GREENWICH ASTRONOMICAL OBSERVATIONS.

1841.

INTRODUCTION.

I. *Personal Establishment and Arrangements.*

THE establishment of Assistants, and the division of labour among them, has remained during the year 1841, essentially the same as it was from the month of November 1840, of which an account is given in the Introduction to the Observations for 1840. It is sufficient to repeat here, that it is established as a rule, to be adhered to as closely as circumstances permit, that no assistant be occupied on two successive days with astronomical observations. And, as the usual time of dividing observations is 15^h astronomical (3 o'clock in the morning, civil reckoning), it is always arranged, if possible, when the Moon's time of transit passes 15^h, that the same assistant should not be required to observe the Moon and accompanying stars late in the night when the Moon passes last before 15^h, and early in the morning when the Moon passes first after 15^h.

II. *Instruments.*

No addition of important astronomical instruments has been made during the year 1841; and the only important change in the use of any is that by which the Zenith Tube is rendering capable of producing a complete and independent observation of the Zenith Distance of γ Draconis by rapid reversion at the same transit. This will be fully described in its proper place.

III. *Subjects of Observations in the Year* 1841.

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

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

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

The other stars observed are chiefly those remaining on the lists of the preceding year; consisting of stars compared with Galle's first and second Comets, and with Bremicker's Comet; stars observed for Colonel Everest in connexion with the Indian Survey; and a few others. In addition, those have been observed which were compared with Mars at his opposition, and those whose occultations by the Moon had been observed.

The Zenith Tube has been applied to the observations of γ Draconis at every opportunity.

The East Equatoreal has been employed in comparing Mars with the stars set down in the Nautical Almanac for 1841, at his opposition; and in taking transits of the Moon for the comparison of her diameter with that given by Burckhardt's Tables.

The Double-image Micrometer attached to the South Equatoreal has been used solely for measuring the diameters of the planets.

IV. *Explanation of the Printed Observations.*

§ 1. *Transits as observed, and calculation of Apparent Right Ascensions,* page [2] to [119].

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

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

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

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

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

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

The clocks are wound up every Monday.

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

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

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

The corrections applied to the transit at each wire in order to obtain the time of transit over the line corresponding to the mean of the wires, are as follows :

For an equatoreal star.

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

For Polaris, declination = $88^\circ.27'+n''$.

A	+23ᵐ.48ˢ·33 + n × 0ˢ·260
B	+15.49·91 + n × 0·172
C	+ 7.57·64 + n × 0·087
D	+ 1·77
E	− 7.55·64 − n × 0·086
F	−15.52·33 − n × 0·173
G	−23.49·72 − n × 0·260

For δ Ursæ Minoris, declination = $86^\circ.35'+n''$.

A	+10ᵐ.47ˢ·35 + n × 0ˢ·053
B	+ 7.10·87 + n × 0·035
C	+ 3.36·75 + n × 0·018
D	+ 0·81
E	− 3.35·85 − n × 0·018
F	− 7.11·96 − n × 0·035
G	−10.47·98 − n × 0·053

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

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

For a planet, the number thus obtained is multiplied by

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

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

I = Var. in R. A. in 1ʰ.	$\frac{3600 + I}{3600}$ Nat. N°.	$\frac{3600 + I}{3600}$ Log.	I = Var. in R. A. in 1ʰ.	$\frac{3600 + I}{3600}$ Nat. N°.	$\frac{3600 + I}{3600}$ Log.
+ $\overset{s}{1}$	1·00028	0·00012	− $\overset{s}{1}$	0·99972	9·99988
2	·00056	·00024	2	·99944	·99976
3	·00083	·00036	3	·99917	·99964
4	·00111	·00048	4	·99889	·99952
5	·00139	·00060	5	·99861	·99940
6	·00167	·00072	6	·99833	·99927
7	·00194	·00084	7	·99806	·99916
8	·00222	·00096	8	·99778	·99903
9	·00250	·00108	9	·99750	·99891
10	·00278	·00120	10	·99722	·99879
11	·00306	·00132	11	·99694	·99867
12	·00333	·00144	12	·99667	·99855
13	·00361	·00156	13	·99638	·99842
14	·00389	·00169	14	·99611	·99831
15	·00417	·00181	15	·99583	·99819
16	·00444	·00192	16	·99556	·99807
17	·00472	·00204	17	·99528	·99795
18	·00500	·00216	18	·99500	·99782
19	·00528	·00229	19	·99472	·99770
20	·00555	·00240	20	·99445	·99758
21	·00583	·00252	21	·99417	·99746
22	·00611	·00265	22	·99389	·99734
23	·00639	·00277	23	·99361	·99722
24	·00667	·00289	24	·99333	·99709
25	·00694	·00300	25	·99306	·99698
26	·00722	·00312	26	·99278	·99685
27	·00750	·00324	27	·99250	·99673
28	·00778	·00337	28	·99222	·99661
29	·00806	·00349	29	·99194	·99649
+ 30	1·00833	0·00361	− 30	0·99167	9·99637

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

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

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

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

I = Var. in R.A. for 1h of Longitude.	$\frac{3600 + I}{3600}$ Nat. N°.	$\frac{3600 + I}{3600}$ Log.	I = Var. in R.A. for 1h of Longitude.	$\frac{3600 + I}{3600}$ Nat. N°.	$\frac{3600 + I}{3600}$ Log.
s 100	1·02778	0·01190	s 145	1·04028	0·01715
101	·02806	·01202	146	·04056	·01727
102	·02834	·01213	147	·04083	·01738
103	·02861	·01225	148	·04111	·01750
104	·02889	·01237	149	·04139	·01761
105	·02917	·01249	150	·04166	·01773
106	·02945	·01260	151	·04195	·01784
107	·02972	·01272	152	·04222	·01796
108	·03000	·01284	153	·04250	·01808
109	·03028	·01296	154	·04278	·01819
110	·03055	·01307	155	·04306	·01831
111	·03084	·01319	156	·04333	·01842
112	·03111	·01330	157	·04361	·01854
113	·03139	·01342	158	·04389	·01866
114	·03167	·01354	159	·04417	·01877
115	·03195	·01366	160	·04444	·01888
116	·03222	·01377	161	·04472	·01900
117	·03250	·01389	162	·04500	·01912
118	·03278	·01401	163	·04528	·01923
119	·03306	·01413	164	·04556	·01935
120	·03333	·01424	165	·04583	·01946
121	·03361	·01436	166	·04611	·01958
122	·03389	·01447	167	·04639	·01969
123	·03417	·01459	168	·04667	·01981
124	·03444	·01471	169	·04694	·01992
125	·03472	·01482	170	·04722	·02004
126	·03500	·01494	171	·04750	·02015
127	·03528	·01506	172	·04778	·02027
128	·03556	·01518	173	·04806	·02039
129	·03583	·01529	174	·04833	·02050
130	·03611	·01541	175	·04861	·02061
131	·03639	·01552	176	·04889	·02073
132	·03667	·01564	177	·04916	·02084
133	·03694	·01575	178	·04944	·02096
134	·03722	·01587	179	·04972	·02107
135	·03750	·01599	180	·05000	·02119
136	·03778	·01611	181	·05028	·02130
137	·03806	·01622	182	·05056	·02142
138	·03833	·01634	183	·05083	·02153
139	·03861	·01645	184	·05111	·02165
140	·03889	·01657	185	·05139	·02176
141	·03917	·01669	186	·05167	·02188
142	·03945	·01680	187	·05194	·02199
143	·03972	·01692	188	·05222	·02211
144	·04000	·01703	189	·05250	·02222
145	1·04028	0. 01715	190	1·05278	0·02234

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

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

The *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 method has been used.

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

The value of one revolution of the micrometer-screw of the transit was found in 1836 to be $16''\cdot266$.

The following are the details of the observations for the error of collimation in 1841 :—

1841, Jan. 26, 22^h. Observations by Mr. Main. The morning dull and calm, and generally favourable.

Illuminated end West.	r
Micrometer reading on coincidence with collimator (5 measures)..........	7·275
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)..........	12·094
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)..........	7·335
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)..........	12·084
Illuminated end West.	
Micrometer reading on coincidence with collimator (5 measures)..........	7·352
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)..........	12·076
Hence reading for true line of collimation by 1st and 2nd Sets................	9·685
,, ,, by 3rd and 4th Sets................	9·709
,, ,, by 5th and 6th Sets................	9·714
Reading for true line of collimation	9·703
Micrometer reading on coincidence with *D*............................	9·704
Hence apparent error of collimation for *D*	0·001

The error of collimation, therefore, for the middle wire (D) is insignificantly small; and as, for the position of the illuminated end of the axis west (in which position the instrument was left), stars pass the mean of the seven wires earlier than D by $0^s\cdot048$, which corresponds to $0''\cdot72$ of arc, we must apply for the mean of the seven wires the correction

+ 0″·72. For diurnal aberration, we must apply − 0″·19. Thus, finally, the error of collimation to be used is + 0″·53.

1841, April 28. The object-glass of the transit was taken out and cleaned (a quantity of water having insinuated itself between its lenses), and was replaced.

1841, May 3, $21\frac{1}{2}^h$. Observations by Mr. Main. The morning not altogether favourable.

	r
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)	11 ·738
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)	8 ·833
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)	11 ·852
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)	8 ·732
Hence reading for true line of collimation by 1st and 2nd Sets	10 ·286
,, ,, by 3rd and 4th Sets	10 ·292
Reading for true line of collimation	10 ·289
Micrometer reading on coincidence with *D*	9 ·710
Hence apparent error of collimation for *D*	0 ·579

The apparent error of collimation of D is + 0^r·579 = + 9″·42. Correcting this as before by + 0″·72 and − 0″·19, the resulting error of collimation is + 9″·95.

1841, May 21, 22^h. Observations by Mr. Main. The morning generally favourable.

	r
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)	11 ·031
Illuminated end East.	
Micrometer reading on coincidence with collimator (5 measures)	9 ·048
Hence reading for true line of collimation	10 ·040
Micrometer reading on coincidence with *D*	9 ·719
Hence apparent error of collimation for *D*	0 ·321

This result was not used.

1841, May 21, 22^h. The position of the wire-frame having been shifted, the following observations were immediately made by Mr. Main to determine the error of collimation :—

	r
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)	11 ·859

Illuminated end West.	r
Micrometer reading on coincidence with collimator (6 measures)...........	8·381
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	11·869
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)...........	8·336
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	11·880
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)...........	8·317
Hence, reading for true line of collimation by 1st and 2nd Sets................	10·120
,, ,, by 3rd and 4th Sets	10·103
,, ,, by 5th and 6th Sets................	10·099
Reading for true line of collimation	10·107
Micrometer reading on coincidence with *D*.............................	10·164
Hence apparent error of collimation for *D*............................	0·057

The apparent error of collimation of D is $-0^{r}\cdot057 = -0''\cdot93$. Correcting this as before by $+0''\cdot72$ and $-0''\cdot19$, the resulting error of collimation for the mean of wires is $-0''\cdot40$.

1841, June 22, 0^{h}. Observations by Mr. Main for the purpose of determining roughly the error of collimation before the disturbance of the object-glass. The day warm, and generally unfavourable.

Illuminated end West	r
Micrometer reading on coincidence with collimator (6 measures)...........	11·757
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	8·068
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)...........	11·861
Hence, reading for true line of collimation..............................	9·939
Micrometer reading on coincidence with *D*.............................	10·167
Hence apparent error of collimation for *D*	0·228

This result was not used.

1841, June 22, $21\frac{1}{2}^{h}$. Observations by Mr. Main, to determine the error of collimation to be applied to the Transit Observations of June 22, the object-glass having been slightly disturbed.

Illuminated end West.	r
Micrometer reading on coincidence with collimator (6 measures)...........	11·126

Illuminated end East.	r
Micrometer reading on coincidence with collimator (6 measures)...........	9·237
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)...........	11·162
Hence reading for true line of collimation..............................	10·191
Micrometer reading on coincidence with *D*.............................	10·161
Hence apparent error of collimation for *D*.............................	0·030

The apparent error of collimation of D is $+0^{r}{\cdot}030 = +0''{\cdot}49$. Correcting this by $+0''{\cdot}72$ and $-0''{\cdot}19$, the resulting error of collimation for the mean of wires is $+1''{\cdot}02$.

1841, July 12, 23^{h}. Observations by Mr. Henry. The day fine, but the temperature steady.

Illuminated end West.	r
Micrometer reading on coincidence with collimator (6 measures)...........	9·103
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	10·884
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)...........	9·327
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	10·728
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)...........	9·450
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	10·633
Hence reading for true line of collimation by 1st and 2nd Sets.................	9·994
,, ,, by 3rd and 4th Sets.................	10·028
,, ,, by 5th and 6th Sets.................	10·042
Reading for true line of collimation..................................	10·021
Micrometer reading on coincidence with *D*............................	9·743
Hence apparent error of collimation for *D*............................	0·278

The apparent error of collimation of D is $+0^{r}{\cdot}278 = +4''{\cdot}52$. Correcting this by $+0''{\cdot}72$ and $-0''{\cdot}19$, the resulting error of collimation for the mean of wires is $+5''{\cdot}05$.

1841, August 2, 22^{h}. Observations by Mr. Main. The morning gloomy and calm, after heavy rain.

Illuminated end West.	r
Micrometer reading on coincidence with collimator (6 measures)...........	8·505
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	11·756

Illuminated end West.	r
Micrometer reading on coincidence with collimator (6 measures)...........	8·526
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	11·750
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)...........	8·524
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	11·764
Hence, reading for true line of collimation by 1st and 2nd Sets................	10·131
,, ,, by 3rd and 4th Sets................	10·138
,, ,, by 5th and 6th Sets................	10·144
Reading for true line of collimation..................................	10·138
Micrometer reading on coincidence with *D*............................	9·744
Hence apparent error of collimation for *D*............................	0·394

The apparent error of collimation of D is $0^{r}{\cdot}394 = +6''{\cdot}41$. Correcting this as before, the error of collimation to be used is $+6''{\cdot}94$.

1841, November 1, 22^{h}. The error of collimation being inconveniently large, the following observations were made by Mr. Main, to determine its amount previously to shifting the position of the wire frame. The morning gloomy and calm.

Illuminated end West.	r
Micrometer reading on coincidence with collimator (6 measures)...........	7·284
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	12·839
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)...........	7·352
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	12·864
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)...........	7·359
Hence, reading for true line of collimation by 1st and 2nd Sets................	10·062
,, ,, by 3rd, 4th and 5th Sets.............	11·110
Reading for true line of collimation..................................	10·086
Micrometer reading on coincidence with *D*............................	9·742
Hence apparent error of collimation for *D*............................	0·344

The apparent error of collimation for D is $+0^{r}{\cdot}344 = +5''{\cdot}60$. Correcting this as before, the error of collimation for use is $+6''{\cdot}13$.

1841, November 1, 22^{h}. After the position of the wire-frame had been shifted, the following observations were made by Mr. Main.

Illuminated end East.	r
Micrometer reading on coincidence with collimator (6 measures)	11·872
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)	8·291
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)	11·886
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)...........	8·315
Illuminated end East.	
Micrometer reading on coincidence with collimator (6 measures)...........	11·980
Illuminated end West.	
Micrometer reading on coincidence with collimator (6 measures)...........	8·273
Hence reading for true line of collimation by 1st and 2nd Sets	10·082
,, ,, by 3rd and 4th Sets	10·100
,, ,, by 5th and 6th Sets................	10·127
Reading for true line of collimation..................................	10·103
Micrometer reading on coincidence with *D*............................	10·052
Hence apparent error of collimation for *D*............................	0·051

The apparent error of collimation for D is $+ 0^{r}\cdot051 = + 0''\cdot83$. Correcting this as before, the error of collimation for use is $+ 1''\cdot36$.

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

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

The *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. In the year 1841, as in the two preceding, the correction $+ 0^{d}\cdot06$ has been applied for inequality of pivots, as determined in the beginning of 1839. The value of one division of the level-scales was determined in 1836 to be $1''\cdot086$.

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 of the transits is,

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

On Jan. 2, 1841, the pivots were very carefully examined by Mr. Main and Mr. Henry, and found to be in excellent condition. The rubs caused by the level (as remarked in the Introduction to 1840), are in a great measure worn off, and the only thing observable is several marks, or veins, running east and west. The level was then applied, and the readings of the ends of the bubble were taken, while the instrument was turned slowly as far as the construction of the level would permit. The following are the readings :—

Position of Object-glass.	Elevation of Object-glass.	Reading of East Scale.	Reading of West Scale.	Position of Object-glass.	Elevation of Object-glass.	Reading of East Scale.	Reading of West Scale.
S.	0°	123·5	124·6	N.	0°	122·3	124·2
	10	123·7	124·0		10	122·6	124·0
	20	123·5	124·0		20	122·4	124·0
	30	123·3	124·0		30	122·4	123·9
	40	123·0	123·9		40	122·4	123·9
	50	123·0	123·9		50	122·4	123·9
	60	123·0	123·8		60	122·3	123·9
	0	122·9	124·0		0	122·3	123·8
	−10	122·9	123·9		−10	122·1	123·8
	−20	122·9	123·9		−20	122·2	123·8
	−30	122·8	123·8		−30	122·3	123·7
	−40	122·7	123·9		−40	122·3	123·6
	−50	122·8	123·8		−50	122·3	123·6
	−60	122·6	123·9		−60	122·2	123·5

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

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 R.A., and the estimated clock-rate for 12^h; and the difference, in seconds of time, between the altered first transit and the second transit (rejecting 12^h) is divided by 3·038 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 R.A. and the clock's rate, and is then 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 R.A. of the Nautical Almanac (with a small alteration hereafter mentioned) with the time of transit including a term multiplied by z. The clock-error, therefore, from Polaris, contains a term depending on z. In like manner the clock error from some other star not near the pole contains a term depending on z. Equating these (with the proper allowance for rate of the clock), z is found.

