24. 30.38	11.682	2	
46	τ ¹ Eridani	114. 23. 14.70	11.470	9	
47	γ Eridani	103. 58. 48.63	10.762	3	
48	λ ¹ Persei	40. 6. 5.86	10.441		2
49	Δ ¹ Tauri	68. 22. 15.38	10.424	2	
50	μ Persei	42. 0. 56.47	9.836	2	
51	ν ⁴ Eridani	124. 12. 14.87	9.142	4	
52	δ ¹ Tauri	72. 50. 56.81	9.011	2	
53	ε Tauri	71. 11. 26.13	8.574	1	
54	Aldebaran	73. 49. 37.69	7.979	12	
55	τ Tauri	67. 21. 52.88	7.504	2	
56	A. S. C. 552	23. 56. 52.95	7.084	2	
57	i Tauri	71. 26. 48.31	6.737	2	
58	ε Aurigæ	46. 25. 40.32	6.045	28	
59	i Tauri	68. 39. 6.26	5.782	4	
60	Capella	44. 10. 40.61	4.837	46	22
61	A. S. C. 617	98. 20. 49.50	4.732	8	
62	Rigel.	98. 23. 50.93	4.647	2	
63	n Tauri	68. 4. 49.83	4.419	3	
64	β Tauri	61. 32. 20.56	3.863	12	
65	γ Orionis	83. 48. 20.37	3.823	2	
66	Groombridge 966.	15. 4. 52.32	3.653	2	
67	δ Orionis	90. 25. 36.93	3.194	3	
68	α Leporis	107. 56. 43.63	3.029	9	
69	ζ Tauri	68. 57. 53.73	2.835	2	
70	ζ Orionis	92. 2. 10.33	2.427	2	
71	α Columbæ	124. 10. 5.89	2.313	4	
72	136 Tauri	62. 26. 4.68	1.517	4	
73	α Orionis	82. 37. 49.72	1.226	6	
74	β Aurigæ	45. 4. 42.13	-1.131	24	16

INTRODUCTION TO GREENWICH OBSERVATIONS, 1837.

