

VI. *On the Values of the Constants of Nutation and Aberration, and of the Parallax of γ Draconis, as deduced from the Observations made with the Twenty-five-foot Zenith Tube at the Royal Observatory, Greenwich.* By the Rev. R. MAIN, M.A.

Read June 8, 1855.

THE observations discussed in this paper extend from June 1837 to May 1848, and during this interval of time they were made with tolerable continuity, the only interruptions being such as were inevitable, either on account of periods of bad weather, or from the difficulty of seeing the star in the daytime, or from occasional readjustments or alterations in the instrument.

Before proceeding with the detail of the calculations by which the results deduced from the observations have been obtained, it will be well first to recapitulate briefly the principal results deduced by other astronomers for the nutation and aberration; and, secondly, to give a short account of the zenith tube with which the observations were made.

1. For the constant of lunar nutation the values most entitled to credit, both from the number of observations employed and the mode of treatment of them, are those by LINDENAU, BUSCH, ROBINSON, BRINKLEY, LUNDAHL, and PETERS.

LINDENAU'S complete discussion of the values of the constants of aberration and nutation, published in 1842 at Berlin, is entitled, *Versuch einer neuen Bestimmung der Nutations und Aberrations Constanten aus beobachteten Geraden Aufsteigungen des Polaris*. For the purpose the author searched the records of all the great observatories during the eighteenth and nineteenth centuries, and found nearly 1600 transits adapted to the object he had in view, from which 800 right ascensions were deduced.

By a treatment which differs in no material respect from that ordinarily employed he finds for the constant of aberration the definitive value $20''\cdot449$, and for that of nutation $8''\cdot977$. The latter result is smaller than that deduced by any other modern astronomer.

Dr. BUSCH undertook the investigation of the constants of nutation and aberration by the discussion of the observations of BRADLEY, published by RIGAUD in 1832, in his work entitled *Miscellaneous Works of the Rev. James Bradley*. For this purpose he used the observations of twenty-three stars made at Wanstead with the twelve-foot zenith tube, between the years 1727 and 1747, in which space of time the moon's node had made more than a revolution, and which were, therefore, admirably suited to the determination of nutation as well as of aberration.

The results deduced by him are,—

$$\begin{aligned} \text{Constant of nutation} &= 9''\cdot2320 \\ \text{,, aberration} &= 20''\cdot2116 \end{aligned}$$

In the eleventh volume of the *Memoirs* of this Society is a paper on Nutation by Dr. ROBINSON, in which he investigates the value of the constant by means of the observations made at Greenwich with TROUGHTON'S mural circle, between the years 1812 and 1835. In this investigation he uses, in addition to *Polaris*, fourteen stars, equally distributed in right ascension through the twenty-four hours, which had been frequently observed, and whose meridian altitudes are all greater than 50° .

The value of the constant of nutation deduced by him is $9''\cdot239$.

Another value of the constant of nutation entitled to some credit is that by Dr. BRINKLEY, in his paper on the Parallaxes and the Aberrations of the Fixed Stars, in the *Philosophical Transactions* for 1821. Using for this purpose the observations of ten stars made with the Dublin circle from the year 1809 to 1814, and from the year 1818 to 1820, he obtains for the value of the constant $9''\cdot25$.

This determination, which is based on observations extending through only half a revolution of the moon's node, is liable to error, arising from the imperfectly-known proper motions of the stars employed, though this is always capable of correction by using the results of modern observations, if it should be thought worth while.

LUNDAHL'S paper, published in 1842, is entitled, "*De Numeris Nutationis et Aberrationis Constantibus atque de Parallaxi annuâ stellæ Polaris, quæ deducuntur ex Declinationibus stellæ Polaris; Dorpato, annis 1822-1838, observatis.*" The observations discussed by LUNDAHL were made with the meridian circle of REICHENBACH, and, extending as they do through the greater part of a period of the moon's node, and being of indisputable excellence, the result is entitled to considerable credit. The definitive result obtained for the constant of lunar nutation is $9''\cdot236$, with probable error $0''\cdot040$.

PETERS'S paper, published also in 1842, is entitled, "*Numerus constans Nutationis ex Ascensionibus rectis stellæ Polaris in speculâ Dorpatensi annis 1822 ad 1838 observatis deductus.*" This paper is, therefore, complementary to that of LUNDAHL, the result being deduced from observations of right ascension, instead of declination, of *Polaris*; and, though it is not intended to offer any criticism, it may be assumed, that, in general, observations of right ascension of a circumpolar star are much less favourable than those of declination for any similar investigation, unless the constancy of the instrument between consecutive transits with regard to azimuthal deviation is unusually great. This paper is, however, by far the most elaborate of all that have appeared on nutation since the time of BESSEL, for, in addition to the deduction of the value of the constant, the whole theory is revised, and every term which can possibly produce any sensible effect in the expressions for the nutation of longitude and of obliquity is taken scrupulously into account. At present we are concerned only with the value of the constant. The definitive value is $9''\cdot217$, with probable error $0''\cdot020$.