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

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

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

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

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

Star.	Collimation $\frac{1}{15\,\text{Sin.N.P.D.}}$	Level. $\frac{\text{Cos. Z.D.}}{15\,\text{Sin.N.P.D.}}$	Azimuth. $\frac{\text{Sin. Z.D.}}{15\,\text{Sin.N.P.D.}}$	Star.	Collimation $\frac{1}{15\,\text{Sin.N.P.D.}}$	Level. $\frac{\text{Cos. Z.D.}}{15\,\text{Sin.N.P.D.}}$	Azimuth. $\frac{\text{Sin. Z.D.}}{15\,\text{Sin.N.P.D.}}$
α Andromedæ......	+0·076	+0·069	+0·030	ζ Ursæ Minoris S.P.	−0·329	−0·210	+0·253
γ Pegasi..........	+0·069	+0·055	+0·042	η Draconis S.P.....	−0·141	−0·056	+0·130
α Cassiopeiæ.......	+0·118	+0·118	−0·009	Aldebaran.........	+0·070	+0·057	+0·040
β Ceti.............	+0·070	+0·024	+0·066	ε Ursæ Minoris S.P.	−0·497	−0·344	+0·359
Polaris...........	+2·440	+1·950	−1·467	Capella...........	+0·095	+0·095	+0·009
θ Ceti............	+0·067	+0·033	+0·059	Rigel.............	+0·067	+0·034	+0·058
η Ursæ Majoris S.P.	−0·104	−0·021	+0·102	β Tauri...........	+0·076	+0·070	+0·030
α Arietis..........	+0·072	+0·063	+0·035	δ Orionis..........	+0·067	+0·041	+0·052
γ Ceti............	+0·067	+0·044	+0·050	α Leporis.........	+0·070	+0·025	+0·066
β Ursæ Minoris S.P.	−0·254	−0·151	+0·205	β Draconis S.P.....	−0·109	−0·026	+0·106
α Ceti.............	+0·067	+0·045	+0·050	ε Orionis..........	+0·067	+0·040	+0·053
α Persei..........	+0·102	+0·102	+0·004	α Columbæ........	+0·080	+0·006	+0·080
η Tauri...........	+0·073	+0·064	+0·034	α Orionis..........	+0·067	+0·048	+0·047
γ Eridani..........	+0·069	+0·028	+0·062	γ Draconis S.P.....	−0·107	−0·024	+0·104

Star.	Collimation $\frac{1}{15\,\text{Sin.N.P.D.}}$	Level. $\frac{\text{Cos. Z.D.}}{15\,\text{Sin.N.P.D.}}$	Azimuth. $\frac{\text{Sin. Z.D.}}{15\,\text{Sin.N.P.D.}}$	Star.	Collimation $\frac{1}{15\,\text{Sin.N.P.D.}}$	Level. $\frac{\text{Cos. Z.D.}}{15\,\text{Sin.N.P.D.}}$	Azimuth. $\frac{\text{Sin. Z.D.}}{15\,\text{Sin.N.P.D.}}$
μ Geminorum	+0·072	+0·063	+0·035	ζ Ursæ Minoris	+0·329	+0·293	−0·148
Cephei 51 (Hev.)	+1·397	+1·133	−0·817	β¹ Scorpii	+0·071	+0·023	+0·067
δ Ursæ Minoris S.P.	−1·120	−0·834	+0·749	δ Ophiuchi	+0·067	+0·038	+0·054
Sirius	+0·070	+0·026	+0·065	Antares	+0·074	+0·016	+0·072
ε Canis Majoris	+0·076	+0·013	+0·075	η Draconis	+0·141	+0·139	−0·026
δ Geminorum	+0·072	+0·063	+0·035	ε Ursæ Minoris	+0·497	+0·427	−0·255
Castor	+0·079	+0·074	+0·026	Capella S. P.	−0·095	−0·012	+0·095
Procyon	+0·067	+0·047	+0·048	α Herculis	+0·069	+0·055	+0·041
Pollux	+0·075	+0·070	+0·030	β Draconis	+0·109	+0·109	−0·002
15 Argûs	+0·073	+0·018	+0·070	α Ophiuchi	+0·068	+0·053	+0·043
λ Ursæ Minoris S.P.	−3·227	−2·482	+2·061	γ Draconis	+0·107	+0·107	0·000
α Cygni S.P.	−0·094	−0·010	+0·093	μ Sagittarii	+0·071	+0·021	+0·068
ε Hydræ	+0·067	+0·048	+0·047	Cephei 51 (Hev.) S.P.	−1·397	−1·050	+0·921
ι Ursæ Majoris	+0·101	+0·101	+0·005	δ Ursæ Minoris	+1. 120	+0·917	−0·644
α Cephei S.P.	−0·141	−0·056	+0·130	α Lyræ	+0·086	+0·083	+0·019
α Hydræ	+0·067	+0·034	+0·058	β Lyræ	+0·080	+0·076	+0·025
θ Ursæ Majoris	+0·109	+0·109	−0·002	ζ Aquilæ	+0·068	+0·054	+0·042
β Cephei S.P.	−0·193	−0·101	+0·165	δ Aquilæ	+0·067	+0·044	+0·050
ε Leonis	+0·073	+0·065	+0·033	γ Aquilæ	+0·068	+0·051	+0·045
Regulus	+0·068	+0·053	+0·043	α Aquilæ	+0·067	+0·049	+0·046
α Ursæ Majoris	+0·145	+0·142	−0·028	β Aquilæ	+0·067	+0·047	+0·048
δ Leonis	+0 072	+0·062	+0·036	α² Capricorni	+0·068	+0·029	+0·062
δ Crateris	+0·069	+0·029	+0·062	λ Ursæ Minoris	+3·227	+2·565	−1·957
γ Cephei S.P.	−0·290	−0·179	+0·228	α Cygni	+0·094	+0·093	+0·011
β Leonis	+0·069	+0·056	+0·041	ι Ursæ Majoris S.P.	−0·101	−0·018	+0·099
γ Ursæ Majoris	+0·115	+0·115	−0·006	61 Cygni	+0·085	+0·082	+0·020
β Corvi	+0·072	+0·020	+0·069	ζ Cygni	+0·077	+0·071	+0·029
α Cassiopeiæ S.P.	−0·118	−0·035	+0·113	α Cephei	+0·141	+0·139	−0·026
12 Canum Venaticûm	+0·086	+0·084	+0·018	θ Ursæ Majoris S.P.	−0·109	−0·026	+0·106
Polaris S.P.	−2·440	−1·867	+1·571	β Aquarii	+0·067	+0·036	+0·057
Spica	+0·068	+0·032	+0·060	β Cephei	+0·193	+0·184	−0·061
η Ursæ Majoris	+0·104	+0·104	+0·002	ε Pegasi	+0·067	+0·050	+0·045
η Bootis	+0·070	+0·060	+0·038	α Aquarii	+0·067	+0·040	+0·053
Arcturus	+0·071	+0·061	+0·037	ζ Pegasi	+0·068	+0·051	+0·045
ε Bootis	+0·075	+0·069	+0·030	Fomalhaut	+0·077	+0·011	+0·077
α Libræ	+0·069	+0·027	+0·064	α Ursæ Majoris S.P.	−0·145	−0·059	+0·132
β Ursæ Minoris	+0·254	+0·234	−0·101	α Pegasi	+0·069	+0·055	+0·041
β Libræ	+0·067	+0·033	+0·058	ι Piscium	+0·067	+0·046	+0·049
α Persei S. P.	−0·102	−0·019	+0·100	γ Cephei	+0·290	+0·262	−0·124
α Coronæ Borealis	+0·075	+0·069	+0·031	γ Ursæ Majoris S.P.	−0·115	−0·032	+0·111
α Serpentis	+0·067	+0·048	+0·047				

N. P. D.	Collimation. $\frac{1}{15 \text{ Sin. N. P. D.}}$	Level. $\frac{\text{Cos. Z. D.}}{15 \text{ Sin. N. P. D.}}$	Azimuth. $\frac{\text{Sin. Z. D.}}{15 \text{ Sin. N. P. D.}}$	N. P. D.	Collimation. $\frac{1}{15 \text{ Sin. N. P. D.}}$	Level. $\frac{\text{Cos. Z. D.}}{15 \text{ Sin. N. P. D.}}$	Azimuth. $\frac{\text{Sin. Z. D.}}{15 \text{ Sin. N. P. D.}}$
° ′ 6. 0	+0·638	+0·538	−0·343	° ′ 43. 0	+0·098	+0·097	+0·007
30	+0·589	+0·499	−0·312	44. 0	+0·096	+0·096	+0·009
7. 0	+0·547	+0·466	−0·286	45. 0	+0·094	+0·094	+0·011
30	+0·511	+0·438	−0·263	46. 0	+0·093	+0·092	+0·012
8. 0	+0·479	+0·413	−0·243	47. 0	+0·091	+0·090	+0·013
30	+0·451	+0·391	−0·226	48. 0	+0·090	+0·088	+0·015
9. 0	+0·426	+0·371	−0·210	49. 0	+0·088	+0·087	+0·016
30	+0·404	+0·353	−0·196	50. 0	+0·087	+0·085	+0·017
10. 0	+0·384	+0·337	−0·183	51. 0	+0·086	+0·084	+0·018
30	+0·366	+0·323	−0·172	52. 0	+0·085	+0·082	+0·020
11. 0	+0·349	+0·310	−0·161	53. 0	+0·083	+0·081	+0·021
30	+0·334	+0·298	−0·152	54. 0	+0·082	+0·080	+0·022
12. 0	+0·321	+0·287	−0·143	55. 0	+0·081	+0·078	+0·023
30	+0·308	+0·277	−0·135	56. 0	+0·080	+0·077	+0. 024
13. 0	+0·296	+0·267	−0·128	57. 0	+0·080	+0·075	+0·025
30	+0·286	+0·259	−0·122	58. 0	+0·079	+0·074	+0·026
14. 0	+0·276	+0·251	−0·116	59. 0	+0·078	+0·073	+0·027
30	+0·266	+0·244	−0·111	60. 0	+0·077	+0·072	+0·028
15. 0	+0·257	+0·236	−0·105	61. 0	+0·076	+0·070	+0·029
30	+0·249	+0·230	−0·099	62. 0	+0·076	+0·069	+0·030
16. 0	+0·242	+0·224	−0·093	63. 0	+0·075	+0·068	+0·031
30	+0·235	+0·218	−0·088	64. 0	+0·074	+0·067	+0·032
17. 0	+0·228	+0·212	−0·084	65. 0	+0·073	+0·066	+0·033
30	+0·222	+0·207	−0·080	66. 0	+0·073	+0·065	+0·034
18. 0	+0·216	+0·202	−0·076	67. 0	+0·072	+0·064	+0·035
30	+0·210	+0·197	−0·072	68. 0	+0·072	+0·063	+0·035
19. 0	+0·205	+0·193	−0·068	69. 0	+0·071	+0·061	+0·036
30	+0·200	+0·189	−0·065	70. 0	+0·071	+0·060	+0·037
20. 0	+0·195	+0·185	−0·062	71. 0	+0·071	+0·059	+0·038
21. 0	+0·186	+0·177	−0·056	72. 0	+0·070	+0·058	+0·039
22. 0	+0·178	+0·171	−0·051	73. 0	+0·070	+0·057	+0·039
23. 0	+0·171	+0·164	−0·046	74. 0	+0·069	+0·056	+0·040
24. 0	+0·164	+0·159	−0·041	75. 0	+0·069	+0·055	+0·041
25. 0	+0·158	+0·153	−0·037	76. 0	+0·069	+0·054	+0·042
26. 0	+0·152	+0·148	−0·033	77. 0	+0·068	+0·053	+0·043
27. 0	+0·147	+0·144	−0·029	78. 0	+0·068	+0·053	+0·043
28. 0	+0·142	+0·140	−0·026	79. 0	+0·068	+0·052	+0·044
29. 0	+0·138	+0·136	−0·023	80. 0	+0·068	+0·051	+0·045
30. 0	+0·133	+0·131	−0·020	81. 0	+0·067	+0·050	+0·045
31. 0	+0·129	+0·128	−0·017	82. 0	+0·067	+0·049	+0·046
32. 0	+0·126	+0·125	−0·014	83. 0	+0·067	+0·048	+0·047
33. 0	+0·122	+0·122	−0·012	84. 0	+0·067	+0·047	+0·048
34. 0	+0·119	+0·119	−0·009	85. 0	+0·067	+0·046	+0·048
35. 0	+0·116	+0·116	−0·007	86. 0	+0·067	+0·045	+0·049
36. 0	+0·113	+0·113	−0·005	87. 0	+0·067	+0·044	+0·050
37. 0	+0·111	+0·111	−0·003	88. 0	+0·067	+0·043	+0·051
38. 0	+0·108	+0·108	−0·001	89. 0	+0·067	+0·042	+0·052
39. 0	+0·106	+0·106	+0·001	90. 0	+0·067	+0·041	+0·052
40. 0	+0·104	+0·104	+0·003	91. 0	+0·067	+0·040	+0·053
41. 0	+0·102	+0·101	+0·004	92. 0	+0·067	+0·040	+0·054
42. 0	+0·100	+0·099	+0·006	93. 0	+0·067	+0·039	+0·054
43. 0	+0·098	+0·097	+0·007	94. 0	+0·067	+0·038	+0·055

N. P. D.	Collimation. $\frac{1}{15 \text{ Sin. N. P. D.}}$	Level. $\frac{\text{Cos. Z. D.}}{15 \text{ Sin. N. P. D.}}$	Azimuth. $\frac{\text{Sin. Z. D.}}{15 \text{ Sin. N. P. D.}}$	N. P. D.	Collimation. $\frac{1}{15 \text{ Sin. N. P. D.}}$	Level. $\frac{\text{Cos. Z. D.}}{15 \text{ Sin. N. P. D.}}$	Azimuth. $\frac{\text{Sin. Z. D.}}{15 \text{ Sin. N. P. D.}}$
° ′				° ′			
94. 0	+0·067	+0·038	+0·055	110. 0	+0·071	+0·023	+0·067
95. 0	+0·067	+0·037	+0·056	111. 0	+0·072	+0·022	+0·068
96. 0	+0·067	+0·036	+0·057	112. 0	+0·072	+0·021	+0·069
97. 0	+0·067	+0·035	+0·057	113. 0	+0·073	+0·020	+0·070
98. 0	+0·067	+0·034	+0·058	114. 0	+0·073	+0·018	+0·071
99. 0	+0·067	+0·033	+0·059	115. 0	+0·074	+0·017	+0·072
100. 0	+0·068	+0·032	+0·060	116. 0	+0·075	+0·016	+0·072
101. 0	+0·068	+0·031	+0·060	117. 0	+0·076	+0·015	+0·073
102. 0	+0·068	+0·030	+0·061	118. 0	+0·076	+0·014	+0·074
103. 0	+0·068	+0·029	+0·062	119. 0	+0·076	+0·013	+0·075
104. 0	+0·069	+0·028	+0·063	120. 0	+0·077	+0·012	+0·076
105. 0	+0·069	+0·027	+0·063	121. 0	+0·078	+0·011	+0·077
106. 0	+0·069	+0·027	+0·064	122. 0	+0·079	+0·009	+0·078
107. 0	+0·070	+0·026	+0·065	123. 0	+0·080	+0·008	+0·079
108. 0	+0·070	+0·025	+0·066	124. 0	+0·080	+0·007	+0·080
109. 0	+0·071	+0·024	+0·066	125. 0	+0·081	+0·005	+0·081
110. 0	+0·071	+0·023	+0·067	126. 0	+0·082	+0·004	+0·082

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 R. A. of the stars which are used for determining the clock-error. The stars are taken from the list of the Nautical Almanac, those only being used whose N. P. D. exceeds 50°. The tabular R. A. of Polaris also is set down, to enable the reader to judge of the general state of adjustment of the instrument. The tabular R. A. are computed by adding to the place given in the Nautical Almanac a constant for each star, 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 R. A. for 1841. Jan. 1, which in fact are used in these computations, and the constant alterations to the places of the Nautical Almanac.