No.	Star's Name.	Mean N. P. D. Jan. 1, 1836.	Annual Variation.	No. of Obs.	
				Above Pole.	Below Pole.
75	1 Geminorum.....	66. 44. 9.09	— 0.543	2	
76	κ Aurigæ.....	60. 26. 59.47	+ 0.396	2	
77	η Geminorum.....	67. 27. 11.44	0.403	2	
78	μ Geminorum.....	67. 24. 36.82	1.107	4	
79	β Canis Majoris.....	107. 52. 48.98	1.329	6	
80	48 Aurigæ.....	59. 24. 50.63	1.541	1	
81	Cephei (51 Hev.)....	2. 44. 7.90	1.889	2	
82	A. S. C. 808.....	57. 26. 4.14	1.865	2	
83	Sirius.....	106. 29. 48.91	4.418	28	
84	ε Canis Majoris.....	118. 45. 13.86	4.504	18	
85	63 Aurigæ.....	50. 25. 13.23	5.184	4	
86	τ Geminorum.....	59. 29. 37.65	5.213	2	
87	δ Canis Majoris.....	116. 8. 15.91	5.312	20	
88	Groombridge 1295..	44. 28. 38.69	5.947	8	
89	δ Geminorum.....	67. 43. 22.47	6.024	10	
90	Groombridge 1316..	41. 45. 12.45	6.609	2	
91	η Canis Majoris.....	118. 59. 16.30	6.638	8	
92	* A. R. 7 ^h . 22 ^m	41. 27. 52.26	7.020	2	
93	α ¹ Geminorum.....	57. 45. 37.13	7.161	3	
94	α ² Geminorum.....	57. 45. 35.33	7.161	28	
95	Piazzi VII. 156.....	41. 29. 39.20	7.594	2	
96	Procyon.....	84. 21. 38.30	8.682	12	
97	Pollux.....	61. 35. 4.59	8.064	28	
98	τ Argûs.....	118. 33. 57.85	8.230	1	
99	ξ Argûs.....	114. 27. 11.14	8.640	11	
100	6 Cancrî.....	61. 45. 10.87	9.491	2	
101	ι Argûs.....	113. 50. 9.50	10.044	2	
102	Piazzi VIII. 15.....	35. 21. 29.02	10.443	2	4
103	* A. R. 8 ^h . 6 ^m	34. 56. 15.65	10.473	5	2
104	λ Cancrî.....	65. 28. 2.25	10.799	2	
105	* A. R. 8 ^h . 39 ^m	31. 52. 16.54	12.817	3	
106	ι Ursæ Majoris.....	41. 19. 14.08	13.380		10
107	α Hydræ.....	97. 57. 5.14	15.310	6	
108	θ Ursæ Majoris.....	37. 34. 48.07	16.034	8	12
109	λ Leonis.....	66. 18. 49.00	15.466	2	
110	26 Ursæ Majoris....	37. 13. 26.21	15.551		2
111	ψ Leonis.....	75. 13. 55.50	16.135	2	
112	υ Ursæ Majoris.....	30. 11. 41.20	16.359	26	19
113	η Leonis.....	72. 26. 25.63	17.271	2	
114	Regulus.....	77. 14. 4.19	17.327	32	
115	λ Ursæ Majoris.....	46. 16. 12.39	17.647	34	20
116	γ Leonis.....	69. 19. 56.05	17.802	4	
117	ρ Leonis.....	79. 51. 7.01	18.305	2	
118	Groombridge 1702..	26. 10. 46.53	18.953	2	
119	* A. R. 10 ^h . 52 ^m	25. 59. 55.39	19.155	2	
120	β Ursæ Majoris.....	32. 44. 25.56	19.155	16	14
121	α Ursæ Majoris.....	27. 21. 55.99	19.196	32	20
122	χ Leonis.....	81. 46. 47.52	19.272	1	
123	ψ Ursæ Majoris.....	44. 36. 47.98	19.361	39	18
124	η Leonis.....	75. 47. 58.62	19.508	1	
125	σ Leonis.....	83. 4. 23.26	+19.611	2	

CATALOGUE OF MEAN N. P. D. FROM OBSERVATIONS OF 1836.