For the sake of distinctness, putting in juxtaposition the values of the nutation-constant obtained through the investigations given above, we have the following:—

| | | | |
|----------------|---------------|----------------|---------------|
| LINDENAU | $8''\cdot977$ | BRINKLEY | $9''\cdot25$ |
| BUSCH | $9''\cdot232$ | LUNDAHL | $9''\cdot236$ |
| ROBINSON | $9''\cdot239$ | PETERS | $9''\cdot217$ |

The investigations relating to the determination of the *constant of aberration* most entitled to credit are those by RICHARDSON, LUNDAHL, LINDENAU, W. STRUVE, and LINDHAGEN.

Of the above, LUNDAHL and LINDENAU have deduced the values of the constant from the same series of observations by which the constant of nutation was determined: the values obtained by them are respectively $20''\cdot551$ and $20''\cdot449$. RICHARDSON'S result is based upon more than 4000 observations made with the two mural circles at Greenwich, between the years 1825 and 1828: his definitive result is $20''\cdot504$.

STRUVE'S result is founded on the observations made with REPSOLD'S transit instrument placed in the prime vertical. The stars employed are seven,—namely, β and δ *Cassiopeiæ*; ν *Ursæ Majoris*; ι , b , and o *Draconis*; and *Piazzi* xix. 371. The definitive value of the constant is $20''\cdot445$. One of the most important deductions made by M. STRUVE from his discussion of the observations of each star separately is, that the velocity of the light coming from each star is the same.

LINDHAGEN'S value of the constant is founded on the observations of right ascension of *Polaris* made at Poulkova, with ERTEL'S transit instrument, in the years 1842–1844. His definitive result is $20''\cdot408$.

I will now proceed with the description of the zenith tube with which the observations were made which are the basis of my own investigation. The tube was erected by TROUGHTON during the directorship of Mr. POND, with the expectation of observing several stars, in addition to γ *Draconis*, which pass the meridian of Greenwich very near to the zenith, but no regular series of observations capable of being used for any delicate inquiry was made with it till the accession of Mr. AIRY. One of the first points taken into consideration by the latter astronomer was the examination and improvement of this instrument, with a view to rendering it efficient for making an extensive series of observations of γ *Draconis*.

The focal length of the vertical telescope is twenty-five feet, and its aperture five inches, and it turned freely in azimuth upon a conical pivot at its lower extremity, and in a collar, with steadying springs, near its upper end. The collar was carried by the upper extremity of a very massive iron tube, supported by four curved iron legs. The telescope was furnished with a plumb-line, attached for convenience to a reel near the upper extremity, and passing through a small tube contained in the larger one. It was read by two microscopes, one placed near the upper and the other near the lower extremity, the use of the upper reading being to obviate any error arising from lateral shift of the plumb-line; and, as the thickness

of the line was considerable, it was customary to place the crosses of the micrometers on each edge of the image, so that two separate readings of each microscope were made at each observation.

In the eye-piece of the telescope there were, carried by a fixed plate, ten pairs of wires arranged as acute crosses; and, carried by the moveable micrometer-plate, eleven single wires placed vertically at intervals not widely different from those of the fixed crosses. The micrometer-plate was acted on by a fine micrometer-screw acting against a spring in the usual way, the object of this arrangement of the crosses and wires being for the purpose of measuring the intervals of the wires in terms of the revolutions of the micrometer-screw, and thus obtaining very accurately the value of a revolution by a comparison of the spaces thus measured, with their values in arc, obtained by transits of γ *Draconis* over all the wires.

Other details relating to the construction of the instrument will be found in the Introduction to the *Greenwich Observations* for 1837, and the subsequent volumes; in this place it is sufficient to add, for the sake of showing the fineness of the micrometer-screw, that the value of a revolution was found from the mean of several determinations made in the winter of 1836, agreeing very closely with each other, to be $6''\cdot714$. Another determination made in the spring of 1846 gave $6''\cdot724$. The chief causes which might have an influence in vitiating the observations, and which were therefore chiefly to be guarded against, were,—1st. The possibility of the plumb-line being bent in some portion of its length, and of its revolving by the circular motion imparted to the bob suspended in the water-vessel; and, 2dly. The probability of a change of adjustment of some parts of the instrument between two consecutive observations in reversed positions. As the necessity for obviating these sources of possible error became apparent, means were taken for the purpose. First, to prevent the rotation of the plumb-line, a supplementary plumb-line was added, having its bob in a separate water-vessel, so that any tendency to twist was immediately counteracted. Secondly, in the year 1841, the instrument was furnished with convenient means for reversing it rapidly, and with a supplementary wire at a distance from the original wire very nearly equal to double the zenith distance of γ *Draconis*, and by this means the observer was enabled to make a complete observation in reversed positions of the instrument at a single transit of the star.