Star's Name.	Assumed Mean R. A. Jan. 1, 1841.	Correction to N. A.	Star's Name.	Assumed Mean R. A. Jan. 1, 1841.	Correction to N. A.
	h m s	s		h m s	s
α Andromedæ	0. 0. 10·89	+ 0·10	β Corvi	12. 26. 2·81	− 0·03
γ Pegasi	0. 5. 3·33	+ 0·01	Spica	13. 16. 49·49	− 0·02
β Ceti	0. 35. 36·33	+ 0·05	η Bootis	13. 47. 6·85	− 0·02
Polaris	1. 2. 27·62	+ 0·44	Arcturus	14. 8. 24·70	0·00
θ Ceti	1. 16. 4·59	− 0·06	ε Bootis	14. 38. 2·58	− 0·04
α Arietis	1. 58. 13·38	+ 0·09	α Libræ	14. 42. 5·60	− 0·01
γ Ceti	2. 35. 4·11	0·00	β Libræ	15. 8. 27·47	− 0·03
α Ceti	2. 53. 58·44	− 0·03	α Coronæ Borealis	15. 27. 57·48	+ 0·09
η Tauri	3. 38. 2·66	− 0·02	α Serpentis	15. 36. 26·38	+ 0·01
γ Eridani	3. 50. 36·81	+ 0·01	β^1 Scorpii	15. 56. 12·04	− 0·01
Aldebaran	4. 26. 48·28	+ 0·08	δ Ophiuchi	16. 6. 1·14	− 0·03
Rigel	5. 6. 54·00	+ 0·03	Antares	16. 19. 40·12	− 0·03
β Tauri	5. 16. 14·74	0·00	α Herculis	17. 7. 23·99	− 0·04
δ Orionis	5. 23. 53·17	0·00	α Ophiuchi	17. 27. 33·38	+ 0·04
α Leporis	5. 25. 43·20	0·00	μ Sagittarii	18. 4. 15·30	− 0·01
ε Orionis	5. 28. 8·91	+ 0·01	δ Ursæ Minoris	18. 23. 37·13	− 0·10
α Columbæ	5. 33. 53·68	− 0·01	α Lyræ	18. 31. 33·31	0·00
α Orionis	5. 46. 33·99	+ 0·04	β Lyræ	18. 44. 12·62	− 0·03
μ Geminorum	6. 13. 20·41	− 0·03	ζ Aquilæ	18. 58. 6·19	+ 0·05
Sirius	6. 38. 8·66	+ 0·10	δ Aquilæ	19. 17. 28·86	+ 0·05
ε Canis Majoris	6. 52. 22·79	+ 0·05	γ Aquilæ	19. 38. 42·07	+ 0·09
δ Geminorum	7. 10. 37·36	− 0·06	α Aquilæ	19. 43. 1·54	+ 0·06
Castor	7. 24. 26·72	− 0·12	β Aquilæ	19. 47. 30·16	0·00
Procyon	7. 30. 58·50	+ 0·01	α^2 Capricorni	20. 9. 13·70	+ 0·07
Pollux	7. 35. 34·69	− 0·07	ζ Cygni	21. 6. 10·33	− 0·05
15 Argus	8. 0. 46·53	− 0·10	β Aquarii	21. 23. 11·01	− 0·07
ε Hydræ	8. 38. 21·14	− 0·08	ε Pegasi	21. 36. 22·63	− 0·04
α Hydræ	9. 19. 46·42	− 0·10	α Aquarii	21. 57. 36·93	− 0·01
ε Leonis	9. 36. 48·90	− 0·06	ζ Pegasi	22. 33. 31·99	0·00
Regulus	9. 59. 53·93	− 0·10	Fomalhaut	22. 48. 51·07	+ 0·15
δ Leonis	11. 5. 38·62	0·00	α Pegasi	22. 56. 50·73	0·00
δ Crateris	11. 11. 23·71	− 0·19	ι Piscium	23. 31. 46·46	+ 0·14
β Leonis	11. 40. 56·74	− 0·03			

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 *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 bars across these columns (in far the greater number of instances the same as the limits of each individual's observations). On two or three occasions, the observations of clock-stars by one observer have been combined with those by another; but in those cases it is believed that personal equation does not exist to any amount worth consideration. The mean of the clock-errors given by all the clock-stars in the same group is then taken, and this is held to be the clock-error corresponding to the mean of all the times of transit of the same stars. The next step is to allow for personal equation. It was found in the Introduction to the Volume of Observations for 1838, page xiii, that the clock-error given by Mr. Ellis's observations is always greater than that given by Mr. Henry's by $0^s{\cdot}36$. The quantity $0^s{\cdot}36$ is therefore subtracted from each of the mean clock-errors determined by Mr. Ellis, and it is then considered that we have a set of clock-errors justly comparable among themselves. Each mean clock-error is now compared with that which precedes and with that which follows; a preceding rate and a following rate are thus found, and by this the computer is guided in adopting the clock-rate to be used through the group of observations: this adopted clock-rate is set down in the eighth column. For facility of calculation, the proportional part of this rate, corresponding to the mean sidereal time or mean of all the times of transit for the group, is applied with changed sign to the mean clock-error (unaltered for personal equation), and thus the clock-error at 0^h sidereal is found. If it happen that any observations included in the same group are made in the sidereal day preceding or following that for which the mean error has been found, the whole adopted daily rate is subtracted from or added to the error found for 0^h, and thus the error for 0^h of the preceding or following sidereal day is obtained. These errors at 0^h are set down in the ninth column. It is to be remarked that, in the application of these errors, if the observations of small stars and planets have been made by the same person as the observations of the clock-stars (whether it be Mr. Henry or Mr. Ellis), no further computation is necessary for obtaining the right ascension of these objects than the application to the time of transit of clock-error at 0^h, and a proportional part of clock-rate corresponding to the right ascension of the object: but if the clock-stars are observed by Mr. Ellis and the other object by Mr. Henry, a further correction of $-0^s{\cdot}36$ must be applied; if the clock-stars are observed by Mr. Henry and the object by Mr. Ellis, $+0^s{\cdot}36$ must be applied. These quantities are *not* applied in the column of *Apparent Right Ascension from the Observations* in this Section.

In the Introductions for 1838 and 1839, observations were exhibited which shewed that the difference between the clock-errors given by Mr. Main, Mr. Henry, and Mr. Glaisher was inconsiderable. In 1840, a few observations were made, of which the results are recorded in the Introduction for that year, shewing that the clock-errors given by Mr. Rogerson are greater by $0^s{\cdot}15$ than those given by Mr. Main.

In the year 1841, the following sets of observations have been found available for determining personal equations. They have been treated in the same manner as in former years, by comparing the clock-error at the same sidereal noon given by two different groups of stars observed by different observers.

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

Day, 1841.		Interval of nearest Stars.	Order of Observations.	Clock Slow at 0^h by M.	Clock Slow at 0^h by H.	M — H.
		h		s	s	s
March	10 to 11	3	H M	12·47	12·31	+ 0·16
May	30 to 31	12	M H	53·13	53·10	+ 0·03

The mean of these two values is $+ 0^{s}\cdot10$.

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

Day, 1841.		Interval of nearest Stars.	Order of Observations.	Clock Slow at 0^h by M.	Clock Slow at 0^h by E.	E — M
		h		s	s	s
March	11 to 12	5	M E	13·12	13·47	+ 0·35
April	26 to 27	6	E M	38·99	39·28	+ 0·29
Aug.	9	8	E M	34·81	34·75	— 0·06
	23 to 24	12	M E	42·58	42·93	+ 0·35
Sept.	14 to 15	11	M E	57·23	57·35	+ 0·12
	16 to 17	10	M E	58·05	58·42	+ 0·37

The mean of the values of E — M is $+ 0^{s}\cdot24$.

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

Day, 1841.		Interval of nearest Stars.	Order of Observations.	Clock Slow at 0^h by H.	Clock Slow at 0^h by E.	E — H.
		h		s	s	s
Jan.	8 to 9	$8\frac{1}{2}$	H E	13·14	13·39	+ 0·25
	20 to 21	11	E H	24·70	24·75	+ 0·05
	21	8	H E	25·70	25·95	+ 0·25
March	12	2	E H	13·59	13·94	+ 0·35
	15 to 16	$9\frac{1}{2}$	H E	14·99	15·29	+ 0·30
	17 to 18	9	H E	15·87	16·30	+ 0·43
	19 to 20	5	H E	15·89	16·34	+ 0·45
	22 to 23	9	H E	16·48	16·87	+ 0.39
	24 to 25	3	H E	17·07	17·53	+ 0·46

OBSERVATIONS for the PERSONAL EQUATION—*continued.*

Day, 1841.	Interval of nearest Stars.	Order of Observations.	Clock Slow at 0^h by H.	Clock Slow at 0^h by E.	E — H.
	h		s	s	s
April 15 to 16	6	E H	29·08	29·56	+ 0·48
23	6	H E	35·71	36·03	+ 0·32
29 to 30	6	H E	40·13	40·67	+ 0·54
30 to May 1	11	E H	40·37	40·87	+ 0·50
May 12 to 13	8½	H E	45·46	45·67	+ 0·21
26 to 27	11	E H	52·60	52·90	+ 0·30
Oct. 6 to 7	12	E H	12·83	13·15	+ 0·32
19 to 20	10½	E H	26·49	26·73	+ 0·24
Nov. 5 to 6	12	E H	45·98	46·32	+ 0·34
22	11	E H	5·79	5·96	+ 0·17
Dec. 3	5½	H E	14·87	15·20	+ 0·33
16 to 17	10	H E	29·79	30·12	+ 0·33
17 to 18	10	E H	30·64	30·91	+ 0·27
27 to 28	12	E H	39·83	40·12	+ 0·29

The mean of all the values of E — H is + 0^s·33.

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

Day, 1841.	Interval of nearest Stars.	Order of Observation.	Clock Slow at 0^h by W R.	Clock Slow at 0^h by E.	E — W R.
	h		s	s	s
July 16	12½	E, W R	19·13	19·19	+ 0·06
28	12	E, W R	27·40	27·62	+ 0·12
Sep. 6	3	E, W R	51·94	51·90	— 0·04

The mean of the values of E — W R is + 0^s·05.

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

Day, 1841.	Interval of nearest Stars.	Order of Observation.	Clock Slow at 0^h by R.	Clock Slow at 0^h by E.	E — R.
	h		s	s	s
Aug. 19 to 20	8½	E R	40·90	41·03	+ 0·13
20 to 21	13½	R E	41·50	41·69	+ 0·19

The mean of these values is + 0^s·16.

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 in the same work. No corrections are made in this section to the semidiameters: these are noticed in a subsequent section.

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 Polaris or δ Ursæ Minoris has been observed at opposite passages.

The *twelfth* column contains the correction with its proper sign, as it is to be applied for reducing the apparent right ascension at the time of observation to the mean right ascension on the 1st January, 1841. It is computed in the following way:

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

For other stars, the corrections are computed by the formula

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

or

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

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

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

§ 2. *Apparent Right Ascensions of Polaris and δ Ursæ Minoris, and Mean Right Ascensions of Stars observed in the Year* 1841, page [120] to [132].

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 all the stars are found by applying to the apparent right ascensions in the eleventh column, the corrections in the twelfth column.

The resulting mean right ascensions have been increased by $0^s \cdot 36$ when the star whose right ascension is determined was observed by Mr. Ellis, and the clock-stars by any other observer: or diminished by $0^s \cdot 36$ when the clock-stars were observed by Mr. Ellis, and the dependent star by any other observer.

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

§ 3. *Observations with Troughton's Mural Circle*, page (2) to (149).

The facility and accuracy with which the observations can be made with one instrument leaving nothing to be desired, the adjustments of Jones's Circle have not been completed, and the observations throughout the year have been made with Troughton's Circle. If circumstances should arise of pressure of observations which should render its use desirable, the requisite adjustments could be readily completed.

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

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

TRANSITS FOR THE POSITION OF TROUGHTON'S CIRCLE,
Throughout the Year 1841.

Day, 1841.	Object.	Transit by Graham 2.	Transit by Hardy.	Sidereal Time.	Sec. of R.A.	Error.
		h m s	h m s	h m s	s	s
January... 3	α Arietis........	1. 58. 37·08	1. 58. 5·08	1. 58. 13·60	14·35	− 0·75
5	α Persei........	3. 13. 27·72	3. 12. 50·52	3. 13. 0·96	2·03	− 1·07
6	β Draconis......	17. 27. 17·50	17. 26. 37·70	17. 26. 49·79	49·05	+ 0·74
March... 11	Rigel...........	5. 7. 27·72	5. 6. 39·42	5. 6. 52·68	55.15	− 2·47
,,	β Tauri.........	5. 16. 50·00	5. 16. 1·70	5. 16. 14·96	16·29	− 1·33
,,	ε Orionis........	5. 28. 42·76	5. 27. 54·46	5. 28. 7·72	10.25	− 2·53
,,	α Columbæ......	5. 34. 25·70	5. 33. 37·40	5. 33. 50·67	54·74	− 4·07
15	β Aquarii.......	21. 23. 43·50	21. 22. 53·50	21. 23. 9·14	11·48	− 2·34
,,	ε Pegasi........	21. 36. 55·40	21. 36. 5·40	21. 36. 21·05	22·83	− 1·78
16	α Andromedæ....	0. 0. 43·60	23. 59. 53·70	0. 0. 9·39	10·48	− 1·09

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

Day, 1841.		Object.	Transit by Graham 2.	Transit by Hardy.	Sidereal Time.	Sec. of R.A.	Error.
			h m s	h m s	h m s	s	s
May	13	Aldebaran.......	4. 27. 26·47	4. 26. 1·87	4. 26. 47·68	48·81	− 1·13
	15	β Leonis........	11. 41. 33·30	11. 40. 10·30	11. 40. 58·32	59·34	− 1·02
	26	α Orionis........	5. 46. 48·20	5. 45. 39·80	5. 46. 32·49	34·72	− 2·23
	,,	ε Leonis.........	9. 37. 4·52	9. 35. 57·02	9. 36. 49·76	50·92	− 1·16
	,,	β Corvi.........	12. 26. 16·43	12. 25. 8·93	12. 26. 1·70	5·35	− 3·65
	27	α Arietis........	1. 58. 22·80	1. 57. 20·30	1. 58. 13·21	14·14	− 0·93
June....	22	Spica...........	13. 15. 58·98	13. 15. 45·18	13. 16. 49·64	52·16	− 2·52
	,,	η Bootis.........	13. 46. 17·34	13. 46. 3·57	13. 47. 8·04	9·68	− 1·64
	,,	α Libræ.........	14. 41. 14·60	14. 41. 0·90	14. 42. 5·40	8·84	− 3·44
July....	22	α Lyræ	18. 31. 43·70	18. 31. 15·30	18. 31. 38·27	36·55	+ 1·72
August..	3	Castor..........	7. 24. 0·30	7. 23. 57·50	7. 24. 29·02	28·85	+ 0·17
	,,	Procyon........	7. 30. 29·87	7. 30. 27·07	7. 30. 58·59	0·02	− 1·43
	,,	Pollux..........	7. 35. 7·40	7. 35. 4·60	7. 35. 36·12	36·63	− 0·51
	23	Procyon........	7. 31. 31·23	7. 30. 15·83	7. 30. 58·92	0·42	− 1·50
	,,	Pollux..........	7. 36. 8·93	7. 34. 53·53	7. 35. 36·62	37·10	− 0·48
September	7	α Hydræ........	9. 19. 37·70	9. 18. 52·10	9. 19. 45·24	48·17	− 2·93
	,,	Regulus.........	9. 59. 46·20	9. 59. 0·60	9. 59. 53·76	55·98	− 2·22
	16	Regulus.........	9. 59. 53·38	9. 58. 55·88	9. 59. 54·64	56·11	− 1·47
	17	Regulus.........	9. 59. 50·60	9. 58. 55·30	9. 59. 54·56	56·12	− 1·56
	27	Arcturus........	14. 7. 59·43	14. 8. 19·73	14. 8. 25·31	26·42	− 1·11
October..	6	δ Leonis.........	11. 5. 53·63	11. 5. 26·23	11. 5. 39·49	40·88	− 1·39
	17	Venus 2 L.......	11. 33. 13·20	11. 32. 54·70	11. 33. 19·80	20·31	− 0·51
	18	Arcturus........	14. 8. 19·72	14. 8. 1·52	14. 8. 26·74	26·37	+ 0·37
	19	Arcturus........	14. 8. 16·13	14. 7. 59·33	14. 8. 25·63	26·37	− 0·74
	20	α Aquarii	21. 57. 29·20	21. 57. 12·00	21. 57. 39·58	40·85	− 1·27
	,,	Fomalhaut	22. 48. 42·48	22. 48. 25·48	22. 48. 53·10	55·64	− 2·54
November	6	α Coronæ Borealis	15. 27. 30·60	15. 27. 12·90	15. 27. 59·88	58·84	+ 1·04
	,,	α Serpentis......	15. 35. 58·68	15. 35. 40·98	15. 36. 27·96	28·34	− 0·38
	11	α Ophiuchi......	17. 27. 0·38	17. 26. 41·88	17. 27. 36·16	35·29	+ 0·87
	,,	Arcturus........	14. 7. 50·83	14. 7. 32·03	14. 8. 27·35	26·58	+ 0·77
	12	ε Bootis.........	14. 37. 28·17	14. 37. 9·17	14. 38. 5·54	4·26	+ 1·28
	16	ε Bootis.........	14. 37. 27·48	14. 37. 4·68	14. 38. 4·89	4·31	+ 0·58
	23	η Ursæ Majoris ..	13. 41. 44·20	13. 41. 14·40	13. 41. 22·15	17·48	+ 4·67
	,,	η Bootis.........	13. 47. 32·00	13. 47. 2·30	13. 47. 10·05	9·16	+ 0·89
	,,	Arcturus R......	14. 8. 46·50	14. 8. 16·80	14. 8. 24·56	26·78	− 2·22
	,,	Venus 2 L.......	14. 24. 21·20	14. 23. 51·50	14. 23. 59·27	0·45	− 1·18
	,,	α Serpentis......	15. 36. 50·00	15. 36. 20·30	15. 36. 28·12	28·48	− 0·36
	24	η Draconis	16. 22. 11·30	16. 21. 41·60	16. 21. 49·44	49·23	+ 0·21
December	15	α Serpentis......	15. 36. 38·40	15. 35. 59·60	15. 36. 29·05	28·86	+ 0·19
	17	α Serpentis......	15. 36. 38·07	15. 35. 57·77	15. 36. 28·86	28·90	− 0·04
	,,	β Draconis	17. 27. 4·00	17. 27. 4·00	17. 26. 54·84	50·17	+ 4·67

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

The *first* column on the left-hand page contains the day, always beginning with the Sun's transit: the *second* contains numbers of reference: the *third* contains the name of the object observed (the nomenclature of the stars following the same general rules as in the section of *Transits observed*, &c., except that, as a last resource, the place of the star is defined by its right ascension, which may sometimes be in error 10^s). The letters N.L. and S.L. denote the north and south limbs, and N.C. and S.C. the north and south cusps, of planets. The letter M denotes that the object is observed, not on the fixed horizontal wire, but on the wire carried by a micrometer-screw. The letter R denotes that the object is observed by reflexion from a trough of mercury. The troughs used for this purpose are about eighteen inches long and four inches broad : they are placed either on a ledge of the circle-pier, about thirty inches below the lower limb of the circle, or upon a bracket, which admits of being placed at different elevations on a carriage travelling with wheels on the ledge of the pier.