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No.	Star's Name.	Mean N. P. D. Jan. 1, 1836.	Annual Variation.	No. of Obs.	
				Above Pole.	Below Pole.
126	* A. R. 11 ^b . 17 ^m	25. 58. 54.22	+ 19.690	2	
127	τ Leonis	86. 14. 28.21	19.726	2	
128	ν Virginis	82. 33. 7.67	19.943	5	
129	β Leonis	74. 30. 41.92	19.969	30	
130	β Virginis	87. 18. 39.93	19.980	4	
131	γ Ursæ Majoris	35. 23. 36.82	19.999	42	20
132	δ Virginis	85. 25. 52.28	20.028	2	
133	π Virginis	82. 28. 16.67	20.031	1	
134	δ Ursæ Majoris	32. 3. 21.04	20.033	52	18
135	c Virginis	85. 46. 25.39	20.016	4	
136	Piazzi XII. 118	81. 25. 1.38	19.923	2	
137	* A. R. 12 ^b . 25 ^m	83. 7. 42.74	19.923	1	
138	κ Draconis	19. 18. 25.02	19.912	36	6
139	γ Virginis	90. 32. 55.89	19.835	6	
140	ϵ Ursæ Majoris	33. 8. 55.30	19.631	22	4
141	δ Virginis	85. 42. 36.02	19.622	6	
142	Piazzi XII. 230	5. 41. 24.39	19.604	4	6
143	Piazzi XII. 232	5. 41. 42.70	19.604	6	6
144	θ Virginis	94. 39. 40.77	19.333	8	
145	Spica	100. 18. 10.83	18.944	34	
146	ζ^1 Ursæ Majoris	34. 12. 58.54	18.921	36	37
147	ζ^2 Ursæ Majoris	34. 13. 11.57	18.921	2	6
148	l^2 Virginis	95. 24. 24.38	18.739	1	
149	24 Canum Venat.	40. 8. 36.65	18.560	2	
150	m Virginis	97. 52. 22.54	18.425	5	
151	i Centauri	122. 12. 42.45	18.307	10	
152	η Ursæ Majoris	39. 51. 57.18	18.134	58	19
153	h Centauri	121. 6. 57.26	18.035	2	
154	i Draconis	24. 27. 54.06	17.919	10	
155	Piazzi XIII. 296 ...	38. 14. 13.97	17.487	2	
156	α Draconis	24. 50. 19.61	17.367	6	2
157	κ Virginis	99. 30. 23.97	17.187	2	
158	i Virginis	95. 12. 52.39	17.038	1	
159	Arcturus	69. 57. 39.25	18.962	36	
160	Groombridge 2091 ..	19. 47. 46.60	16.951	10	8
161	4 Ursæ Minoris	11. 40. 54.37	16.922		2
162	λ Bootis	43. 9. 21.09	16.908	10	4
163	λ Virginis	102. 36. 46.89	16.907	2	
164	i Bootis	37. 52. 25.62	16.897	2	
165	2 Libræ	100. 57. 40.20	16.700	2	
166	θ Bootis	37. 23. 19.87	16.988	8	2
167	5 Ursæ Minoris	13. 34. 30.69	16.007	4	10
168	Groombridge 2127 ..	42. 29. 31.11	16.007	6	
169	ϵ Bootis	62. 13. 50.30	15.490	20	
170	μ Libræ	103. 27. 41.04	15.353	2	
171	α Libræ	105. 21. 21.69	15.270	2	
172	h Bootis	43. 11. 50.62	15.154	4	
173	39 ¹ Bootis	40. 36. 8.10	15.120	2	
174	ξ^2 Libræ	100. 44. 36.70	14.921	2	
174	Piazzi XIV. 235 ...	39. 41. 52.08	14.747	2	
176	β Ursæ Minoris	15. 10. 27.76	+ 14.712	36	32

INTRODUCTION TO GREENWICH OBSERVATIONS, 1837.