I will now proceed to explain the processes pursued in the calculations.

First, the observations have been divided into convenient groups, rarely extending over an interval of time greater than fourteen days; and it is assumed that, for these intervals, the mean of the observed apparent zenith distances corresponds accurately to the mean of the days of observation. This supposition is sufficiently accurate even with reference to the changes of the coefficients of aberration and parallax.

We have then a series of normal apparent zenith distances which theoretically ought to be very accurate, and each of these may be represented by an expression containing the following terms:—

1. The assumed mean north zenith distance for an assumed epoch.
2. The correction due for precession and proper motion for the interval of time between the epoch and the day corresponding to the mean of each group of observed zenith distances.
3. The correction due to aberration.
4. The correction due to parallax.
5. The correction due to nutation.

I will treat of these in order.

1. The assumed epoch is 1840, January 1, and the assumed north zenith distance for that epoch is $118''\cdot00 + v$.

2. For the precession the assumed value of n is that of PETERS, in his *Numerus Constans Nutationis*, for 1840, namely $20''\cdot057$, and the assumed proper motion is that deduced by myself in my paper on the Proper Motion of the Fixed Stars. These, when combined, give for the annual variation in north zenith distance $-0''\cdot66$. For convenience of application a table is made of the amount of this correction for every hundred days.

3. The constant of aberration being assumed to be $20'' + x$, the correction to be applied to the mean north zenith distance will be generally

$$-(20 + x) \{ \cos \alpha \cos \Delta \sin \odot + (\sin \omega \sin \Delta - \cos \omega \sin \alpha \cos \Delta) \cos \odot \}$$

where α = star's R.A.; Δ = N.P.D.; \odot = sun's longitude; and ω = the obliquity of the ecliptic.

By reduction, this formula may, in the case of γ *Draconis*, be represented, for the epochs respectively of 1840 and 1850, by the expressions

$$\begin{aligned} & -0\cdot96588 \cos (1^\circ 26' + \odot) \times (20'' + x) \\ \text{and} & -0\cdot96566 \cos (1^\circ 24' + \odot) \times (20'' + x) \end{aligned}$$

The above expression, for the epoch 1840, has been tabulated for every degree of sun's longitude, and the result is given in two distinct tables, the former of which gives the numerical value of the correction to be applied, assuming the value of the constant to be 20'', and the latter gives the values of the factors, which are the multipliers of x , the residual correction of the constant.

4. If y be the value of the constant of parallax, then the correction to be applied to the mean N.P.D. is deduced immediately from the expression for aberration, by substituting $90^\circ + \odot$, and will be, for 1840,

$$+ 0.96588 \sin (1^\circ 26' + \odot) \times y.$$

This expression is tabulated in the same manner as the preceding for every degree of sun's longitude.

5. For nutation, the expression is taken from PETERS' *Constans Nutationis*, page 74, assuming the constant to be, for 1840, $9''.2235 \times \left(1 + \frac{z}{10}\right)$. Neglecting terms which are utterly insensible for γ *Draconis*, the whole correction to mean N.Z.D. will be

$$\begin{aligned} & \left(1 + \frac{z}{10}\right) \left\{ -6''.866 \cos \alpha \sin \Omega + 9''.223 \sin \alpha \cos \Omega \right. \\ & \quad \left. - 0''.090 \sin \alpha \cos 2\Omega + 0''.089 \sin \alpha \cos 2\zeta \right\} \\ & + \left(1 - 2.162 \times \frac{z}{10}\right) \left\{ -0''.505 \cos \alpha \sin 2\odot + 0''.551 \sin \alpha \cos 2\odot \right\} \end{aligned}$$

and this expression can be readily reduced, for γ *Draconis*, to the shape

$$\begin{aligned} & \left(1 + \frac{z}{10}\right) \left\{ -9''.221 \cos (\Omega + 1^\circ 19') + 0''.090 \cos (2\Omega + 1^\circ 38') \right. \\ & \quad \left. - 0''.089 \cos (2\zeta + 1^\circ 38') \right\} \\ & - \left(1 + \frac{z}{10} - 0''.316 \times z\right) \times 0''.551 \cos (2\odot + 1^\circ 38') \end{aligned}$$

The terms of lunar and solar nutation have been separately tabulated, and the values are given for every degree of the longitudes of the sun and moon, and of the moon's node.