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

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

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." The amount of correction then necessary is, the correction which would have been applied if the observations had been made in the usual way, diminished by the whole correction for 5′.

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

ERRORS OF EACH MICROSCOPE OF TROUGHTON'S CIRCLE, FOR A READING OF 5′, Throughout the Year 1841.

Day, 1841.	Pointer Reading.	MICROSCOPES.						Sum.
		A	B	C	D	Ė	F	
	°	″	″	″	″	″	″	″
January..... 4	224	0·0	+ 1·2	− 1·9	+ 0·7	− 2·4	0·0	− 2·4
,,	116	+ 2·6	− 0·8	− 0·5	− 1·2	+ 0·6	− 0·7	0·0
,,	12	0·0	+ 1·6	+ 1·0	+ 1·4	− 0·5	− 2·6	+ 0·9
12	56	+ 1·0	+ 3·1	− 1·2	+ 0·4	+ 0·1	+ 0·6	+ 4·0
,,	178	+ 0·1	+ 2·0	+ 1·4	+ 0·5	− 0·2	+ 1·6	+ 5·4
,,	300	+ 1·5	+ 0·9	+ 1·1	+ 0·1	− 0·3	− 0·2	+ 3·1
18	53	+ 1·1	+ 0·9	+ 1·4	+ 0·2	− 2·2	− 0·9	+ 0·5
,,	171	+ 1·6	+ 1·8	+ 2·2	+ 0·6	− 1·6	+ 1·1	+ 5·7
,,	299	+ 0·8	+ 1·6	+ 0·4	− 0·4	− 0·1	+ 2·6	+ 4·9
25	228	+ 1·4	+ 2·2	+ 0·9	− 0·5	− 1·4	− 0·9	+ 1·7
,,	322	+ 1·1	0·0	− 1·2	− 0·9	+ 0·5	+ 0·8	+ 0·3
,,	100	+ 0·6	+ 0·9	+ 0·1	− 0·6	+ 2·2	+ 0·2	+ 3·4
February ... 1	125	+ 0·4	+ 1·0	+ 1·6	− 1·8	− 0·3	0·0	+ 0·9
,,	225	+ 1·0	+ 0·6	− 0·3	− 1·5	+ 1·6	+ 0·1	+ 1·5
,,	348	+ 1·8	+ 0·2	+ 0·7	+ 0·4	+ 2·5	+ 1·0	+ 6·6
8	99	− 0·7	+ 0·4	+ 1·0	+ 1·8	− 1·6	0·0	+ 0·9
,,	220	+ 0·3	+ 0·9	+ 0·6	− 1·3	+ 1·1	+ 0·8	+ 2·4
,,	338	− 0·8	+ 3·1	0·0	− 0·2	− 2·0	− 1·0	− 0·9
14	219	+ 2·1	+ 2·2	− 0·6	− 0·5	− 0·5	+ 0·4	+ 3·1
,,	108	+ 2·9	− 0·4	+ 2·2	+ 1·3	− 0·3	+ 2·0	+ 7·7
,,	327	+ 0·4	+ 0·6	− 1·9	+ 0·4	+ 0·5	0·0	0·0
21	32	+ 0·7	+ 0·5	+ 0·3	− 0·8	+ 0·2	− 0·5	+ 0·4
,,	150	+ 1·0	+ 0·4	+ 0. 2	− 0·3	+ 0·1	− 0·8	+ 0·6
,,	268	+ 0·2	0·0	+ 0·3	+ 1·6	+ 1·3	− 0·9	+ 2·5

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

Day, 1841.	Pointer Reading.	MICROSCOPES.						Sum.
		A	B	C	D	E	F	
	c	"	"	"	"	"	"	"
March...... 1	210	+ 3·0	− 1·0	+ 0·3	− 1·3	+ 1·3	0·0	+ 2·3
,,	329	+ 0·7	− 0·9	+ 1·6	− 2·0	0·0	+ 0·7	+ 0·1
,,	100	+ 0·6	+ 1·2	+ 0·3	− 0·8	− 1·3	+ 0·2	+ 0·2
8	18	+ 2·9	+ 1·5	+ 1·6	+ 0·2	+ 0·5	− 1·6	+ 5·1
,,	139	+ 1·8	+ 2·5	+ 1·9	+ 0·8	+ 0·4	+ 1·9	+ 9·3
,,	253	+ 1·9	+ 0·9	+ 3·3	0·0	+ 1·8	+ 2·1	+10·0
14	89	+ 2·4	+ 0·3	0·0	+ 1·9	+ 1·0	− 0·4	+ 5·2
,,	232	+ 1·4	− 0·2	+ 1·2	+ 1·0	+ 0·8	+ 0·3	+ 4·5
,,	356	+ 0·4	+ 1·4	+ 0·4	+ 0·9	− 1·0	+ 1·4	+ 3·5
22	50	+ 1·0	+ 3·4	+ 2·6	− 1·4	+ 1·1	+ 0·3	+ 7·0
,,	126	+ 2·1	+ 3·2	+ 1·8	− 2·5	− 1·2	+ 3·4	+ 6·8
,,	299	+ 1·2	− 0·4	− 0·6	− 0·4	+ 0·9	+ 2·7	+ 3·4
29	86	+ 0·9	− 1·2	+ 1·4	− 0·8	+ 0·2	+ 1·5	+ 2·0
,,	201	+ 1·5	+ 1·7	− 0·3	− 0·1	− 0·6	0·0	+ 2·2
,,	347	+ 2·8	+ 1·7	0·0	+ 0·2	+ 0·4	+ 1·4	+ 6·5
April....... 5	4	+ 2·1	− 0·8	+ 0·2	− 0·6	0·0	+ 1·5	+ 2·4
,,	126	− 1·1	+ 3·4	− 0·5	− 1·4	0·0	+ 2·2	+ 2·6
,,	250	+ 1·0	+ 0·5	+ 1·1	− 1·7	+ 1·6	+ 2·0	+ 4·5
12	217	+ 1·0	− 1·8	+ 0·6	− 0·1	− 0·5	+ 0·4	− 0·4
,,	330	+ 0·6	+ 1·2	+ 0·8	− 0·6	+ 1·5	− 0·5	+ 3·0
,,	95	+ 1·2	+ 0·5	0·0	+ 0·1	− 1·5	+ 0·3	+ 0·6
19	220	+ 2·2	+ 2·4	+ 1·8	− 1·1	+ 0·6	+ 1·2	+ 7·1
,,	335	− 0·6	+ 1·5	+ 1·5	− 0·8	+ 0·4	+ 0·8	+ 2·8
,,	105	+ 1·6	+ 0·6	+ 1·9	+ 0·3	− 0·5	− 1·0	+ 2·9
26	104	+ 1·7	+ 1·6	+ 1·2	+ 0·3	+ 2·1	+ 2·9	+ 9·8
,,	238	+ 1·9	+ 1·6	+ 2·6	+ 0·5	+ 1·9	0·0	+ 8·5
,,	351	− 1·3	+ 2·8	+ 1·9	0·0	+ 0·9	+ 0·5	+ 4·8
May........ 3	53	+ 1·4	+ 1·6	+ 0·9	− 1·9	+ 0·4	+ 0·4	+ 2·8
,,	177	− 0·3	+ 2·1	+ 0·8	+ 1·1	+ 2·4	+ 0·1	+ 6·2
,,	283	+ 1·4	+ 2·1	+ 0·5	0·0	+ 2·8	+ 1·8	+ 8·6
10	220	+ 1·3	+ 2·5	+ 3·0	− 1·0	− 2·2	+ 0·3	+ 3·9
,,	342	+ 1·6	+ 3·8	+ 2·2	− 1·0	+ 0·4	+ 1·1	+ 8·1
,,	95	+ 1·0	+ 0·1	+ 1·1	− 1·5	− 0·6	+ 0·9	+ 1·0
17	19	+ 0·3	+ 2·8	+ 1·6	− 1·4	+ 1·2	+ 0·6	+ 5·1
,,	135	+ 0·9	+ 1·9	+ 0·8	+ 0·2	0·0	− 1·2	+ 2·6
,,	261	− 0·7	+ 2·4	+ 0·9	− 0·6	− 0·3	− 1·4	+ 0·3

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

Day, 1841.	Pointer Reading.	MICROSCOPES. A	B	C	D	E	F	Sum.
	°	"	"	"	"	"	"	"
May....... 24	58	+ 3·0	+ 2·7	+ 2·4	− 0·5	+ 1·5	+ 2·2	+11·3
,,	175	+ 3·0	+ 2·1	+ 0·8	− 0·2	+ 0·5	+ 0·1	+ 6·3
,,	308	+ 3·6	+ 1·5	+ 1·9	− 1·8	+ 2·6	+ 2·6	+10·4
31	142	+ 1·1	− 1·6	+ 0·8	− 1·3	+ 0·2	+ 2·6	+ 1·8
,,	268	− 0·1	− 2·2	+ 0·6	+ 0·9	+ 0·1	+ 2·8	+ 2·1
,,	324	+ 1·2	+ 1·6	+ 1·0	+ 0·4	+ 1·1	− 0·4	+ 4·9
June 7	15	+ 2·2	+ 0·6	+ 1·5	− 0·4	+ 0·3	+ 1·1	+ 5·3
,,	148	+ 2·2	+ 0·8	+ 1·4	− 2·2	0·0	+ 1·5	+ 3·7
,,	271	+ 1·4	+ 2·7	+ 0·8	− 1·1	+ 1·2	+ 0·1	+ 5·1
14	165	+ 1·9	+ 0·2	+ 1·1	− 0·2	+ 1·2	+ 1·1	+ 5·3
,,	286	+ 0·3	− 0. 2	+ 1·1	− 0·6	+ 1·7	+ 0·6	+ 2·9
,,	44	+ 2·4	+ 1·9	+ 1·9	+ 1·1	− 1·7	+ 0·8	+ 6·4
21	229	+ 0·4	− 0·2	+ 2·1	+ 0·4	+ 0·4	+ 1·1	+ 4·2
,,	356	+ 3·9	+ 2·7	+ 1·2	− 0·8	+ 0·6	− 0·6	+ 7·0
,,	116	+ 2·4	+ 0·6	+ 1·4	0·0	+ 1·4	+ 0·2	+ 6·0
28	190	+ 2·2	+ 1·8	+ 1·4	+ 1·0	− 0·6	+ 2·0	+ 7·8
,,	312	+ 4·0	+ 2·4	+ 0·7	− 2·1	+ 3·2	+ 1·1	+ 9·3
,,	69	+ 2·9	+ 2·6	+ 0·5	− 0·3	+ 0·8	+ 3·2	+ 9·7
July........ 5	85	+ 2·0	+ 1·6	+ 0·8	− 0·6	+ 0·9	+ 1·0	+ 5·7
,,	200	+ 1·8	+ 0·9	+ 2·5	− 1·7	+ 2·2	+ 1·1	+ 6·8
,,	326	+ 1·6	+ 2·2	+ 2·8	− 0·9	+ 2·6	+ 1·4	+ 9·7
12	82	+ 2·5	+ 1·7	+ 2·8	− 1·3	− 0·1	− 0·2	+ 5·4
,,	200	+ 1·3	+ 1·3	+ 2·6	− 1·2	+ 2·7	+ 0·5	+ 7·2
,,	322	+ 2·0	+ 2·4	+ 0·6	− 0·8	+ 1·0	+ 1·0	+ 6·2
21	90	+ 1·4	+ 1·8	+ 0·7	− 0·3	− 0·3	+ 0·5	+ 3·8
,,	208	+ 1·5	+ 1·0	+ 3·0	+ 1·1	+ 1·7	− 1·7	+ 6·6
,,	329	+ 2·0	+ 1·4	+ 3·2	− 2·0	+ 1·6	+ 2·0	+ 8·2
26	53	+ 1·4	+ 0·4	+ 1·8	− 0·4	+ 0·4	+ 1·6	+ 5·2
,,	175	+ 1·8	+ 2·2	+ 1·3	− 0·6	+ 1·2	+ 0·9	+ 6·8
,,	298	+ 2·9	+ 2·5	+ 1·8	− 0·1	+ 1·4	− 0·9	+ 7·6
August 2	64	+ 0·2	+ 2·2	+ 2·4	− 0·4	+ 1·2	+ 0·5	+ 6·1
,,	186	+ 4·9	+ 2·1	+ 0·6	− 1·7	+ 0·1	+ 1·1	+ 7·1
,,	309	+ 1·9	+ 3·1	+ 0·8	0·0	+ 0·9	+ 0·2	+ 6·9
9	2	+ 0·8	+ 1·8	+ 3·7	− 0·6	+ 2·9	− 0·5	+ 8·1
,,	121	+ 3·6	+ 1·3	+ 3·2	− 2·3	+ 2·1	+ 0·8	+ 8·7
,,	250	+ 3·8	+ 0·9	+ 2·1	+ 1·2	+ 3·9	+ 1·4	+13·3

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

Day, 1841.	Pointer Reading.	MICROSCOPES.						Sum.
		A	B	C	D	E	F	
	°	″	″	″	″	″	″	″
August 16	155	+ 1·0	+ 0·5	+ 1·6	− 0·9	+ 1·9	+ 1·1	+ 5.2
,,	33	+ 2·6	+ 3·6	+ 2·2	− 1·1	+ 2·5	+ 1·3	+11·1
,,	272	+ 0·9	+ 2·5	+ 0·4	+ 0·2	+ 0·8	+ 1·1	+ 5·9
23	52	+ 1·2	− 0·3	+ 3·3	− 1·2	+ 1·7	+ 0·8	+ 5·5
,,	175	+ 3·4	+ 0·9	+ 0·6	− 0·3	0·0	+ 1·7	+ 6·3
,,	298	+ 2·4	+ 3·2	+ 1·7	− 1·8	+ 1·8	+ 0·7	+ 8·0
30	9	+ 1·5	+ 1·5	+ 2·6	+ 0·4	+ 1·8	+ 1·4	+ 9·2
,,	126	+ 2·1	+ 0·2	+ 2·0	− 0·6	+ 1.4	+ 3·6	+ 8·7
,,	231	+ 1·1	+ 2·5	+ 3·1	− 2·9	+ 1·9	+ 1·5	+ 7·2
September .. 6	78	+ 0·9	+ 0·9	+ 1·1	− 1·8	+ 1·3	+ 1·5	+ 3·9
,,	199	+ 3·7	+ 3·0	+ 0·2	− 1·2	+ 1·4	+ 0·7	+ 7·8
,,	311	+ 2·9	+ 1·9	+ 0·3	− 1·7	− 0·5	− 0·8	+ 2·1
13	21	+ 1·6	+ 1·2	+ 1·8	− 1·8	+ 0·1	+ 2·9	+ 5·8
,,	145	+ 2·3	+ 2·4	+ 2·7	− 0·7	+ 3·8	+ 0·9	+11·4
,,	263	+ 1·2	+ 3·1	+ 0·8	− 0·6	+ 1·1	+ 1·1	+ 6·7
21	58	+ 1·6	+ 2·5	+ 0·2	− 0·2	+ 0·7	+ 1·5	+ 6·3
,,	179	+ 2·4	+ 2·8	+ 1·2	+ 1·4	+ 2·4	− 0·8	+ 9·4
,,	301	+ 1·6	+ 2·1	+ 0·8	+ 0·2	+ 0·8	+ 0·2	+ 5·7
27	19	+ 2·4	+ 1·9	+ 1·6	− 1·6	+ 2·4	+ 0·9	+ 7·6
,,	148	+ 3·1	− 1·8	+ 2·6	− 2·4	− 0·6	+ 1·4	+ 2·3
,,	275	+ 1·4	− 0·2	+ 1·8	0·0	+ 0·2	+ 0·7	+ 3·9
October..... 4	90	+ 3·1	+ 1·8	+ 0·7	+ 0·5	+ 0·2	+ 1·0	+ 7·3
,,	211	+ 1·3	+ 1·8	+ 0·4	− 1·4	+ 3·5	− 0·2	+ 5·4
,,	333	+ 2·6	+ 0·4	+ 1·6	− 0·9	+ 0·8	− 0·6	+ 3·9
11	15	+ 1·4	+ 1·8	+ 2·2	− 1·5	+ 1·2	+ 1·7	+ 6·8
,,	135	+ 3·0	+ 2·8	+ 1·4	− 0·1	+ 1·4	+ 0·1	+ 8·6
,,	260	+ 1·7	+ 1·8	+ 1·3	0·0	+ 2·7	− 0·6	+ 6·9
18	55	+ 1·1	+ 1·3	+ 2·2	− 2·1	+ 0·3	+ 1·7	+ 4·5
,,	178	+ 2·4	+ 0·6	+ 1·6	− 2·5	+ 0·5	− 1·2	+ 1·4
,,	300	+ 2·2	0·0	+ 2·6	− 2·9	+ 0·5	− 0·2	+ 2·2
25	77	− 1·1	+ 1·4	+ 0·1	+ 0·7	+ 2·2	+ 1·8	+ 5·1
,,	196	+ 1·6	+ 2·2	− 0·4	+ 0·8	− 1·0	+ 0·5	+ 3·7
,,	315	+ 1·4	+ 0·1	+ 0·2	+ 0·1	+ 0·8	− 0·5	+ 2·1
November .. 1	22	+ 0·8	+ 2·6	+ 0·4	− 0·4	+ 1·4	+ 0·4	+ 5·2
,,	127	+ 0·4	+ 1·2	− 0·2	− 1·8	+ 1·6	− 0·1	+ 1·1
,,	250	+ 1·2	− 0·2	+ 0·4	− 1·6	+ 0·3	+ 1·1	+ 1·2