No.	Star's Name.	Mean N. P. D. Jan. 1, 1836.	Annual Variation.	No. of Obs.	
				Above Pole.	Below Pole.
177	δ^2 Bootis	41. 42. 15.61	+ 14.285	4	
178	δ^1 Libræ	109. 9. 57.69	14.014	4	
179	Groombridge 2198 ..	40. 41. 9.90	13.798	2	
180	Groombridge 2230 ..	42. 21. 30.29	12.884	4	
181	γ Ursæ Minoris	17. 34. 57.34	12.813	10	6
182	δ Draconis	30. 27. 25.87	12.806	2	4
183	γ Libræ	104. 14. 13.97	12.475	4	
184	α Coronæ Borealis ..	62. 43. 45.23	12.375	16	
185	Groombridge 2254 ..	39. 45. 14.98	12.201	3	
186	Groombridge 2258 ..	45. 51. 28.02	12.060	6	
187	α Serpentis	83. 3. 12.48	11.788	2	
188	θ Ursæ Minoris	12. 6. 26.80	11.734	6	
189	* A. R. 15 ^b . 38 ^m	37. 7. 7.88	11.640	6	
190	δ Scorpii	115. 14. 46.46	11.441	2	
191	Groombridge 2285 ..	36. 35. 55.68	10.989	4	
192	Groombridge 2288 ..	33. 41. 10.66	10.918	5	
193	ζ Ursæ Minoris	11. 42. 16.79	10.772		2
194	ν Herculis	43. 30. 17.09	10.211	2	
195	θ Draconis	30. 59. 41.19	10.118	22	13
196	ϵ^2 Scorpii	117. 29. 37.43	9.880	4	
197	14 Herculis	45. 44. 21.03	9.634	2	
198	τ Herculis	43. 17. 33.23	8.893	15	2
199	19 Ursæ Minoris	13. 42. 45.68	8.821		4
200	Antares	116. 3. 39.62	8.550	8	
201	Groombridge 2339 ..	44. 55. 57.02	8.469	6	
202	η Draconis	20. 6. 46.75	8.336		15
203	τ Scorpii	117. 52. 6.91	8.047	2	
204	* A. R. 16 ^b . 27 ^m	70. 38. 39.77	7.911	3	
205	* A. R. 16 ^b . 28 ^m	70. 42. 2.29	7.831	4	
206	λ Draconis	20. 52. 36.85	7.803		1
207	16 Draconis	36. 46. 3.61	7.484	12	2
208	17 ¹ Draconis	36. 44. 35.50	7.480	12	2
209	42 Herculis	40. 44. 52.10	7.320	5	
210	* A. R. 16 ^b . 37 ^m	76. 4. 46.84	7.096	4	
211	* A. R. 16 ^b . 37 ^m	76. 4. 25.47	7.096	2	
212	Groombridge 2374 ..	34. 0. 21.39	6.856	6	
213	* A. R. 16 ^b . 40 ^m	76. 2. 12.68	6.856	2	
214	* A. R. 16 ^b . 41 ^m	76. 6. 46.46	6.772	6	
215	52 Herculis	43. 43. 38.57	6.504	6	
216	ι Ophiuchi	79. 33. 32.37	6.362	4	
217	* A. R. 16 ^b . 59 ^m	85. 24. 44.93	5.271	3	
218	Piazzi XVI. 307.	45. 57. 40.30	5.181	10	
219	* A. R. 17 ^b . 0 ^m	85. 20. 47.90	5.189	7	
220	* A. R. 17 ^b . 1 ^m	85. 19. 59.02	5.105	2	
221	ϵ Ursæ Minoris	7. 42. 17.14	4.939		9
222	* A. R. 17 ^b . 3 ^m	89. 29. 53.62	4.934	2	
223	* A. R. 17 ^b . 4 ^m	87. 40. 14.25	4.850	1	
224	* A. R. 17 ^b . 4 ^m	87. 40. 37.69	4.850	1	
225	* A. R. 17 ^b . 5 ^m	89. 26. 31.81	4.766	4	
226	* A. R. 17 ^b . 7 ^m	91. 6. 1.83	4.603	2	
227	α Herculis	75. 25. 2.22	+ 4.603	2	

CATALOGUE OF MEAN N. P. D. FROM OBSERVATIONS OF 1836.