The tabular arrangement of the whole work will now need no further explanation, except that every normal group will give an equation between the apparent and the mean values of the north zenith distance; involving,

besides the three unknown quantities, x , y , z , a constant and unknown correction to the mean N.Z.D. which we denote by v .

Each equation, after the requisite reductions, will be of the form

$$v + ax + by + cz = d$$

and to each is appended the number of determining equations, the square root of which denotes its relative weight.

TABLE I.

Observed Apparent North Zenith Distances of γ Draconis.

| Day. | Observed Apparent N.Z.D. | Day. | Observed Apparent N.Z.D. | Day. | Observed Apparent N.Z.D. | Day. | Observed Apparent N.Z.D. |
|-----------------|--------------------------------|------------------|--------------------------------|-------------------|--------------------------------|------------------|--------------------------------|
| 1837. June 7 | 106'36 | 1837. July 21 | 121'23 | 1837. Sept. 13 | 131'09 | 1837. Nov. 15 | 121'71 |
| 15 | 111'41 | 22 | 121'81 | 15 | 130'97 | 16 | 121'47 |
| 19 | 113'09 | 24 | 122'65 | 20 | 130'78 | 17 | 121'24 |
| 22 | 112'48 | 25 | 122'94 | 21 | 130'92 | 20 | 120'52 |
| 23 | 111'64 | 26 | 123'15 | 22 | 130'38 | 25 | 119'81 |
| 24 | 112'19 | Aug. 3 | 124'96 | 23 | 130'22 | 27 | 119'56 |
| 26 | 113'92 | 7 | 125'36 | 25 | 130'20 | 29 | 118'58 |
| 27 | 114'82 | 8 | 124'98 | 28 | 130'10 | Dec. 1 | 118'06 |
| 28 | 114'76 | 11 | 125'78 | 29 | 130'21 | 8 | 116'32 |
| 29 | 114'59 | 13 | 126'85 | 30 | 129'90 | 14 | 114'50 |
| 30 | 114'75 | 14 | 127'32 | Oct. 3 | 129'41 | 15 | 113'82 |
| July 1 | 114'82 | 15 | 127'52 | 4 | 129'50 | 28 | 108'53 |
| 4 | 116'12 | 16 | 128'03 | 6 | 129'54 | 1838. Jan. 2 | 105'58 |
| 6 | 116'98 | 17 | 128'31 | 9 | 129'20 | March 5 | 90'25 |
| 9 | 117'62 | 18 | 127'66 | 14 | 128'56 | 6 | 90'07 |
| 10 | 118'60 | 24 | 127'56 | 20 | 127'82 | 8 | 90'30 |
| 11 | 119'87 | 25 | 127'64 | 27 | 126'71 | 20 | 90'95 |
| 12 | 120'03 | 30 | 128'43 | Nov. 2 | 125'77 | 26 | 91'51 |
| 13 | 119'70 | 31 | 128'43 | 3 | 125'58 | 27 | 90'05 |
| 15 | 119'88 | Sept. 2 | 128'62 | 7 | 124'28 | April 1 | 90'16 |
| 18 | 120'38 | 6 | 129'76 | 8 | 123'68 | 8 | 90'83 |

Constants of Nutation and Aberration, &c.

Observed Apparent North Zenith Distances of γ Draconis (continued).