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

Day, 1841.	Pointer Reading.	MICROSCOPES. A	B	C	D	E	F	Sum.
	°	"	"	"	"	"	"	"
November... 8	148	+ 0·6	+ 1·3	+ 1·6	− 0·1	+ 1·1	− 1·2	+ 3·3
,,	266	+ 0·6	+ 1·1	+ 0·7	− 0·4	+ 1·6	+ 1·7	+ 5·3
,,	24	− 0·4	+ 1·9	+ 0·8	− 0·5	+ 1·2	− 0·8	+ 2·2
16	16	+ 0·3	− 0·2	− 0·1	+ 0·5	0·0	+ 2·0	+ 2·5
,,	130	0·0	+ 0·8	− 0·8	+ 0·6	− 0·9	0·0	− 0·3
,,	245	+ 0·4	+ 1·6	− 0·8	+ 2·0	+ 1·5	+ 2·0	+ 6·7
23	103	+ 2·5	− 0·4	+ 0·7	− 0·8	+ 0·7	− 0·7	+ 2·0
,,	224	+ 0·8	+ 1·5	+ 0·4	+ 0·3	+ 0·6	− 0·2	+ 3·4
,,	345	− 0·2	+ 1·1	+ 0·6	− 1·4	+ 2·4	+ 0·3	+ 2·8
29	83	+ 3·4	+ 0·9	+ 0·5	+ 0·1	+ 1·9	+ 1·8	+ 8·6
,,	202	+ 3·4	+ 2·5	+ 1·7	+ 0·2	+ 0·3	− 0·8	+ 7·3
,,	323	+ 1·7	+ 1·3	+ 1·8	+ 0·1	+ 3·2	+ 0·9	+ 9·0
December... 7	171	+ 0·1	− 1·1	+ 2·1	− 0·4	+ 1·2	+ 0·3	+ 2·2
,,	298	+ 2·3	+ 0·8	+ 1·1	− 1·3	+ 2·5	− 1·2	+ 4·2
,,	43	+ 1·4	+ 1·4	+ 2·9	− 0·8	+ 0·6	+ 0·9	+ 6·4
14	15	+ 1·3	+ 0·8	+ 1·7	− 1·1	− 0·5	+ 1·4	+ 3·6
,,	143	+ 3·6	0·0	− 0·6	− 1·7	+ 1·6	+ 2·6	+ 5·5
,,	269	+ 1·1	+ 1·8	+ 1·8	− 0·8	+ 2·1	+ 2·1	+ 8·1
21	3	+ 2·6	+ 0·3	+ 0·3	− 0. 8	− 1·6	+ 0·3	+ 1·1
,,	123	+ 0·2	+ 2·6	+ 0·7	− 0·1	+ 2·1	+ 1·2	+ 6·7
,,	243	+ 1·1	+ 2·3	+ 1·3	− 1·2	+ 1·1	+ 0·7	+ 5·3
29	14	+ 0·2	+ 0·4	+ 2·1	− 1·2	+ 0·6	+ 2·4	+ 4·5
,,	135	+ 0·9	+ 0·1	+ 3·3	− 1·6	+ 0·8	+ 1·7	+ 5·2
,,	257	+ 1·4	+ 0·6	− 0·8	− 1·1	+ 0·2	+ 1·9	+ 2·2

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 an object is observed by reflexion and directly at the same transit (the circle being clamped and the microscopes read before the object is seen by reflexion; and the observation, when it enters the field, being made with the micrometer-wire), or 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 at least once every week: this reading is given at the bottom of the page. The wires being not perfectly parallel, it is thought desirable to ascertain the coincidence-reading at each of the points where the horizontal wire is intersected by the five vertical wires. It does not appear necessary to give any further details of the observations for the coincidences.

The *thirteenth* column contains the value, in minutes and seconds, of the arc measured with the micrometer. The value of one revolution which is used throughout the year is 53″·24, and the details of the observations from which this value is determined are fully given in the Introduction to the Observations for 1840.

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

The *fifteenth* column contains the correction to be applied to the circle-reading in consequence of the object not having been observed when passing the middle wire. It consists of two parts, one due to the body's change of N. P. D. (if it be the Sun, the Moon, a planet, or a comet), the other due to the difference between the small circle described by the body and the great circle of which the horizontal wire forms a part. Of the former of these no explanation is required, except that for the Moon the change is computed by the formula, change of declination for 1 hour of terrestrial longitude (from the section of Moon-culminating Stars in the Nautical Almanac) × sec. declination × n°. (log. = 7·745) × number of intervals of wires. The latter is calculated by this formula: tan. declination × n°. (log. = 9·350) × (number of intervals of wires)². (A table has been formed of the values of this latter correction for convenient intervals of N. P. D., and the correction itself for one or for two intervals can always be taken out at sight.) The two numbers are combined together to form the number in the *fifteenth* column.

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

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

The *second* column contains the sums of the circle-readings when the same object has been observed by reflexion and directly at the same transit. These are necessary for the determination of the Zenith Point, or the circle-reading corresponding to a vertical position of the telescope. The observations being divided into groups (seldom exceeding four days), and each of these groups being subdivided into two parcels, one containing the stars which passed north of the zenith, and the other containing the stars which passed south of the zenith: the mean value of D + R for each parcel is ascertained: the mean between the two values of D + R for the two parcels is found, and is considered to be the value of D + R applicable to the whole group: this quantity is increased or diminished by 180° and divided by 2, and the result is adopted as the Zenith Point. It will be seen from this description, that the result as to the Zenith Distance of the objects comprehended in one group is entirely independent of the operations of any kind in any other group. It will also be seen that the system of taking the means of the results from the north parcel and the south parcel, without respect to the number of stars in each parcel, supposing the zenith distance of the stars to be not very unequal, entirely eliminates the effect of any drop of the eye-end or object-end, or of any other cause which acts symmetrically on both sides of the zenith to increase or to diminish the telescope's angle with the vertical. In the daily observations however of 1841, care has also been taken to balance the number of stars observed by reflexion on the north side and on the south side.

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

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

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

When both limbs of the Moon are observed, it usually happens that one of them is slightly defective, from the failure of illumination by the Sun. The necessary correction (which is not applied in this column, but which must be applied with others in order to form the numbers in the column of *Geocentric N.P.D. of center*) is ascertained in the following manner. If the Moon is horned, her apparent place, on a common celestial globe, is brought to the zenith, and, a quadrant of altitude being made to pass over the Sun's place, its deviation from the East or West point is noted. If the Moon is gibbous, her place is brought to the intersection of the meridian and horizon, and the Sun's elevation above or depression below the horizon is noted. The correction to be applied is, the Moon's semidiameter × versine of angle noted: if the Sun's place is nearer the north pole than the E. or W. point in one case, or than the horizon of the globe in the other case, the correction is + for the south limb: if the contrary, it is − for the north limb. The values of the angle corresponding to the instances which occur in 1841 are given in the notes.

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

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

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

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

The *ninth* column contains the parallax. This is computed on the supposition that the earth's ellipticity is $\frac{1}{300}$. For the planets the formula is, log. parallax = log. sin. (zen. dist. − 11′. 12″) + ar. co. log. distance + 0·9325. For the Moon, the horizontal equatoreal parallax, as interpolated with second differences from the Nautical Almanac, is affected with a number from the following table: which is peculiar to the Moon's limb: and of which the details of computation are given in the Cambridge Observations, vol. iv. for 1831.

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

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

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

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

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

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

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

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

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

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

The *fourteenth* column contains the corrections which are to be applied to the apparent N. P. D. of the stars in order to obtain the mean N.P.D. 1841, Jan. 1. For the stars in the list of the Nautical Almanac, the correction is found by subtracting the mean declination of the Nautical Almanac from the apparent declination of the same. For stars in the Astronomical Society's Catalogue, the correction is computed by the formula $A\,a' + B\,b' + C\,c' + D\,d'$. For other stars the correction is computed by the formula A. sin. N. P. D. × (n°. log. = 9·6375) − A. sin. R. A. cos. N. P. D. + B. cos. R. A. cos. N.P.D. + C. cos. R. A. × n°. (log. = 1·3020) − D. sin. R. A.

§ 4. *Mean North Polar Distances of Stars deduced from each day's observations*, page (152) to (173).

The mean north polar distances are found by applying to the North Polar Distances in section 3, the corrections opposite to them in that section.

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

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

EXCESS OF REFLEXION-RESULTS ABOVE DIRECT-RESULTS, WITH TROUGHTON's CIRCLE, 1841.

Name of Star.	N. P. D.	Sec. of R.	Sec. of D.	R — D	No. of Obs. D	No. of Obs. R
	° ′	″	″	″		
33 Cygni S. P......	—33. 55	0 ·96	1 ·74	+ 0 ·78	4	2
ζ Cephei S.P.......	—32. 35	53 ·15	52 ·39	— 0 ·76	1	1
δ² Cephei S.P.......	—32. 24	50 ·97	51 ·62	+ 0 ·65	2	1
ο Draconis S.P.....	—30. 48	17 ·89	17 ·49	— 0 ·40	3	1
ν Cephei S.P........	—29. 37	41 ·80	40 ·95	— 0 ·85	2	1
η Cephei S.P.......	—28. 47	38 ·50	38 ·25	— 0 ·25	2	1
η Draconis S.P.....	—28. 7	30 ·91	30 ·38	— 0 ·53	1	1
β Ursæ Minoris S.P.	—15. 12	43 ·47	40 ·07	— 3 ·40	4	1
γ Cephei S.P.......	—13. 15	20 ·23	17 ·88	— 2 ·35	6	2
ζ Ursæ Minoris S.P.	—11. 43	11 ·66	11 ·52	— 0 ·14	1	1
ε Ursæ Minoris S.P.	— 7. 43	42 ·60	42 ·89	+ 0 ·29	2	2
Cephei 51 (Hev.) S.P.	— 2. 44	19 ·14	18 ·37	— 0 ·77	4	3
Polaris S.P........	— 1. 32	18 ·82	18 ·90	+ 0 ·08	9	9
λ Ursæ Minoris S.P.	— 1. 10	5 ·98	5 ·14	— 0 ·84	6	2
Polaris............	1. 32	17 ·10	18 ·03	— 0 ·93	13	13
Cephei 51 (Hev.)....	2. 44	15 ·44	15 ·68	— 0 ·24	1	1
δ Ursæ Minoris	3. 24	27 ·61	27 ·06	+ 0 ·55	4	5
ε Ursæ Minoris	7. 43	41 ·87	41 ·16	+ 0 ·71	5	3
Groombridge 1480 ..	8. 33	46 ·63	47 ·03	— 0 ·40	4	3
Piazzi VI. 334......	8. 48	60 ·42	59 ·72	+ 0 ·70	3	3
Groombridge 1463...	9. 23	20 ·35	21 ·53	— 1 ·18	2	1
Groombridge 1562 ..	10. 9	29 ·82	31 ·60	— 1 ·78	1	1
ζ Ursæ Minoris.....	11. 43	9 ·99	9 ·95	+ 0 ·04	2	2
Groombridge 1151 ..	11. 54	43 ·86	43 ·34	+ 0 ·52	2	2
γ Cephei	13. 15	16 ·60	16 ·46	+ 0 ·14	8	7
5 Ursæ Minoris.....	13. 36	48 ·92	48 ·83	+ 0 ·09	1	1
Groombridge 784....	14. 18	52 ·70	54 ·14	— 1 ·44	2	2
Groombridge 283....	14. 36	47 ·62	50 ·16	— 2 ·54	4	3
β Ursæ Minoris.....	15. 12	40 ·71	39 ·68	+ 1 ·03	14	13
Groombridge 1374 ..	15. 40	7 ·25	10 ·02	— 2 ·77	1	1
27 Ursæ Majoris....	17. 2	50 ·51	49 ·67	+ 0 ·84	1	1
40 Cassiopeiæ.......	17. 46	28 ·56	25 ·96	+ 2 ·60	1	1
d Ursæ Majoris.....	19. 29	35 ·01	36 ·29	— 1 ·28	1	1
λ Draconis	19. 48	31 ·13	32 ·09	— 0 ·96	2	2
θ Cephei...........	20. 8	9 ·67	9 ·96	— 0 ·29	6	6
σ Draconis.........	20. 37	31 ·90	31 ·75	+ 0 ·15	5	5
43 Camelopardali....	20. 56	17 ·79	18 ·77	— 0 ·98	3	3
55 Camelopardali....	21. 4	2 ·41	2 ·23	+ 0 ·18	4	3
σ² Ursæ Majoris.....	22. 14	38 ·20	35 ·46	+ 2 ·74	2	1
ρ Draconis..........	22. 35	45 ·82	45 ·94	— 0 ·12	11	11
δ Draconis	22. 37	3 ·42	3 ·52	— 0 ·10	2	2
A. S. C. 247........	23. 19	2 ·76	2 ·81	— 0 ·05	2	2
ζ Draconis	24. 5	19 ·37	20 ·17	— 0 ·80	3	3
55 Cassiopeiæ.......	24. 14	31 ·74	31 ·67	+ 0 ·07	2	2
36 Camelopardali....	24. 15	23 ·43	27 ·14	— 3 ·71	1	1
α Draconis.........	24. 52	44 ·52	44 ·73	— 0 ·21	7	7
π Ursæ Majoris	25. 7	7 ·09	6 ·82	+ 0 ·27	1	1
36 Draconis........	25. 39	20 ·47	21 ·02	— 0 ·55	2	2
ε Cassiopeiæ........	27. 7	59 ·14	59 ·18	— 0 ·04	4	3

EXCESS OF REFLEXION-RESULTS ABOVE DIRECT-RESULTS, WITH TROUGHTON's CIRCLE, 1841—*continued.*

Name of Star.	N. P. D.	Sec. of R.	Sec. of D.	R—D	No. of Obs. D	R
	° ′	″	″	″		
α Ursæ Majoris	27. 24	31 ·29	31 ·70	— 0 ·41	11	10
θ Cephei	27. 32	19 ·23	19 ·19	+ 0 ·04	3	1
c Ursæ Majoris	27. 56	40 ·73	40 ·93	— 0 ·20	1	1
κ Cassiopeiæ	27. 57	46 ·79	47 ·37	— 0 ·58	4	4
α Cephei	28. 5	10 ·53	10 ·19	+ 0 ·34	13	13
η Draconis	28. 7	26 ·95	27 ·46	— 0 ·51	8	8
4 Cassiopeiæ	28. 35	21 ·32	21 ·29	+ 0 ·03	9	9
o Ursæ Majoris	28. 45	26 ·24	27 ·68	— 1 ·44	3	3
η Cephei	28. 47	37 ·17	37 ·67	— 0 ·50	3	2
Groombridge 2332	29. 51	27 ·39	26 ·67	+ 0 ·72	2	1
18 Lyncis	30. 5	19 ·51	16 ·54	+ 2 ·97	1	1
γ Cassiopeiæ	30. 9	42 ·58	44 ·54	— 1 ·96	1	1
υ Ursæ Majoris	30. 13	3 ·54	2 ·89	+ 0 ·65	1	1
ι Draconis	30. 28	28 ·89	29 ·04	— 0 ·15	4	4
δ Cassiopeiæ	30. 36	36 ·10	37 ·73	— 1 ·63	3	2
A. S. C. 371	30. 37	14 ·19	14 ·38	— 0 ·19	4	5
o Draconis	30. 48	16 ·17	15 ·76	+ 0 ·41	3	3
24 Lyncis	30. 56	33 ·71	32 ·40	+ 1 ·31	1	1
θ Draconis	31. 1	28 ·43	30 ·90	— 2 ·47	2	2
b Draconis	31. 17	22 ·66	21 ·98	+ 0 ·68	7	7
β Cassiopeiæ	31. 44	37 ·64	38 ·46	— 0 ·82	4	4
δ Ursæ Majoris	32. 5	59 ·95	59 ·71	+ 0 ·24	8	8
τ Cassiopeiæ	32. 14	59 ·39	59 ·14	+ 0 ·25	2	2
A. S. C. 2807	32. 20	36 ·76	36 ·53	+ 0 ·23	5	4
48 Draconis	32. 24	37 ·38	38 ·23	— 0 ·85	4	3
β Ursæ Majoris	32. 46	59 ·90	60 ·53	— 0 ·63	5	5
Piazzi VII. 311	33. 5	42 ·38	42 ·50	— 0 ·12	3	2
ξ Draconis	33. 6	59 ·31	60 ·34	— 1 ·03	3	3
ε Ursæ Minoris	33. 11	32 ·41	32 ·44	— 0 ·03	3	4
Bradley 328	33. 21	36 ·92	36 ·79	+ 0 ·13	2	2
ε Cephei	33. 45	50 ·40	50 ·29	+ 0 ·11	4	3
ζ^1 Ursæ Majoris	34. 15	33 ·23	32 ·59	+ 0 ·64	4	3
ζ^2 Ursæ Majoris	34. 15	44 ·46	44 ·70	— 0 ·24	2	2
α Cassiopeiæ	34. 20	7 ·09	8 ·49	— 1 ·40	9	10
Piazzi XXI. 336	34. 32	5 ·65	6 ·08	— 0 ·43	4	1
ν^1 Draconis	34. 42	15 ·61	15 ·92	— 0 ·31	1	1
η Persei	34. 46	9 ·50	9 ·90	— 0 ·40	2	2
i Persei	34. 53	11 ·23	9 ·96	+ 1 ·27	1	1
μ Draconis	35. 19	3 ·99	3 ·71	+ 0 ·28	2	2
e Ursæ Majoris	35. 20	35 ·68	35 ·00	+ 0 ·68	4	3
γ Ursæ Majoris	35. 25	15 ·81	14 ·80	+ 1 ·01	10	10
Groombridge 2822	35. 55	3 ·49	2 ·67	+ 0 ·82	1	1
46 Aurigæ	40. 38	22 ·17	24 ·21	— 2 ·04	1	1
7 Andromedæ	41. 28	39 ·97	40 ·02	— 0 ·05	7	6
8 Andromedæ	41. 51	8 ·09	9 ·38	— 1 ·29	4	3
μ Persei	42. 0	5 ·75	5 ·17	+ 0 ·58	2	2
δ Persei	42. 44	36 ·33	38 ·62	— 2 ·29	3	3
φ Andromedæ	43. 36	27 ·68	27 ·40	+ 0 ·28	3	2
41 Lyncis	43. 42	21 ·41	20 ·52	+ 0 ·89	2	2