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No.	Star's Name.	Mean N. P. D. Jan. 1, 1836.	Annual Variation.	No. of Obs.	
				Above Pole.	Below Pole.
228	* A. R. 17 ^h . 8 ^m	87. 37. 24. 76	+ 4.508	3	
229	ζ Draconis	24. 4. 57. 07	4.483		1
230	* A. R. 17 ^h . 10 ^m	91. 19. 53. 75	4.338	2	
231	* A. R. 17 ^h . 11 ^m	93. 52. 19. 88	4.252	3	
232	ν Serpentis	102. 40. 20. 17	4.229	2	
233	* A. R. 17 ^h . 14 ^m	96. 56. 19. 60	3.996	2	
234	Piazzi XVII. 79 ...	99. 11. 51. 09	3.911	4	
235	* A. R. 17 ^h . 15 ^m	95. 9. 58. 59	3.910	2	
236	74 Herculis	43. 35. 41. 73	3.847	6	
237	A. S. C. 1998	94. 56. 5. 97	3.686	5	
238	* A. R. 17 ^h . 21 ^m	31. 12. 32. 55	3.393	2	
239	x Herculis	41. 35. 57. 08	3.275	6	
240	* A. R. 17 ^h . 26 ^m	101. 7. 25. 84	2.962	4	
241	β Draconis	37. 34. 27. 72	2.912	22	10
242	α Ophiuchi	77. 18. 53. 44	2.872	4	
243	f Draconis	21. 45. 39. 30	2.386		2
244	i Herculis	43. 54. 11. 08	2.212	10	2
245	30 Draconis	39. 10. 38. 13	1.297	6	
246	ξ Draconis	33. 5. 58. 19	0.824	10	
247	γ Draconis	38. 29. 20. 33	+ 0.642	39	11
248	* A. R. 17 ^h . 59 ^m	41. 32. 24. 31	0.000	6	
249	μ Sagittarii	111. 5. 38. 72	- 0.314	2	
250	* A. R. 18 ^h . 7 ^m	35. 45. 35. 62	0.612	10	
251	* A. R. 18 ^h . 12 ^m	33. 27. 57. 20	0.962	10	
252	ε Sagittarii	124. 27. 23. 46	1.127	2	
253	* A. R. 18 ^h . 16 ^m	38. 43. 18. 30	1.399	6	
254	λ Sagittarii	115. 30. 16. 46	1.527	2	
255	b Draconis	31. 17. 33. 11	1.871	7	
256	δ Ursæ Minoris	3. 24. 38. 36	2.189	16	5
257	* A. R. 18 ^h . 25 ^m	30. 33. 29. 97	2.182	4	
258	42 Draconis	24. 32. 16. 02	2.227	12	
259	d Draconis	33. 4. 40. 37	2.594	10	
260	α Lyrae	51. 21. 53. 67	2.718	184	
261	* A. R. 18 ^h . 38 ^m	45. 14. 4. 85	3.308	6	
262	c Draconis	34. 37. 27. 79	3.423	6	
263	Groombridge 2677 ..	41. 25. 2. 20	3.807	6	
264	β Lyrae	56. 49. 23. 79	3.807	2	
265	o Draconis	30. 48. 37. 02	4.225	10	1
266	13 Lyrae	46. 15. 59. 02	4.366	10	
267	ζ Sagittarii	120. 6. 23. 98	4.491	4	
268	τ Sagittarii	117. 54. 8. 85	4.876	2	
269	* A. R. 18 ^h . 58 ^m	37. 58. 28. 56	5.018	6	
270	51 Draconis	36. 51. 9. 50	5.292	12	
271	* A. R. 19 ^h . 4 ^m	39. 53. 51. 48	5.526	6	
272	Groombridge 2809 ..	43. 18. 21. 31	6.110	6	
273	δ Draconis	22. 37. 36. 50	6.234	22	
274	κ Cygni	36. 55. 54. 52	6.290	6	
275	δ Aquilæ	87. 12. 24. 23	6.601	2	
276	ι ² Cygni	38. 37. 0. 49	7.298	16	
277	h ² Sagittarii	115. 14. 17. 97	7.374	2	
278	θ Cygni	40. 9. 20. 07	- 7.821	24	

INTRODUCTION TO GREENWICH OBSERVATIONS, 1837.