| Day. | Observed Apparent N.Z.D. | Day. | Observed Apparent N.Z.D. | Day. | Observed Apparent N.Z.D. | Day. | Observed Apparent N.Z.D. |
|-------------------|--------------------------------|------------------|--------------------------------|-----------------|--------------------------------|------------------|--------------------------------|
| 1838. April 11 | 91 ^{''} 27 | 1838. Aug. 21 | 124 ^{''} 63 | 1839. Jan. 7 | 102 ^{''} 95 | 1839. July 16 | 116 ^{''} 22 |
| 27 | 94 ^{''} 02 | 23 | 124 ^{''} 31 | 8 | 102 ^{''} 25 | 20 | 118 ^{''} 10 |
| May 2 | 95 ^{''} 25 | 27 | 125 ^{''} 93 | 9 | 102 ^{''} 63 | 22 | 118 ^{''} 61 |
| 4 | 96 ^{''} 27 | 29 | 127 ^{''} 32 | 21 | 99 ^{''} 28 | Aug. 1 | 123 ^{''} 04 |
| 11 | 98 ^{''} 30 | 30 | 127 ^{''} 36 | Feb. 27 | 88 ^{''} 11 | 2 | 123 ^{''} 61 |
| 15 | 99 ^{''} 54 | 31 | 127 ^{''} 42 | Mar. 3 | 87 ^{''} 60 | 8 | 124 ^{''} 90 |
| 18 | 101 ^{''} 22 | Sept. 2 | 127 ^{''} 22 | 20 | 89 ^{''} 67 | 10 | 124 ^{''} 44 |
| 22 | 103 ^{''} 75 | 3 | 127 ^{''} 13 | April 19 | 91 ^{''} 68 | 12 | 124 ^{''} 35 |
| 31 | 103 ^{''} 98 | 5 | 126 ^{''} 94 | 21 | 90 ^{''} 97 | 17 | 125 ^{''} 38 |
| June 4 | 105 ^{''} 11 | 10 | 127 ^{''} 16 | 28 | 93 ^{''} 40 | 20 | 126 ^{''} 55 |
| 5 | 104 ^{''} 91 | 11 | 127 ^{''} 64 | 29 | 94 ^{''} 14 | 21 | 127 ^{''} 02 |
| 6 | 104 ^{''} 48 | 12 | 128 ^{''} 04 | May 1 | 93 ^{''} 76 | 23 | 126 ^{''} 99 |
| 7 | 104 ^{''} 58 | 15 | 128 ^{''} 36 | 15 | 97 ^{''} 24 | Sept. 4 | 127 ^{''} 82 |
| 13 | 106 ^{''} 99 | 21 | 128 ^{''} 35 | 17 | 97 ^{''} 31 | 6 | 128 ^{''} 00 |
| 15 | 107 ^{''} 94 | 28 | 128 ^{''} 72 | 21 | 97 ^{''} 98 | 9 | 128 ^{''} 70 |
| 19 | 109 ^{''} 15 | Oct. 3 | 128 ^{''} 83 | 25 | 103 ^{''} 62 | 18 | 129 ^{''} 18 |
| 22 | 110 ^{''} 60 | 12 | 128 ^{''} 22 | 27 | 104 ^{''} 26 | 21 | 128 ^{''} 97 |
| 23 | 111 ^{''} 57 | 19 | 128 ^{''} 17 | 29 | 102 ^{''} 70 | 23 | 128 ^{''} 43 |
| 29 | 114 ^{''} 06 | 24 | 128 ^{''} 18 | June 5 | 103 ^{''} 67 | 25 | 128 ^{''} 24 |
| July 4 | 115 ^{''} 80 | 29 | 127 ^{''} 41 | 7 | 101 ^{''} 86 | 26 | 128 ^{''} 29 |
| 9 | 113 ^{''} 72 | 30 | 126 ^{''} 27 | 8 | 102 ^{''} 70 | 28 | 128 ^{''} 05 |
| 11 | 115 ^{''} 69 | 31 | 125 ^{''} 30 | 11 | 106 ^{''} 44 | 30 | 128 ^{''} 40 |
| 12 | 116 ^{''} 21 | Nov. 7 | 123 ^{''} 89 | 12 | 107 ^{''} 88 | Oct. 9 | 128 ^{''} 47 |
| 13 | 117 ^{''} 02 | 12 | 122 ^{''} 32 | 15 | 109 ^{''} 30 | 10 | 128 ^{''} 10 |
| 18 | 118 ^{''} 97 | 13 | 121 ^{''} 69 | 18 | 110 ^{''} 30 | 16 | 127 ^{''} 44 |
| 20 | 119 ^{''} 67 | 26 | 118 ^{''} 01 | 19 | 108 ^{''} 31 | 18 | 126 ^{''} 31 |
| 24 | 120 ^{''} 20 | Dec. 3 | 115 ^{''} 48 | July 1 | 112 ^{''} 15 | Nov. 23 | 118 ^{''} 47 |
| Aug. 6 | 122 ^{''} 78 | 4 | 115 ^{''} 53 | 6 | 114 ^{''} 58 | 26 | 119 ^{''} 30 |
| 9 | 122 ^{''} 92 | 8 | 114 ^{''} 84 | 8 | 115 ^{''} 22 | Dec. 17 | 112 ^{''} 24 |
| 11 | 122 ^{''} 71 | 10 | 115 ^{''} 01 | 9 | 115 ^{''} 65 | 20 | 110 ^{''} 79 |
| 13 | 123 ^{''} 61 | 15 | 114 ^{''} 03 | 10 | 116 ^{''} 33 | 1840. Jan. 1 | 106 ^{''} 69 |
| 14 | 124 ^{''} 11 | 26 | 109 ^{''} 30 | 13 | 117 ^{''} 03 | 5 | 105 ^{''} 76 |
| 15 | 124 ^{''} 10 | 30 | 107 ^{''} 29 | 15 | 116 ^{''} 59 | 6 | 104 ^{''} 62 |