EXCESS OF REFLEXION-RESULTS ABOVE DIRECT-RESULTS, WITH TROUGHTON's CIRCLE, 1841—*continued.*

Name of Star.	N. P. D.	Sec. of R.	Sec. of D.	R–D	No. of Obs. D	No. of Obs. R
	° ′	″	″	″		
ι Herculis..........	43. 54	20·53	21·31	– 0·78	8	7
Capella............	44. 10	17·61	18·41	– 0·80	6	7
2 Lacertæ..........	44. 16	42·48	44·08	– 1·60	1	1
δ Cygni............	45. 15	13·80	14·70	– 0·90	3	3
α Cygni............	45. 17	5·21	5·08	+ 0·13	12	11
55 Aurigæ	45. 20	49·80	49·39	+ 0·41	1	1
57 Cygni...........	46. 13	44·10	42·20	+ 1·90	2	2
λ Ursæ Majoris	46. 18	39·03	38·63	+ 0·40	2	2
31 Lyncis..........	46. 18	28·58	29·59	– 1·01	2	1
Groombridge 57	46. 37	59·93	61·70	– 1·77	2	1
ξ Cygni............	46. 42	12·57	12·77	– 0·20	2	2
6 Lacertæ..........	47. 41	22·99	23·37	– 0·38	1	1
γ Andromedæ	48. 26	10·92	11·01	– 0·09	4	3
Groombridge 4199 ..	48. 31	5·70	4·10	+ 1·60	3	1
ο Andromedæ.......	48. 32	36·86	37·51	– 0·65	5	5
64 Aurigæ	48. 50	28·48	27·96	+ 0·52	1	1
β Bootis...........	48. 59	44·09	45·15	– 1·06	1	1
Groombridge 2538 ..	49. 8	16·02	14·44	+ 1·58	2	1
50 Andromedæ	49. 24	33·15	30·84	+ 2·31	1	1
ν Cygni............	49. 27	30·46	31·61	– 1·15	2	2
39 Andromedæ	49. 31	40·63	39·12	+ 1·51	3	2
β Persei...........	49. 40	42·23	41·92	+ 0·31	3	3
ν Andromedæ.......	49. 47	16·61	17·11	– 0·50	3	2
Groombridge 2950 ..	49. 48	5·85	3·56	+ 2·29	1	1
γ Cygni............	50. 15	57·17	56·14	+ 1·03	1	1
ε Persei...........	50. 27	22·87	19·68	+ 3·19	2	1
5 Lyræ (1st star)....	50. 33	60·71	57·41	+ 3·30	1	1
η Herculis	50. 46	16·79	17·09	– 0·30	4	2
12 Can. Venat. (2nd star)	50. 49	17·43	16·97	+ 0·46	6	3
α Lyræ	51. 22	37·55	37·69	– 0·14	33	32
μ Bootis...........	52. 4	42·80	41·54	+ 1·26	1	1
θ Lyræ	52. 9	43·82	44·63	– 0·81	1	1
β Andromedæ	55. 13	27·09	26·22	+ 0·87	3	2
β Trianguli.........	55. 46	4·65	5·10	– 0·45	3	3
θ Geminorum.......	55. 51	14·80	14·46	+ 0·34	4	2
Piazzi I. 56........	56. 36	31·35	31·93	– 0·58	3	1
β^1 Lyræ...........	56. 49	4·13	4·42	– 0·29	8	7
β^2 Lyræ...........	56. 50	43·79	44·43	– 0·64	1	2
ι Aurigæ...........	57. 6	33·50	33·61	– 0·11	2	1
Castor.............	57. 46	11·07	10·37	+ 0·70	6	3
ρ Geminorum	57. 54	23·63	20·94	+ 2·69	4	1
A Herculis.......	58. 38	49·02	47·35	+ 1·67	1	1
48 Aurigæ	59. 25	57·85	55·84	+ 2·01	3	2
15 Cancri..........	59. 52	23·13	20·18	+ 2·95	3	1
A. S. C. 871........	60. 24	10·82	9·87	+ 0·95	4	2
ζ Cygni............	60. 25	19·81	18·34	+ 1·47	4	3
κ Aurigæ...........	60. 27	1·86	0·45	+ 1·41	2	1
12 Trianguli........	61. 3	38·44	38·34	+ 0·10	4	2
α Trianguli........	61. 12	53·64	52·10	+ 1·54	2	1

EXCESS OF REFLEXION-RESULTS ABOVE DIRECT-RESULTS, WITH TROUGHTON'S CIRCLE, 1841—*continued.*

Name of Star.	N. P. D.	Sec. of R.	Sec. of D.	R — D	No. of Obs. D	No. of Obs. R
	° ′	″	″	″		
A. S. C. 359	61. 32	58·38	57·46	+ 0·92	5	2
β Tauri	61. 32	60·76	59·96	+ 0·80	4	2
Pollux	61. 36	44·00	44·35	— 0·35	6	3
6 Cancri	61. 46	55·84	55·31	+ 0·53	3	4
α Andromedæ	61. 47	14·52	14·57	— 0·05	5	2
ι Geminorum	61. 54	33·69	32·07	+ 1·62	3	1
ε Bootis	62. 15	6·74	7·18	— 0·44	13	5
15 Vulpeculæ	62. 41	54·68	53·96	+ 0·72	1	1
α Coronæ Borealis	62. 45	46·66	46·72	— 0·06	14	6
56 Arietis	63. 21	49·90	50·30	— 0·40	4	1
λ Herculis	63. 46	54·47	53·61	+ 0·86	3	3
139 Tauri	64. 4	21·58	20·32	+ 1·26	2	1
κ Tauri	65. 11	24·42	23·33	+ 1·09	5	1
k Tauri	65. 12	4·76	3·85	+ 0·91	3	1
64 Arietis	65. 51	37·66	38·22	— 0·56	2	1
7 Tauri	66. 4	27·29	26·76	+ 0·53	3	1
η Tauri	66. 24	29·54	30·25	— 0·71	8	2
82 Geminorum	66. 28	15·08	17·70	— 2·62	6	1
α Arietis	67. 18	32·74	32·27	+ 0·47	4	2
τ Tauri	67. 21	14·70	14·21	+ 0·49	2	1
μ Geminorum	67. 25	41·37	41·19	+ 0·18	2	2
υ^1 Tauri	67. 33	10·53	10·12	+ 0·41	3	1
δ Geminorum	67. 44	51·03	51·35	— 0·32	4	3
66 Arietis	67. 45	57·74	54·86	+ 2·88	5	1
35 Comæ Berenices	67. 53	20·98	21·42	— 0·44	1	1
A^1 Tauri	68. 21	27·89	29·77	— 1·88	2	2
δ Leonis	68. 36	21·57	21·45	+ 0·12	10	5
ν Arietis	68. 44	46·18	46·55	— 0 37	3	2
ζ^2 Geminorum	69. 12	9·26	8·13	+ 1·13	4	3
ε Arietis	69. 18	60·62	58·34	+ 2·28	3	2
γ Leonis	69. 21	24·31	23·56	+ 0·75	2	2
τ^1 Arietis	69. 26	50·21	49·24	+ 0·97	4	1
ζ Arietis	69. 33	57·45	56·98	+ 0·47	3	1
β Arietis	69. 58	19·76	17·54	+ 2·22	4	2
Arcturus	69. 59	12·78	12·44	+ 0·34	19	11
η Bootis	70. 48	8·48	9·19	— 0·71	9	2
θ Arietis	70. 50	16·11	14·60	+ 1·51	1	1
θ Cancri	71. 22	23·02	22·37	+ 0·65	4	1
γ Arietis (south star)	71. 29	18·43	18·08	+ 0·35	3	3
83 Cancri	71. 37	27·35	28·13	— 0·78	5	1
τ Bootis	71. 45	53·27	52·12	+ 1·15	1	1
δ^2 Tauri	72. 56	49·13	47·74	+ 1·39	4	1
27 Arietis	73. 0	11·26	8·06	+ 3·20	3	3
π Arietis	73. 12	3·30	1·57	+ 1·73	4	2
γ Geminorum	73. 28	15·10	15·17	— 0·07	3	2
Aldebaran	73. 49	57·59	57·75	— 0·16	5	2
68 Geminorum	73. 50	12·14	13·71	— 1·57	3	1
θ^1 Tauri	74. 24	48·61	46·75	+ 1·86	4	1
β Leonis	74. 32	20·56	22·18	— 1·62	3	1

EXCESS OF REFLECTION-RESULTS ABOVE DIRECT-RESULTS, WITH TROUGHTON'S CIRCLE, 1841—*concluded.*

Name of Star.	N. P. D.	Sec. of R.	Sec. of D.	R — D	No. of Obs. D	No. of Obs. R
	° ′	″	″	″		
48 Tauri	75. 0	11·22	8·72	+ 2·52	4	1
α Herculis	75. 25	24·59	23·44	+ 1·15	8	3
η Piscium	75. 29	33·13	32·33	+ 0·80	2	1
α Pegasi	75. 39	56·49	55·69	+ 0·80	8	4
29 Arietis	75. 40	24·61	21·99	+ 2·62	5	1
γ Pegasi	75. 42	1·61	1·58	+ 0·03	7	2
ζ Aquilæ	76. 22	5·12	5·04	+ 0·08	2	2
Regulus	77. 16	30·13	29·71	+ 0·42	9	2
α Ophiuchi	77. 19	9·00	7·90	+ 1·10	13	11
l Leonis	78. 37	53·36	54·27	— 0·91	3	2
ο Leonis	79. 23	14·11	15·17	— 1·06	3	2
γ Aquilæ	79. 46	9·75	10·60	— 0·85	7	3
ρ Leonis	79. 53	37·75	38·38	— 0·63	2	1
ζ Pegasi	80. 0	46·87	47·92	— 1·05	9	4
ε Pegasi	80. 51	2·95	2·74	+ 0·21	3	2
π Leonis	81. 12	43·80	44·08	— 0·28	5	3
α Aquilæ	81. 33	47·94	47·98	— 0·04	4	1
χ Leonis	81. 48	21·30	20·32	+ 0·98	5	2
48 Leonis	82. 14	46·72	45·93	+ 0·79	3	1
α Serpentis	83. 4	9·56	10·08	— 0·52	11	1
β Aquilæ	83. 59	7·41	7·61	— 0·20	9	5
Procyon	84. 22	19·66	21·12	— 1·46	7	1
β Virginis	85. 28	32·67	33·22	— 0·55	3	2
d Leonis	85. 32	49·08	48·14	+ 0·94	2	2
34 Sextantis	85. 35	16·92	16·51	+ 0·41	3	1
τ Leonis	86. 16	7·19	7·32	— 0·13	1	1
β Piscium	87. 2	5·33	4·52	+ 0·81	1	1
δ Aquilæ	87. 12	48·94	49·54	— 0·60	1	1
λ Ophiuchi	87. 40	44·56	46·20	— 1·64	3	2
η Virginis	89. 47	55·96	57·61	— 1·65	2	1
υ Leonis	89. 57	46·83	46·74	+ 0·09	2	1
3 Piscium	90. 40	58·48	58·78	— 0·30	1	1
ζ Aquarii (south star)	90. 50	53·27	53·82	— 0·65	2	1
α Aquarii	91. 5	21·45	22·62	— 1·17	8	1
e Leonis	92. 8	35·90	36·35	— 0·45	1	1
δ Ophiuchi	93. 17	45·90	46·84	— 0·94	3	1
θ Virginis	94. 41	16·62	18·61	— 1·99	8	1
β Aquarii	96. 16	59·57	61·37	— 1·80	7	1
α Hydræ	97. 58	21·34	21·51	— 0·17	5	1
q Virginis	98. 34	25·26	26·86	— 1·60	2	1
β Libræ	98. 48	28·42	30·39	— 1·97	2	2
g Virginis	99. 53	18·29	18·70	— 0·41	3	1
ε Aquarii	100. 4	23·23	23·29	— 0·06	3	2
η Ophiuchi	105. 31	16·92	17·01	— 0·09	3	1
Sirius	106. 30	12·47	9·88	+ 2·59	5	1
δ Capricorni	106. 51	43·16	43·57	— 0·41	3	1
η Capricorni	110. 29	45·03	44·50	+ 0·53	3	1
μ Sagittarii	111. 6	39·12	36·33	+ 2·79	8	2
β Cygni	112. 31	58·41	59·18	— 0·77	6	1
15 Argûs	113. 51	0·85	0·59	+ 0·26	4	1

As the number of stars observed is too great to allow the eye to see clearly any law which may be followed by these errors, I have grouped the stars, and have taken the mean of the values of R — D for each group, giving to each star a weight proportional to the smaller of the two numbers of observations. The following table exhibits the particulars of each group, and the result for R — D :—

EXCESS OF REFLEXION-RESULTS ABOVE DIRECT-RESULTS,
FROM GROUPS OF STARS, WITH TROUGHTON'S CIRCLE, 1841.

Extent of Group.	No. of Obs.	Mean N. P. D.	R — D
		° ′	″
33 Cygni S. P. to η Draconis S. P.	8	— 31. 16	— 0·07
β Ursæ Minoris S. P. to ε Ursæ Minoris S. P.	6	— 11. 29	— 1·28
Cephei 51 (Hev.) S. P. to δ Ursæ Minoris...	32	+ 0. 22	— 0·42
ε Ursæ Minoris to Groombridge 1374.......	42	+ 12. 43	+ 0·06
27 Ursæ Majoris to δ Draconis	36	+ 21. 6	— 0·05
A. S. C. 247 to η Draconis	58	+ 26. 48	— 0·29
4 Cassiopeiæ to b Draconis	41	+ 30. 2	— 0·12
β Cassiopeiæ to ε Cephei.................	39	+ 32. 36	— 0·22
ζ¹ Ursæ Majoris to Groombridge 2822......	35	+ 34. 52	— 0·04
46 Aurigæ to 55 Aurigæ	48	+ 43. 42	— 0·46
57 Cygni to θ Lyræ.....................	74	+ 50. 1	+ 0·12
β Andromedæ to κ Aurigæ...............	31	+ 57. 42	+ 0·61
12 Trianguli to 139 Tauri................	33	+ 62. 15	+ 0·27
11 Tauri to ν Arietis....................	27	+ 67. 29	— 0·08
ζ² Geminorum to τ Bootis................	31	+ 70. 10	+ 0·71
δ² Tauri to ζ Aquilæ.....................	27	+ 74. 37	+ 0·94
Regulus to 48 Leonis	34	+ 79. 12	+ 0·12
α Serpentis to λ Ophiuchi................	17	+ 85. 20	— 0·29
η Virginis to θ Virginis..................	8	+ 91. 33	— 0·88
β Aquarii to ε Aquarii...................	8	+ 98. 48	— 1·01
η Ophiuchi to 15 Argûs	8	+109. 44	+ 0·95

The values of R — D are so small, and the existence of any law among them so uncertain, that I have thought it best to adopt the circle-results without any correction for R — D.

The results from thirty-two circumpolar stars were then used for examination of the assumed co-latitude. The computations are contained in the subjoined table: of which no explanation appears necessary, except that the weight is approximately determined by multiplying $\frac{a\,b}{a+b}$ (where a is the number of observations above the pole, and b the number below) by the number 32 for the first star, 31 for the second star, 30 for the third, and so on.

CORREECTION OF ASSUMED LATITUDE.

Star's Name, Position, and Mode of Observation.	No. of Obs.	N. P. D. from each Group.	No. of Obs.	Concluded N. P. D. in each Position on assumed Latitude.	No. of Obs.	Algebraic Sum of Determinations.	Weight.	Product.
λ Ursæ Minoris ...... D.	2	° ′ ″ 1. 10. 1·00	2	″ 1·00	10	″ −4·35	51	″ −221·85
R.	..	.....						
S. P. .. D.	6	− 1. 10. 5·14	8	−5·35				
R.	2	5·98						
Polaris .... D.	13	1. 32. 18·03	26	17·57	44	−1·29	330	−425·70
R.	13	17·10						
S. P. .. D.	9	− 1. 32. 18·90	18	−18·86				
R.	9	18·82						
Cephei 51 (Hev.)..... D.	1	2. 44. 15·68	2	15·56	9	−3·14	47	−147·58
R.	1	15·44						
S. P. .. D.	4	− 2. 44. 18·37	7	−18·70				
R.	3	19·14						
ε Ursæ Minoris....... D.	5	7. 42. 41·16	8	41·43	12	−1·32	77	−101·64
R.	3	41·87						
S. P. .. D.	2	− 7. 42. 42·89	4	−42·75				
R.	2	42·60						
ζ Ursæ Minoris....... D.	2	11. 43. 9·95	4	9·97	6	−1·62	37	− 59·94
R.	2	9·99						
S. P. .. D.	1	−11. 43. 11·52	2	−11·59				
R.	1	11·66						
γ Cephei .... D.	8	13. 15. 16·46	15	16·53	23	−1·94	141	−273·54
R.	7	16·60						
S. P. .. D.	6	−13. 15. 17·88	8	−18·47				
R.	2	20·23						
β Ursæ Minoris ...... D.	14	15. 11. 39·68	27	40·18	32	−0·57	110	− 62·70
R.	13	40·71						
S. P. .. D.	4	−15. 11. 40·07	5	−40·75				
R.	1	43·47						
β Cephei .... D.	6	20. 8. 9·96	12	9·82	13	−2·03	23	− 46·69
R.	6	9·67						
S. P. .. D.	1	−20. 8. 11·85	1	−11·85				
R.	..	.....						