No.	Star's Name.	Mean N. P. D. Jan. 1, 1836.	Annual Variation.	No. of Obs.	
				Above Pole.	Below Pole.
279	γ Aquilæ.....	79. 46. 51.78	— 8.326	4	
280	δ Cygni.....	45. 15. 57.81	8.443	32	
281	11 Vulpeculæ.....	63. 7. 2.44	8.556	2	
282	α Aquilæ.....	81. 33. 34.05	8.667	2	
283	b Sagittarii.....	117. 35. 51.31	8.982	4	
284	ϵ Draconis.....	20. 8. 59.53	9.152	14	15
285	c Sagittarii.....	118. 9. 33.58	9.424	2	
286	Piazzi XIX. 371 ...	31. 35. 24.33	9.469	10	
287	A. S. C. 2355.....	122. 30. 37.67	9.527	4	
288	* A. R. 20 ^b . 6 ^m	28. 24. 19.89	10.472	10	
289	68 Draconis.....	28. 24. 58.72	10.667	10	
290	α^2 Capricorni.....	103. 2. 50.44	10.667	6	
291	σ Capricorni.....	109. 37. 26.67	10.738	4	
292	β Capricorni.....	103. 16. 8.89	10.876	4	
293	κ Cephei.....	12. 47. 9.23	11.092	24	21
294	γ Cygni.....	50. 15. 52.78	11.216	2	
295	71 Draconis.....	28. 15. 42.23	11.270	10	
296	θ Cephei.....	27. 33. 19.71	11.971	26	16
297	α Cygni.....	45. 18. 10.23	12.588	22	8
298	$\downarrow$ Capricorni.....	115. 51. 17.45	12.615	8	
299	η Cephei.....	28. 47. 46.75	13.813	22	20
300	η Capricorni.....	110. 29. 54.31	13.842	2	
301	ξ Cygni.....	46. 43. 24.22	14.094	4	
302	61 ¹ Cygni.....	52. 3. 10.56	17.453	2	
303	4 Piscis Australis ...	122. 51. 9.85	14.634	4	
304	α Cephei.....	28. 6. 26.50	15.040	34	34
305	ζ Capricorni.....	113. 7. 1.08	15.180	4	
306	* A. R. 21 ^b . 25 ^m	75. 2. 14.38	15.630	2	
307	37 Capricorni.....	110. 48. 40.42	15.647	2	
308	38 Capricorni.....	110. 58. 31.57	15.650	2	
309	β Cephei.....	20. 9. 29.79	15.708	30	30
310	γ Capricorni.....	107. 23. 57.33	15.936	6	
311	79 ¹ Cygni.....	52. 27. 51.93	16.214	10	
312	79 ² Cygni.....	52. 26. 34.72	16.214	3	
313	δ Capricorni.....	106. 52. 3.89	16.299	2	
314	ν Cephei.....	29. 38. 3.13	16.444	6	2
315	19 Cephei.....	28. 30. 58.44	17.361	10	
316	36 Aquarii.....	98. 59. 20.20	17.375	10	
317	Groombridge 3712...	33. 58. 28.22	17.614	2	
318	ϵ Cephei.....	33. 46. 20.06	17.728	2	3
319	25 Cephei.....	28. 0. 58.03	17.891	10	
320	σ Aquarii.....	101. 31. 52.57	18.225	1	
321	β Piscis Australis ...	123. 11. 8.11	18.232	4	
322	δ^1 Cephei.....	32. 26. 1.38	18.269		2
323	δ^2 Cephei.....	32. 25. 21.47	18.269	24	28
324	ϵ Piscis Australis...	117. 53. 49.15	18.558	16	
325	τ^2 Aquarii.....	104. 27. 22.65	18.851	4	
326	ι Cephei.....	24. 39. 39.26	18.940	28	26
327	δ Aquarii.....	106. 41. 27.98	18.996	2	
328	Fomalhaut.....	120. 29. 23.13	19.068	6	
329	1 Cassiopeiæ.....	31. 27. 55.77	— 19.353	10	

CATALOGUE OF MEAN N.P.D. FROM OBSERVATIONS OF 1836.