Observed Apparent North Zenith Distances of γ Draconis (continued).

| Day. | Observed Apparent N.Z.D. | Day. | Observed Apparent N.Z.D. | Day. | Observed Apparent N.Z.D. | Day. | Observed Apparent N.Z.D. |
|-----------------|--------------------------------|-----------------|--------------------------------|------------------|--------------------------------|------------------|--------------------------------|
| 1840. Jan. 7 | 104 ^h 58 | 1840. Aug. 4 | 121 ^h 85 | 1840. Dec. 15 | 112 ^h 23 | 1841. July 26 | 121 ^h 84 |
| 10 | 103 ^h 97 | 5 | 122 ^h 31 | 22 | 111 ^h 47 | 28 | 122 ^h 04 |
| 12 | 102 ^h 53 | 8 | 123 ^h 90 | 23 | 112 ^h 41 | Aug. 4 | 122 ^h 75 |
| 15 | 100 ^h 32 | 11 | 124 ^h 89 | 1841. Mar. 11 | 91 ^h 62 | 5 | 123 ^h 86 |
| April 1 | 90 ^h 26 | 13 | 125 ^h 27 | 12 | 92 ^h 47 | 7 | 125 ^h 75 |
| 3 | 90 ^h 44 | 14 | 125 ^h 57 | 15 | 92 ^h 50 | 9 | 126 ^h 61 |
| 6 | 90 ^h 39 | 15 | 124 ^h 97 | 17 | 90 ^h 68 | 12 | 125 ^h 35 |
| 10 | 90 ^h 25 | 17 | 124 ^h 00 | 19 | 93 ^h 46 | 14 | 125 ^h 58 |
| 13 | 90 ^h 53 | 21 | 125 ^h 26 | 24 | 93 ^h 37 | 17 | 125 ^h 26 |
| 14 | 90 ^h 67 | 24 | 126 ^h 47 | 25 | 93 ^h 03 | 19 | 125 ^h 94 |
| 15 | 91 ^h 27 | 27 | 125 ^h 86 | April 15 | 94 ^h 73 | 20 | 126 ^h 90 |
| 17 | 92 ^h 26 | 28 | 125 ^h 99 | 23 | 94 ^h 39 | 21 | 126 ^h 46 |
| 20 | 92 ^h 59 | 31 | 127 ^h 78 | 26 | 94 ^h 00 | 24 | 124 ^h 98 |
| 24 | 93 ^h 05 | Sept. 1 | 125 ^h 24 | 29 | 94 ^h 97 | 28 | 127 ^h 90 |
| 27 | 93 ^h 68 | 3 | 126 ^h 31 | 30 | 94 ^h 78 | 30 | 127 ^h 78 |
| 28 | 93 ^h 62 | 5 | 127 ^h 28 | May 13 | 99 ^h 33 | Sept. 1 | 128 ^h 15 |
| 29 | 94 ^h 18 | 7 | 126 ^h 88 | 14 | 98 ^h 88 | 10 | 129 ^h 69 |
| May 22 | 101 ^h 19 | 10 | 125 ^h 79 | 15 | 99 ^h 07 | 13 | 130 ^h 13 |
| 26 | 102 ^h 16 | 11 | 126 ^h 23 | 17 | 100 ^h 78 | 15 | 130 ^h 65 |
| 29 | 103 ^h 09 | 15 | 125 ^h 81 | 20 | 102 ^h 48 | 17 | 131 ^h 17 |
| 30 | 103 ^h 19 | 17 | 125 ^h 34 | 24 | 102 ^h 10 | 24 | 126 ^h 26 |
| June 1 | 102 ^h 76 | 23 | 128 ^h 50 | 26 | 100 ^h 85 | 25 | 127 ^h 81 |
| 2 | 104 ^h 25 | 29 | 129 ^h 68 | 28 | 102 ^h 06 | Oct. 5 | 129 ^h 05 |
| 3 | 105 ^h 25 | Oct. 8 | 126 ^h 59 | June 1 | 104 ^h 64 | 7 | 130 ^h 66 |
| 10 | 105 ^h 76 | 9 | 126 ^h 30 | 3 | 105 ^h 50 | Nov. 8 | 122 ^h 24 |
| 13 | 105 ^h 95 | 10 | 127 ^h 74 | 4 | 104 ^h 84 | 11 | 123 ^h 66 |
| 15 | 107 ^h 56 | 13 | 127 ^h 15 | 10 | 106 ^h 76 | 12 | 121 ^h 02 |
| 18 | 110 ^h 47 | 21 | 126 ^h 17 | 15 | 109 ^h 45 | Dec. 7 | 111 ^h 88 |
| 19 | 110 ^h 87 | Nov. 12 | 123 ^h 22 | 16 | 110 ^h 08 | 9 | 113 ^h 31 |
| 22 | 109 ^h 93 | 14 | 123 ^h 15 | 17 | 110 ^h 23 | 11 | 114 ^h 90 |
| July 31 | 124 ^h 52 | 26 | 118 ^h 89 | 21 | 111 ^h 21 | 16 | 112 ^h 73 |
| Aug. 1 | 123 ^h 30 | 27 | 117 ^h 18 | 22 | 110 ^h 87 | 18 | 111 ^h 18 |
| 3 | 122 ^h 49 | Dec. 9 | 113 ^h 00 | | | 20 | 110 ^h 09 |