Star's Name, Position, and Mode of Observation.	No. of Obs.	N. P. D. from each Group.	No. of Obs.	Concluded N. P. D. in each Position on assumed Latitude.	No. of Obs.	Algebraic Sum of Determinations.	Weight.	Product.
A. S. C. 247 .... D.	2	23°. 19′. 2″·81	4	″ 2·79	5	″ +0·05	19	″ + 0·95
R.	2	2·76						
S. P. .. D.	1	−23. 19. 2·74	1	−2·74				
R.	..	.....						
α Draconis .... D.	7	24. 51. 44·73	14	44·63	15	−1·57	21	− 32·97
R.	7	44·52						
S. P. .. D.	1	−24. 51. 46·20	1	−46·20				
R.	..	.....						
α Ursæ Majoris ...... D.	11	27. 23. 31·70	21	31·50	22	−1·45	21	− 30·45
R.	10	31·29						
S. P. .. D.	1	−27. 23. 32·95	1	−32·95				
R.	..	.....						
α Cephei .... D.	13	28. 5. 10·19	26	10·36	28	−2·05	39	− 79·95
R.	13	10·53						
S. P. .. D.	2	−28. 5. 12·41	2	−12·41				
R.	..	.....						
η Draconis........... D.	8	28. 7. 27·46	16	27·21	18	−3·44	36	−123·84
R.	8	26·95						
S. P. .. D.	1	−28. 7. 30·38	2	−30·65				
R.	1	30·91						
η Cephei .... D.	3	28. 46. 37·67	5	37·47	8	−0·87	36	− 31·32
R.	2	37·17						
S. P. .. D.	2	−28. 46. 38·25	3	−38·34				
R.	1	38·53						
ι Draconis........... D.	4	30. 28. 29·04	8	28·97	10	−1·64	29	− 47·56
R.	4	28·89						
S. P. .. D.	2	−30. 28. 30·61	2	−30·61				
R.	..	.....						
δ Cassiopeiæ .... D.	3	30. 35. 37·73	5	37·08	6	−0·59	14	− 8·26
R.	2	36·10						
S. P. .. D.	1	−30. 35. 37·67	1	−37·67				
R.	..	.....						
A. S. C. 371 .... D.	4	30. 37. 14·38	9	14·27	10	−0·89	14	− 12·46
R.	5	14·19						
S. P. .. D.	1	−30. 37. 15·16	1	−15·16				
R.	..	.....						

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Star's Name, Position, and Mode of Observation.	No. of Obs.	N. P. D. from each Group.	No. of Obs.	Concluded N. P. D. in each Position on assumed Latitude.	No. of Obs.	Algebraic Sum of Determinations.	Weight.	Product.
		° ′ ″		″		″		″
ο Draconis .... D.	3	30. 48. 15·76	6	15·97	10	−1·62	36	−58·32
R.	3	16·17						
S. P. . . D.	3	−30. 48. 17·49	4	−17·59				
R.	1	17·89						
θ Draconis .... D.	2	31. 0. 30·90	4	29·67	5	−2·43	11	−26·73
R.	2	28·43						
S. P. . . D.	1	−31. 0. 32·10	1	−32·10				
R.	..	.....						
β Cassiopeiæ .... D.	4	31. 43. 38·46	8	38·05	10	−1·52	21	−31·92
R.	4	37·64						
S. P. . . D.	2	−31. 43. 39·57	2	−39·57				
R.	..	.....						
δ Ursæ Majoris ...... D.	8	32. 4. 59·71	16	59·83	19	−1·61	30	−48·30
R.	8	59·95						
S. P . . D.	3	−32. 4. 61·44	3	−61·44				
R.	..	.....						
τ Cassiopeiæ .... D.	2	32. 13. 59·14	4	59·27	5	+1·79	9	−16·11
R.	2	59·39						
S. P. . . D.	1	−32. 13. 57·48	1	−57·48				
R.	..	.....						
δ² Cephei .... D.	3	32. 23. 49·32	3	49·32	6	−2·08	15	−31·20
R.	..	.....						
S. P. . . D.	2	−32. 23. 51·62	3	−51·40				
R.	1	50·97						
β Ursæ Majoris ...... D.	5	32. 45. 60·53	10	60·22	13	−0·75	21	−15·75
R.	5	59·90						
S. P. . . D.	3	−32. 45. 60·97	3	−60·97				
R.	..	.....						
α Cassiopeiæ .... D.	9	34. 20. 8·49	19	7·75	20	−1·28	8	−10·24
R.	10	7·09						
S. P. . . D.	1	−34. 20. 9·03	1	− 9·03				
R.	..	.....						
Piazzi XXI. 336..... D.	4	34. 32. 6·08	5	5·99	7	−1·13	10	−11·30
R.	1	5·65						
S. P. . . D.	2	−34. 32. 7·12	2	− 7·12				
R.	..	.....						

Star's Name, Position, and Mode of Observation.	No. of Obs.	N. P. D. from each Group.	No. of Obs.	Concluded N. P. D. in each Position on assumed Latitude.	No. of Obs.	Algebraic Sum of Determinations.	Weight.	Product.
		° ′ ″		″		″		″
e Ursæ Majoris....... D.	4	35. 19. 35 ·00	7	35 ·29	8	−0 ·92	5	− 4 ·60
R.	3	35 ·68						
S. P. .. D.	1	−35. 19. 36 ·21	1	−36 ·21				
R.	..	.....						
γ Ursæ Majoris....... D.	10	35. 25. 14 ·80	20	15 ·31	24	−2 ·32	17	− 39 ·44
R.	10	15 ·81						
S. P. .. D.	4	−35. 25. 17 ·63	4	−17 ·63				
R.	..	.....						
Groombridge 3714.... D.	2	35. 41. 9 ·33	2	9 ·33	3	−1 ·80	3	− 5 ·40
R.	..	.....						
S. P. .. D.	1	−35. 41. 11 ·13	1	−11 ·13				
R.	..	.....						
Groombridge 3771.... D.	3	36. 59. 25 ·94	3	25 ·94	5	−0 ·79	4	− 3 ·16
R.	..	.....						
S. P. .. D.	2	−36. 59. 26 ·73	2	−26 ·73				
R.	..	.....						
θ Bootis............. D.	1	37. 24. 44 ·07	1	44 ·07	4	+0 ·81	2	+ 1 ·62
R.	..	.....						
S. P. .. D.	3	−37. 24. 43 ·26	3	−43 ·26				
R.	..	.....						
γ Draconis........... D.	6	38. 29. 23 ·32	6	23 ·32	7	−1 ·03	1	− 1 ·03
R.	..	.....						
S. P. .. D.	1	−38. 29. 24 ·35	1	−24 ·35				
R.	..	.....						

If z be the correction to be applied to the co-latitude, $2z$ + the algebraic sum of the determinations ought to = 0. Combining the whole with the weights above attached to them, $2z = +1''{\cdot}62$, or $z = +0''{\cdot}81$: and the true co-latitude is $38^\circ.31'.21''{\cdot}81$.

The correction used in the reduction of the Observations of 1841 is $0''{\cdot}80$, being very nearly the mean of all the yearly determinations from the year 1836.

§ 5. *Catalogue of the Mean Places of Stars observed in the Year* 1841, page 2 to 14.

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

The north polar distances in the catalogue are the means of the daily results affected with the correction $+ 0''\cdot 80$. The adopted seconds of N.P.D. are found by taking the mean of the groups of direct and reflexion-observations, giving to each a weight proportional to its number of observations. With regard to circumpolar stars, the following rules have been followed. For stars whose N.P.D. does not exceed 15°, the observations above and below the pole are considered equally good: from N.P.D. 15° to N.P.D. 36°, those below have the weight $\frac{2}{3}$ for each observation: from N.P.D. 36° to N.P.D. 41° those below have the weight $\frac{1}{2}$: beyond 41° N.P.D. the observations are not combined. The annual variations are taken from the Nautical Almanac, as far as its list extends: for other stars they are computed with the elements given in the Nautical Almanac, 1834, 2nd edition, page xiii.

§ 6. *Horizontal and Vertical Diameters, Right Ascensions, and North Polar Distances, of the Sun, Moon, and Planets; deduced from the Observations and compared with the Tables,* page 16 to 31.

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

The Sun's vertical diameter is found by subtracting the zenith-distance of the north limb corrected for refraction and parallax, from that of the south limb similarly corrected. The tabular diameter is found by doubling the semidiameter of the Nautical Almanac.

The excess of the latter above the former is set down as the Apparent Error of the Nautical Almanac, and the mean of all the values of this error is $-1''\cdot32$.

During the year 1841, no meridional observations were made of the transits of both limbs of the Moon at the oppositions, by which the error of the duration of her passage as given in the Nautical Almanac could be ascertained.

The Moon's vertical diameter is found in the same manner as the Sun's (the correction for defective illumination having been already applied, see page xxxii). The mean of the ten values of apparent errors is $-4''\cdot07$.

The vertical diameters of Mercury and Venus are found by doubling the semidiameters given in the section of *Observations made with Troughton's Mural Circle.* These diameters, therefore, are not imperfect diameters, as observed in the first instance. The vertical diameters of the other planets are merely the measures corresponding to the micrometer readings in the 10th column of the right-hand page of the same section, or are the doubles of the semidiameters in the 11th column. The duration of passages of the planet's diameters 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 of Transit of first point of Aries, diminished by 4^{m}.
3. $3^{m}. 47^{s}\cdot00$—hours of Sid. Time + solar equiv. for hours.
4. $10^{s}\cdot00$—minutes of Sid. Time + solar equiv. for minutes.
5. $3^{s}\cdot00$—seconds of Sid. Time + solar equiv. for seconds.

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

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

The Right Ascensions of the Sun are transcribed from those in the *Transits, &c.* with no alteration, except that, when necessary, the personal equation $\pm 0^{s}\cdot36$ is applied as mentioned in a former part of this Introduction; and that, when the first limb only has been observed, the correction $+ 0^{s}\cdot07$ has been applied; and when the second limb only has been observed, the correction $- 0^{s}\cdot07$. The North Polar Distances of the Sun are the means of those deduced from the two limbs, in the 12th column of the right-hand page in the section *Observations with the Mural Circle:* the correction + 0″·80 for alteration of latitude being applied, and the correction + 0″·66 when the N. limb only was observed, and − 0″·66 when the S. limb only was observed. The tabular places are taken from the Nautical Almanac.

The Right Ascensions of the Moon are taken from the *Transits, &c.* corrected, if necessary, for personal equation: the correction + 0ˢ·20 being applied when the first limb was observed, and − 0ˢ·20 when the second limb was observed. This is the same correction which was used in 1836, 1837, 1838, 1839, and 1840: it is fully supported by all the observations hitherto made, as appears from the following collection. The equatoreal observations for 1840 will be found in a subsequent part of this volume. With regard to these and the other equatoreal observations, it is to be noted that, on account of the greater unsteadiness of the instrument, and the smaller number of wires, one set of equatoreal observations is considered equivalent only to one transit observation.

Correction of Moon's Horizontal Diameter.

Year.	Tabular Error.	Number of Observations in Results.	Error × Number.	
	s		s	
1836	− 0·41	3	− 1·23	Transit observations.
1837	− 0·38	1	− 0·38	
1838	− 0·48	2	− 0·96	
1839	− 0·56	3	− 1·68	
1840	− 0·20	2	− 0·40	
1837	− 0·37	2	− 0·74	Equatoreal observations.
1838	− 0·31	2	− 0·62	
1839	− 0·33	4	− 1·32	
1840	− 0·33	3	− 0·99	
1841	− 0·40	1	− 0·40	
		23	− 8·72	
Mean Tabular Error = − 0·38				

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

The North Polar Distances are taken from those in the twelfth column on the right-hand page in the section of *Observations with the Mural Circle*, with the following alterations. The correction + 0″·80 for change of latitude is applied throughout, and the correction + 2″·54 when the N. limb only is observed, and − 2″·54 when the S. limb only is observed. This correction is deduced from the following collection of observations of the Moon's vertical diameter:—

Correction of Moon's Vertical Diameter.

Year.	Tabular Error.	Number of Observations.	Error × Number.
1836	− 6·23″	8	− 49·84″
1837	− 5·94	7	− 41·58
1838	− 5·51	11	− 60·61
1839	− 6·02	6	− 36·12
1840	− 3·56	10	− 35·60
1841	− 4·07	10	− 40·70
		52	− 264·45
	Mean Tabular Error = − 5·09		

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

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

$$-0^{s}{\cdot}05 - {\cdot}03 \times \text{tabular semidiameter in R.A.}$$

The corrections applied in consequence are as follows:—

January	7	to	Feb.	18	+ 0·07ˢ
March	9	to	27		+ 0·08
April	27	to	May	6	+ 0·11
May	23	to	27		− 0·11
May	30	to	June	4	− 0·10
June	13	to	17		− 0·09
July	8	to	14		− 0·08
August	1	to	Sep.	17	− 0·07
October	1	to	Dec.	30	− 0·06

For all the other planets, the Right Ascensions are extracted from the eleventh column on the right-hand page of *Transits observed, &c.*, with no alteration, except for personal equation when necessary: for all the planets, the North Polar Distances are taken from the twelfth column on the right-hand page of the *Observations with the Mural Circle*, with the addition of + 0″·80 for correction of co-latitude. The tabular places are taken entirely from the Nautical Almanac, excepting certain places of Vesta, Pallas, and Ceres, which Lieut. Stratford (Superintendant of the Nautical Almanac) obligingly computed, at my request, from the same elements as those used for the places of those planets in the Nautical Almanac. The following are the days for which the above-mentioned tabular places were furnished:—For Vesta, from September 5 to 16 and from November 24 to December 18; for Pallas, from October 6 to 25; and for Ceres, for September 7 and from November 12 to December 13.

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

For the *Errors in the Tabular Geocentric Places of the Sun and Planets*, the errors in R.A. are increased by 0ˢ·03, as it appears, from a comparison of the assumed R.A. 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, Pallas, and Ceres, whose latitude exceeded the limits of those tables, the longitude and E.P.D. were computed, 1st, from the R.A. and N.P.D. of the Nautical Almanac; 2nd, from these quantities affected with the errors in R.A. and N.P.D.; and the differences between these results gave the errors in longitude and E.P.D.

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

For the four small planets,

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

Then

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

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

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

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

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

For the other planets, the following are used:

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

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

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

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

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

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

It is to be remarked that in the column of *Extent of Group*, the day is given which answers to the day under which the observations may be found in the sections of *Transits as Observed* and *Observations with the Mural Circle*: but in the column of *Mean Day* the day is given whose noon is nearest to the time of observation, or to the mean of times of observation. This sometimes causes an appearance of discordance: thus for Mercury it will be found that a single observation of R.A. on April 26 is referred to April 27 as the nearest noon.

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 + $0^s{\cdot}03$, to reduce them to the same equinox as that adopted for the planets.

§ 7. *Observations of γ Draconis with the Zenith Tube, and Reduction of the Observations,* page 40 to 49.

For a description of the Zenith Tube, and an account of the steps which its construction renders necessary for the reduction of the observations, I beg to refer to the Introduction to the Observations for 1837, pages i and xlvi. It will be sufficient to state here, that the upper part and the lower part of the plumb-line are viewed by micrometer-microscopes, the observation with which detects and measures any inclination of the telescope to the vertical; and that the star while passing the field of view of the telescope is bisected by means of a wire in the field of view carried by the Grand Micrometer. The values of the several micrometer-screws have been found by a process detailed in the Introduction of 1837, and are as follows: Grand Micrometer, one revolution = $6''{\cdot}711$; upper plumb-line micrometer, one revolution = $4''{\cdot}168$; lower plumb-line micrometer, one revolution = $5''{\cdot}243$. The equivalents to the readings of the several micrometers are to be added together, and they will then give the star's apparent Zenith Distance (to be diminished by a certain constant or index-error, called $-c$ in the printed Observations, which depends upon nothing whatever but the instrumental connexion between the object-glass, the upper plumb-line microscope, the grand micrometer, and the lower plumb-line microscope). The Zenith Distance thus deduced is estimated positive towards the north when the eye-piece is west, or towards the south when the eye-piece is east.

The 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.

Then $z_w = s_w + c$

$z_e = -s_e - c$

Therefore $z_w - z_e = s_w + s_e + 2c$

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

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

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

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 equidistant 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.