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No.	Star's Name.	Mean N. P. D. Jan. 1, 1836.	Annual Variation.	No. of Obs.	
				Above Pole.	Below Pole.
330	2 Cassiopeiæ.....	31. 33. 20.90	-19.422	10	
331	γ App. Sculptoris ...	123. 25. 27.69	19.560	6	
332	♃ ³ Aquarii.....	100. 30. 21.87	19.570	4	
333	α Cephei.....	22. 47. 5.96	19.603	12	
334	A. S. C. 2807.....	32. 21. 16.78	19.771	10	
335	γ Cephei.....	13. 16. 57.41	19.898	34	38
336	20 Piscium.....	93. 40. 22.77	19.960	2	
337	27 Piscium.....	94. 27. 57.44	20.023	4	
338	9 Cassiopeiæ.....	28. 37. 32.03	20.040	8	
339	33 Piscium.....	96. 37. 29.79	20.040	2	
340	α Andromedæ.....	61. 48. 54.90	-20.043	2	

II. In the volume for 1836, page 138, the observations of the beginning and end of the Solar Eclipse of 1836, May 15, are given. The following equations are deduced from them. The places and diameters of the Sun and Moon are interpolated between the "Apparent Quantities" in the Observations for 1836, page 139.

First contact at $1^h. 51^m. 30^s.55 + t^s$, Greenwich Mean Solar Time.

$$\begin{aligned}
 \text{Sun's apparent N. P. D.} & \dots\dots\dots 71^\circ. 2'. 23''.46 + f'' & - 0''.0097 \times t \\
 \text{Moon's apparent N. P. D.} & \dots\dots\dots 71. 10. 21.20 + y & - 0.1462 \times t \\
 \text{Moon's app. A. R. — Sun's app. A. R.} & \dots\dots - 31. 22. 75 + x - e + 0.3271 \times t \\
 \text{Sun's apparent Semidiameter} & \dots\dots\dots 15. 49. 90 + \delta S \\
 \text{Moon's apparent Semidiameter} & \dots\dots\dots 15. 0. 51 + \delta s
 \end{aligned}$$

Computed apparent distance between the centers.

$$\begin{aligned}
 & 30'. 44''.26 - 0''.9140 \times \{x - e + 0.3271 \times t\} \\
 & + 0.2605 \times \{y - 0.1462 \times t\} \\
 & - 0.2577 \times \{f - 0.0097 \times t\}
 \end{aligned}$$

Final Equation formed by comparing this with the sum of the semidiameters.

$$+ 6''.15 = - \delta (S+s) - 0.9140 \times (x-e) + 0.2605 \times y - 0.2577 \times f - 0.3348 \times t$$

Last contact at $4^h. 39^m. 15^s.29 + t^s$, Greenwich Mean Solar Time.

$$\begin{aligned}
 \text{Sun's apparent N. P. D.} & \dots\dots\dots 71^\circ. 0'. 46''.22 + f'' & - 0''.0097 \times t \\
 \text{Moon's apparent N. P. D.} & \dots\dots\dots 70. 48. 19.21 + y & - 0.1195 \times t \\
 \text{Moon's app. A. R. — Sun's app. A. R.} & \dots\dots + 29. 50. 07 + x - e + 0.4113 \times t \\
 \text{Sun's apparent Semidiameter} & \dots\dots\dots 15. 49. 87 + \delta S \\
 \text{Moon's apparent Semidiameter} & \dots\dots\dots 14. 55. 55 + \delta s
 \end{aligned}$$

k

Computed apparent distance between the centers.

$$\begin{aligned} 30'.49''.22 &+ 0''.8646 \times \{x - e + 0.4113 \times t\} \\ &+ 0.4053 \times \{f \quad - 0.0097 \times t\} \\ &- 0.4027 \times \{y \quad - 0.1195 \times t\} \end{aligned}$$

Final Equation formed by comparing this with the sum of the semidiameters.

$$- 3''.80 = - 8 (S + s) + 0.8646 \times (x - e) - 0.4027 \times y + 0.4053 \times f + 0.3998 \times t$$

III. In the volume for 1836, page 174, &c., are given the calculations of the occultations observed in 1836, without including the alteration of the parallax-correction introduced by the change of hour-angle depending on an assumed error of time, as mentioned in the Introduction above. This defect is supplied below.