Constants of Nutation and Aberration, &c.

157

Observed Apparent North Zenith Distances of γ Draconis (continued).

| Day. | Observed Apparent N.Z.D. | Day. | Observed Apparent N.Z.D. | Day. | Observed Apparent N.Z.D. | Day. | Observed Apparent N.Z.D. |
|-----------------------------|--------------------------------|-----------------------------|--------------------------------|-----------------------------|--------------------------------|------------------------------|--------------------------------|
| ^{1841.} Dec. 21 | 109 ^{''} 68 | ^{1842.} June 10 | 108 ^{''} 76 | ^{1842.} Aug. 13 | 126 ^{''} 78 | ^{1843.} April 24 | 99 ^{''} 95 |
| ^{1842.} Jan. 2 | 103 ^{''} 90 | 11 | 109 ^{''} 86 | 15 | 128 ^{''} 33 | 30 | 99 ^{''} 98 |
| 6 | 102 ^{''} 54 | 13 | 110 ^{''} 49 | 16 | 128 ^{''} 41 | May 4 | 101 ^{''} 72 |
| 26 | 97 ^{''} 90 | 14 | 108 ^{''} 92 | 20 | 126 ^{''} 96 | 19 | 105 ^{''} 73 |
| 27 | 97 ^{''} 61 | 15 | 110 ^{''} 11 | 23 | 127 ^{''} 94 | 25 | 106 ^{''} 73 |
| March 8 | 96 ^{''} 87 | 16 | 111 ^{''} 80 | 26 | 129 ^{''} 32 | 27 | 108 ^{''} 19 |
| 22 | 92 ^{''} 69 | 21 | 111 ^{''} 86 | 31 | 128 ^{''} 77 | 29 | 107 ^{''} 76 |
| 23 | 94 ^{''} 34 | 28 | 114 ^{''} 11 | Sept. 2 | 129 ^{''} 21 | June 3 | 108 ^{''} 88 |
| 25 | 91 ^{''} 39 | 29 | 115 ^{''} 14 | 3 | 130 ^{''} 02 | 5 | 110 ^{''} 22 |
| April 5 | 93 ^{''} 36 | July 2 | 114 ^{''} 87 | 5 | 130 ^{''} 52 | 16 | 114 ^{''} 43 |
| 7 | 95 ^{''} 55 | 4 | 115 ^{''} 32 | 9 | 129 ^{''} 73 | 22 | 114 ^{''} 83 |
| 10 | 93 ^{''} 10 | 5 | 117 ^{''} 35 | 13 | 131 ^{''} 43 | 26 | 117 ^{''} 32 |
| 19 | 94 ^{''} 30 | 6 | 118 ^{''} 39 | 15 | 131 ^{''} 41 | 28 | 117 ^{''} 71 |
| 20 | 95 ^{''} 78 | 11 | 117 ^{''} 95 | 21 | 131 ^{''} 61 | July 8 | 118 ^{''} 85 |
| 22 | 95 ^{''} 35 | 12 | 119 ^{''} 55 | 28 | 131 ^{''} 97 | 19 | 123 ^{''} 46 |
| 24 | 95 ^{''} 01 | 13 | 118 ^{''} 80 | Oct. 11 | 131 ^{''} 75 | 24 | 125 ^{''} 99 |
| 25 | 95 ^{''} 20 | 14 | 119 ^{''} 50 | 19 | 130 ^{''} 60 | 25 | 126 ^{''} 20 |
| 26 | 96 ^{''} 88 | 15 | 119 ^{''} 74 | Nov. 28 | 121 ^{''} 53 | 29 | 126 ^{''} 49 |
| 27 | 95 ^{''} 74 | 21 | 121 ^{''} 38 | Dec. 13 | 116 ^{''} 20 | Aug. 1 | 127 ^{''} 18 |
| 28 | 95 ^{''} 21 | 23 | 122 ^{''} 07 | 14 | 116 ^{''} 13 | 2 | 128 ^{''} 34 |
| 29 | 96 ^{''} 66 | 25 | 122 ^{''} 58 | 15 | 115 ^{''} 21 | 5 | 128 ^{''} 42 |
| May 1 | 98 ^{''} 84 | 26 | 123 ^{''} 87 | 21 | 113 ^{''} 23 | 10 | 128 ^{''} 75 |
| 2 | 97 ^{''} 58 | 28 | 122 ^{''} 92 | 27 | 111 ^{''} 03 | 11 | 130 ^{''} 42 |
| 10 | 98 ^{''} 92 | 29 | 123 ^{''} 06 | ^{1843.} Jan. 10 | 106 ^{''} 44 | 12 | 129 ^{''} 81 |
| 12 | 100 ^{''} 55 | Aug. 1 | 124 ^{''} 72 | Feb. 12 | 98 ^{''} 22 | 16 | 130 ^{''} 89 |
| 16 | 103 ^{''} 81 | 2 | 125 ^{''} 62 | 16 | 97 ^{''} 76 | 17 | 130 ^{''} 57 |
| 24 | 103 ^{''} 96 | 3 | 126 ^{''} 58 | March 6 | 94 ^{''} 37 | 18 | 130 ^{''} 20 |
| June 2 | 107 ^{''} 15 | 4 | 125 ^{''} 07 | 12 | 94 ^{''} 35 | 24 | 132 ^{''} 32 |
| 3 | 107 ^{''} 80 | 5 | 125 ^{''} 86 | 16 | 94 ^{''} 85 | 31 | 131 ^{''} 96 |
| 6 | 108 ^{''} 38 | 8 | 125 ^{''} 80 | 29 | 94 ^{''} 51 | Sept. 5 | 132 ^{''} 97 |
| 8 | 108 ^{''} 36 | 9 | 125 ^{''} 96 | April 4 | 96 ^{''} 02 | 6 | 133 ^{''} 22 |
| 9 | 108 ^{''} 98 | 11 | 126 ^{''} 48 | 5 | 96 ^{''} 34 | 11 | 132 ^{''} 77 |
| | | 12 | 126 ^{''} 85 | 17 | 96 ^{''} 58 | 12 | 134 ^{''} 54 |