I had hoped that the construction (which is fully described in the Introduction to the Observations for 1840, page liii), by which the rotation of the plumb-line following upon a rapid reversion of the instrument is effectually prevented, would have partly, if not altogether, done away with the startling irregularities which have occurred in the use of this instrument during all the preceding years since 1836. In this expectation, however, I was disappointed, as will be readily seen by an inspection of the results of the observations of γ Draconis for the present year. I was therefore induced to render the instrument capable of rapid and easy reversion, for the purpose of enabling the observer to make a complete observation in reversed positions at the same transit. The means for doing this were simple. Since the number of turns of the micrometer-screw necessary for re-bisecting the star in the reversed position (after the first bisection) could not be made in the time during which the star continues visible in the field, I inserted *two* additional wires (called V and V*) instead of the *one* formerly in use, and at a distance pretty nearly corresponding to twice the Zenith Distance of γ Draconis. A handle, placed at a convenient height, was also fixed to the tube, by which the observer can reverse the instrument rapidly, and with the least possible disturbance to the plumb-line. Also, since it is necessary that the observer should be as free as possible from every cause of distraction of the mind, arising from the trouble of throwing the light of the lamp on the micrometer (which it is necessary to read very rapidly after the first bisection), and from other trifling causes, brackets were attached to the tube to carry the lamps, which relieve him of all such care during the observation, and allow him to give his undivided attention to the bisection of the star. The process, then, of making the complete double observation, is as follows: — The observer, a few minutes previously, reads the upper and lower plumb-line micrometers and the thermometers, and, on the first appearance of the star, bisects it with one of the wires before mentioned, and which has been set near to it; he then reads the grand micrometer, and reverses the tube: he is finally enabled to re-bisect the star before it leaves the field, and he can at his leisure read the grand micrometer and the lower and the upper plumb-line micrometers for the reversed position.

By bringing the two wires above mentioned successively to bisect the cross nearest to them, it was found very accurately that their distance was equal to $32^{r}\cdot027$ of the grand micrometer. (It is proper to mention here that since, when the face of the tube is turned west, the star enters at the top of the field, or at that part which is free from the comb of the micrometer: and, on reversion, it is going out of the field towards the same part: it has been the invariable practice to make the first observation with the face of the instrument turned west.) Thence it will be immediately seen that the correction to be applied to the reading of the wire V*, to reduce it to the reading for wire V, is equal to $+\ 0^{r}\cdot027$ or to $+\ 0''\cdot181$; and this correction, as is specified in the foot note to the Observations, has been applied in forming the star's Apparent Zen. Dist. face west, for the observations made with wire V* during the year 1841. A series of single observations were made for determining the correction which should be applied to the second observation (in the reversed position) on account of the want of verticality of the wires; but the observations were not sufficiently consistent to deduce from them any correction which could be safely applied. The mean of the two readings in each case of this kind has been used in reducing the observations.

I am happy to be able to state, that the results of the observations made with this instrument in the year 1842 (which have been reduced), give good reason for supposing that this last modification of the instrument (by which a complete and independent observation can be made at each passage of the star) has been successful. Whatever irregularities occur in the observations are now mainly due, as is evident on inspecting them, to the bad bisections of the star, for which the generally distorted and fluttering image given by this telescope furnishes sufficient reason.

Before definitively adopting this arrangement, it was thought desirable to ascertain whether the plumb-line was liable to derangement from the rapid reversion which was contemplated in the new method of observing. For this purpose, on 1841, Oct. 20, the instrument was repeatedly reversed, and the readings of the two plumb-line microscopes were taken. The following table contains the results :—

Position of Face of Instrument.	Equivalent in arc, for reading of lower Plumb-line Micrometer.	Equivalent in arc, for reading of upper Plumb-line Micrometer.	Sum of Equivalents.	Mean of each pair of consecutive Sums of Equivalents.
E	514·26″	421·39″	935·65″	
				945·89″
W*	534·88	421·24	956·12	
				946·05
E	514·43	421·54	935·97	
				946·36
W	535·59	421·16	956·75	
				945·97
E	513·62	421·57	935·95	
				945·66
W	534·97	421·15	956·12	
				946·04
E	514·38	421·57	935·19	
				946·34
W	535·64	421·08	956·72	
				946·47
E	514·61	421·60	936·21	
				946·73
W	536·13	421·11	957·24	
				946·72
E	514·60	421·59	936·19	
				946·46
W	535·57	421·16	956·73	

* After this observation, a cobweb was removed from the lower part of the plumb-line.

It seems clear from these observations that nothing is to be feared from the suddenness of reversion of the instrument.

§ 8. *Observations of the Duration of Transit of the Moon's Diameter, with the Eastern Equatoreal,* page 52.

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

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

The columns of the printed observations need little explanation. The correction for defect of illumination is found by estimating the Sun's perpendicular distance from the meridian passing through the Moon, produced to complete the circle: and considering the defect to be equal to the Moon's semidiameter multiplied by the versed sine of that distance. The tabular duration is interpolated for the hour-angle (found by comparing the sidereal time with the Moon's right ascension) between the tabular durations of the Nautical Almanac, which correspond to hour-angles of 0^h and 12^h successively. The correction for defective illumination was found to be insensible. 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 Neighbouring Stars at the Opposition*, page 54 to 71.

The method of observing and the elements of reduction, are explained, for the most part, in the Notes. The mean places of the stars upon which the apparent places used in these reductions are founded, are those given in the Catalogue of Stars in the present volume.

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

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

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

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

The value of one revolution of the micrometer (a) which has been used in the reduction of these observations, is 31''·471, which is the same that has been used for similar observations during the preceding years; the value of one revolution of micrometer (b) is 31''·233, being the result of the determination in 1842, of which the details are given in the Introduction to the Observations for 1840.

§ 10. *Eclipses and Transits of Jupiter's Satellites, and Occultations of Stars and Planets by the Moon; with the Equations deduced from the Occultations*, page 74 to 81.

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

For the computation, the star's place is taken from the "Elements for facilitating the Computation of Occultations" in the Nautical Almanac. The Moon's geocentric place, semidiameter, and hor. eq. parallax, are interpolated with second differences from the Nautical Almanac. The hor. eq. parallax is then corrected by a quantity taken from the following Table, depending on the zenith-distance (Z), and the angle from the vertical (on the Moon's limb), as seen in an inverting telescope, at which the occultation takes place, (V). The investigation from which this table is formed, is given in the Cambridge Observations, 1831, Introduction.

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

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

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

The following quantities are then formed:

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

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

(The 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, assuming a value for δ':

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

For the computations applying to the occultation of the cusps of Venus on March 26, it was assumed that the line of cusps was inclined to the celestial meridian by an angle of 21°.0′, in such a direction that the R.A. of the northern cusp was less than that of the center; and that the semidiameter of Venus was 15″·2. For those relating to the gibbous limb of Venus on September 11, it was assumed that the breadth of the illuminated part of the disk of Venus was 0·715 × whole diameter, and that the semidiameter was 7″·6. In the calculations applying to the enlightened and gibbous limbs, the computed distance of centers is made equal to the sum of the Moon's semidiameter, and the complete or gibbous semidiameter of Venus. The rest of the computations seem to require no special explanation.

§ 11. *Observations of the Diameters of the Planets, with a double-image eye-piece attached to the South Equatoreal,* page 84 to 86.

For a detailed description of the double-image micrometer with which these observations were made, as well as for a statement of the observations for determining the value of one revolution of the screw, and the Polar point of the same, I beg to refer to the Introduction for 1840. It is sufficient here to say, that the value of one revolution has been assumed to be equal to 17″, and that the Polar point used for all the observations of 1841 has been 39°.

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

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

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

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

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

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

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

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

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

The diameters of Venus are compared with those given in the Nautical Almanac. The breadth of the illuminated part is compared with that computed from the diameters in the Nautical Almanac with the values of the illuminated surface given in page 544 of the Nautical Almanac.

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

The stars with which Encke's Comet was compared in the Observations of 1838 having been observed with the meridional instruments, I subjoin a table of corrected places of the Comet. Those determinations only are retained which depend upon comparative observations.

RIGHT ASCENSIONS of ENCKE'S COMET,

Observed at the Royal Observatory, Greenwich, as finally corrected for the Errors of the Assumed Right Ascensions of the Stars of Comparison.

Day, 1838.	No. of Series.	Greenwich Mean Solar Time of Observation of Comet.	True R. A. of Comet.	Name of Comparison Star.	True R. A. of Comparison Star.
		h m s	h m s		h m s
October 29	11	9. 5. 2·3	22.38. 4·2	*A*	22.38.46·3
	12	9. 6.37·0	22.38. 6·2	*A*	
	13	9. 7.31·9	22.37.58·2	*A*	
	14	9.12.17.2	22.37.56·3	*A*	
	15	9.15. 1·7	22.37.48·3	*A*	
	16	9.17.32·2	22.37.49·3	*A*	
	19	9.43. 1·1	22.37.12·7	*A*	
	20	9.45.42·7	22.37. 9·7	*A*	
November 4	23	9. 8.14·8	19.32.11·4	*B*	19.30.36·5
	24	9.11.39·2	19.32. 5·5	*B*	
	25	9.15.32·6	19.32. 2·5	*B*	
	26	9.17.55·1	19.32. 1·5	*B*	
	27	9.19.58·8	19.32. 2·5	*B*	
November 7	28	7. 2. 8·1	18.30. 5·9	*C*	18.30.44·8
	29	7. 3.33·2	18.30.11·4	*C*	
	30	7. 4.51·6	18.30. 1·0	*C*	
	31	7.16.24·7	18.29.53·0	*C*	

RIGHT ASCENSIONS of ENCKE'S COMET, 1838—*continued.*

Day, 1838.	No. of Series.	Greenwich Mean Solar Time of Observation of Comet.	True R. A. of Comet.	Name of Comparison Star.	True R. A. of Comparison Star.
		h m s	h m s		h m s
November 7	32	7. 19. 39 ·2	18. 29. 58 ·1	*C*	18. 30. 44 ·8
	33	7. 21. 10 ·9	18. 29. 49 ·1	*C*	
	34	7. 22. 45 ·7	18. 29. 57 ·1	*C*	
	35	7. 25. 23 ·2	18. 29. 47 ·1	*C*	
November 9	42	7. 4. 48 ·8	17. 59. 32 ·7	Gr. 2490	17. 52. 1 ·6
	45	7. 39. 38 ·0	17. 59. 26 ·6	*D*	17. 59. 48 ·4
	46	7. 43. 5 ·5	17. 59. 21 ·4	*E*	17. 59. 10 ·2
			17. 59. 23 ·6	*D*	17. 59. 48 ·4
	47	7. 44. 38 ·2	17. 59. 16 ·4	*E*	17. 59. 10 ·2
			17. 59. 18 ·6	*D*	17. 59. 48 ·4
	48	7. 48. 19 ·5	17. 59. 14 ·4	*E*	17. 59. 10 ·2
			17. 59. 14 ·6	*D*	17. 59. 48 ·4
	49	7. 50. 45 ·1	17. 59. 12 ·4	*E*	17. 59. 10 ·2
November 10	56	7. 8. 6 ·4	17. 47. 13 ·5	*F*	17. 47. 39 ·5
	57	7. 10. 14 ·1	17. 47. 12 ·5	*F*	
	58	7. 13. 29 ·6	17. 47. 13 ·5	*F*	
	59	7. 15. 55 ·3	17. 47. 12 ·5	*F*	
	60	7. 19. 4 ·7	17. 47. 12 ·5	*F*	
November 12	65	8. 22. 44 ·4	17. 26. 18 ·4	*G*	17. 26. 5 ·5
	66	8. 24. 16 ·1	17. 26. 22 ·3	*G*	
	67	8. 25. 49 ·0	17. 26. 20 ·3	*G*	

RIGHT ASCENSIONS of ENCKE'S COMET, 1838—*continued.*

Day, 1838.	No. of Series.	Greenwich Mean Solar Time of Observation of Comet.	True R. A. of Comet.	Name of Comparison Star.	True R. A. of Comparison Star.
		h m s	h m s		h m s
November 12	68	8. 27. 35 ·8	17. 26. 18 ·3	*G*	17. 26. 5 ·5
			17. 26. 18 ·3	*H*	17. 26. 45 ·5
	69	8. 31. 5 ·3	17. 26. 16 ·3	*G*	17. 26. 5 ·5
			17. 26. 17 ·8	*H*	17. 26. 45 ·5
	70	8. 33. 25 ·9	17. 26. 17 ·3	*G*	17. 26. 5 ·5
			17. 26. 18 ·3	*H*	17. 26. 45 ·5
	71	8. 35. 30 ·7	17. 26. 15 ·8	*G*	17. 26. 5 ·5
			17. 26. 15 ·3	*H*	17. 26. 45 ·5
	72	8. 37. 41 ·5	17. 26. 15 ·8	*G*	17. 26. 5 ·5
			17. 26. 17 ·3	*H*	17. 26. 45 ·5
	73	8. 39. 42 ·3	17. 26. 13 ·3	*G*	17. 26. 5 ·5
			17. 26. 13 ·8	*H*	17. 26. 45 ·5
	74	8. 42. 2 ·0	17. 26. 12 ·3	*G*	17. 26. 5 ·5
			17. 26. 12 ·8	*H*	17. 26. 45 ·5
	75	8. 44. 48 ·7	17. 26. 11 ·3	*G*	17. 26. 5 ·5
			17. 26. 12 ·3	*H*	17. 26. 45 ·5
November 13	93	6. 57. 47 ·4	17. 18. 22 ·4	*I*	17. 18. 33 ·7
	94	7. 10. 18 ·9	17. 18. 18 ·3	*K*	17. 17. 44 ·6
	95	7. 12. 13 ·6	17. 18. 16 ·3	*K*	
	96	7. 14. 4 ·5	17. 18. 17 ·3	*K*	
	97	7. 16. 41 ·1	17. 18. 15 ·3	*K*	
	98	7. 18. 48 ·8	17. 18. 14 ·3	*K*	

RIGHT ASCENSIONS of ENCKE'S COMET, 1838—*concluded.*

Day, 1838.	No. of Series.	Greenwich Mean Solar Time of Observation of Comet.	True R. A. of Comet.	Name of Comparison Star.	True R. A. of Comparison Star.
		h m s	h m s		h m s
November 13	99	7. 20. 58 ·6	17. 18. 15 ·3	*K*	17. 17. 44 ·6
	100	7. 23. 10 ·3	17. 18. 13 ·3	*K*	
	101	7. 25. 12 ·1	17. 18. 12 ·3	*K*	
	102	7. 27. 21 ·9	17. 18. 12 ·3	*K*	
	103	7. 29. 5 ·6	17. 18. 11 ·8	*K*	
	104	7. 31. 22 ·3	17. 18. 9 ·3	*K*	
	105	7. 34. 3 ·1	17. 18. 10 ·4	*I*	17. 18. 33 ·7
	106	7. 36. 5 ·8	17. 18. 9 ·4	*I*	
	107	7. 39. 20 ·4	17. 18. 10 ·4	*I*	
	108	7. 41. 35 ·2	17. 18. 7 ·4	*I*	
	109	7. 43. 56 ·0	17. 18. 8 ·4	*I*	
November 22	111*	6. 43. 16 ·0	16. 30. 22 ·5	*M*	16. 30. 21 ·4

* Series 111. See the note to this Series in the Printed Observations.

NORTH POLAR DISTANCES of ENCKE'S COMET,

Observed at the Royal Observatory, Greenwich, as finally corrected for the Errors of the assumed North Polar Distances of the Stars of Comparison.

Day, 1838.	No. of Series.	Greenwich Mean Solar Time of Observation of Comet.	True N. P. D. of Comet.	Name of Comparison Star.	True N. P. D. of Comparison Star.
		h m s	° ′ ″		° ′ ″
October 26	1	6. 23. 47	26. 33. 26	10 Cassiopeiæ	26. 41. 52
	2	6. 43. 28	26. 32. 49	10 Cassiopeiæ	
October 29	6	7. 32. 9	24. 12. 38	ι Cephei	24. 38. 32
	7	7. 39. 57	24. 16. 12	ι Cephei	
	10	8. 50. 26	24. 13. 34	ι Cephei	
	18	9. 27. 32	24. 13. 34	ι Cephei	
	21	9. 49. 8	24. 13. 12	ι Cephei	
November 7	38	8. 0. 43	38. 36. 14	*C*	38. 23. 23
November 9	42	7. 4. 49	44. 55. 33	Groombridge 2490	44. 59. 21
	44	7. 37. 47	45. 1. 45	*E* *E′*	45. 2. 53 45. 1. 29
November 10	52	6. 36. 39	48. 11. 2	*F*	48. 8. 41
	53	6. 44. 34	48. 13. 31	*F*	
	54	6. 49. 30	48. 14. 6	*F*	
	55	7. 3. 21	48. 14. 32	*F*	
	61	7. 25. 7	48. 17. 50	*F*	
	62	7. 31. 2	48. 19. 24	*F*	
November 12	76	8. 58. 1	55. 2. 58	*H*	55. 8. 8

NORTH POLAR DISTANCES of ENCKE'S COMET—*concluded.*

Day, 1838.	No. of Series.	Greenwich Mean Solar Time of Observation of Comet.	True N. P. D. of Comet.	Name of Comparison Star.	True N. P. D. of Comparison Star.
November 12	77	h m s 9. 7.49	° ′ ″ 55. 4.56	*H*	° ′ ″ 55. 8. 8
	78	9. 9.49	55. 3.26	*H*	
	79	9.15.41	55. 5. 3	*H*	
	80	9.58.44	55.10.17	*G*	55. 3.27
November 13	84	6. 9. 5	57.48.53	*I*	57.35.59
	85	6.11. 4	57.49.15	*I*	
	86	6.15. 2	57.50. 7	*I*	57.35.59
			57.49.46	*L*	57.33.38
	87	6.21.59	50.50.43	*I*	57.35.59
	88	6.37.50	57.52.32	*I*	
	89	6.41.48	57.53.32	*I*	
	90	6.44.47	57.53.39	*I*	
November 22	111	6.43.16	80.31.50	*M*	80.32.11

END OF THE INTRODUCTION.