Disappearance of α^1 Libræ, 1836, Jan. 12.

Factor of t in A. R. of corresponding point	+ 0.1468
in N. P. D.	- 0.0174
in final equation	- 0.3201

The Factor of t in the final equation, is to be *substituted* for that given in the printed volume.

Disappearance of α^2 Libræ, 1836, Jan. 12.

Factor of t in A. R. of corresponding point	+ 0.1498
in N. P. D.	- 0.0157
in final equation	- 0.2886

Reappearance of α^1 Libræ, 1836, Jan. 12.

Factor of t in A. R. of corresponding point	+ 0.1581
in N. P. D.	- 0.0096
in final equation	+ 0.3153

Disappearance of μ Piscium, 1836, Feb. 20.

Factor of t in A. R. of corresponding point	- 0.0068
in N. P. D.	- 0.0135
in final equation	- 0.5056

Disappearance of λ Virginis, 1836, March 6.

Factor of t in A. R. of corresponding point	+ 0.1585
in N. P. D.	+ 0.0041
in final equation	- 0.3533

Reappearance of λ Virginis, 1836, March 6.

Factor of t in A. R. of corresponding point	+ 0.1484
in N. P. D.	+ 0.0122
in final equation	+ 0.3611

CORRECTIONS TO CALCULATED OCCULTATIONS, 1836.

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Disappearance of η Leonis, 1836, April 25.

Factor of t in A. R. of corresponding point	+ 0·1562
in N. P. D.	— 0·0030
in final equation	— 0·3308

Reappearance of η Leonis, 1836, April 25.

Factor of t in A. R. of corresponding point	+ 0·1472
in N. P. D.	— 0·0156
in final equation	+ 0·3398

Disappearance of θ Virginis, 1836, May 26.

Factor of t in A. R. of corresponding point	+ 0·0683
in N. P. D.	+ 0·0118
in final equation	— 0·1549

Disappearance of δ Scorpii, 1836, May 29.

Factor of t in A. R. of corresponding point	+ 0·1403
in N. P. D.	+ 0·0344
in final equation	— 0·4928

Reappearance of ω Sagittarii, 1836, June 29.

Factor of t in A. R. of corresponding point	+ 0·1785
in N. P. D.	+ 0·0033
in final equation	+ 0·3047

Disappearance of α Sagittarii, 1836, June 29.

Factor of t in A. R. of corresponding point	+ 0·1751
in N. P. D.	+ 0·0144
in final equation	— 0·3912

Disappearance of δ Scorpii, 1836, July 23.

Factor of t in A. R. of corresponding point	+ 0·1595
in N. P. D.	+ 0·0193
in final equation	— 0·3607

Reappearance of δ Scorpii, 1836, July 23.

Factor of t in A. R. of corresponding point	+ 0·1400
in N. P. D.	+ 0·0332
in final equation	+ 0·3740

Disappearance of A Tauri, 1836, Sept. 1.

Factor of t in A. R. of corresponding point	+ 0·1571
in N. P. D.	+ 0·0037
in final equation	— 0·3492

Reappearance of C Geminorum, 1836, Oct. 30.

Factor of t in A. R. of corresponding point	+ 0·0941
in N. P. D.	+ 0·0515
in final equation	+ 0·3573

ADDENDUM TO THE INTRODUCTION.

The following stars have been repeatedly sought in the heavens, but no traces of them are discoverable:—

A.S.C. 337
805
2460

The stars *L* and *c'*, observed at Cambridge with Halley's Comet (Camb. Obs. 1835).

The following stars observed by Sir John Herschel with Halley's Comet (Ast. Soc. Mem., vol. x.):—

A.R.	^h 10. ^m 12. ^s 10	N.P.D.	[°] 99. ['] 17
	15. 38. 31		119. 30
	15. 41. 4		119. 16?
	15. 42. 39		119. 6