Observed Apparent North Zenith Distances of γ Draconis (continued).

| Day. | Observed Apparent N.Z.D. | Day. | Observed Apparent N.Z.D. | Day. | Observed Apparent N.Z.D. | Day. | Observed Apparent N.Z.D. |
|------------------------------|--------------------------------|---------------------------|--------------------------------|--------------------------------|--------------------------------|-------------------------------|--------------------------------|
| ^{1843.} Sept. 13 | " 134°24 | ^{1844.} May 6 | " 103°79 | ^{1845.} Jan. 27 21 | " 105°30 | ^{1845.} Oct. 14 4 | " 137°74 |
| 15 | 134°83 | June 10 | 114°56 | Feb. 14 20 | 102°01 | 18 4 | 137°24 |
| 16 | 134°48 | 13 | 114°99 | 19 20 | 102°80 | 20 4 | 137°35 |
| 20 | 134°89 | 22 | 118°00 | 20 20 | 101°05 | 21 4 | 137°38 |
| 21 | 133°69 | July 9 | 123°42 | March 5 19 | 100°46 | 29 3 | 136°30 |
| 22 | 134°42 | 15 | 124°71 | 31 17 | 100°22 | Nov. 1 3 | 135°43 |
| 23 | 134°54 | 19 | 126°81 | April 2 17 | 101°26 | 4 3 | 134°30 |
| Oct. 13 | 134°51 | 20 | 127°06 | 3 17 | 101°44 | 13 2 | 132°35 |
| 19 | 133°32 | 22 | 128°02 | 6 17 | 99°85 | 15 2 | 131°34 |
| 23 | 134°23 | 23 | 128°14 | 13 16 | 101°46 | 24 2 | 129°43 |
| Nov. 20 | 125°87 | 24 | 127°34 | June 9 12 | 119°20 | Dec. 1 1 | 128°01 |
| 23 | 125°10 | 27 | 129°54 | 12 12 | 118°12 | 5 1 | 126°49 |
| 28 | 124°26 | 29 | 128°76 | 14 12 | 118°66 | 6 1 | 125°56 |
| Dec. 6 | 121°06 | 31 | 129°70 | 28 11 | 122°17 | 10 1 | 124°12 |
| ^{1844.} Jan. 9 | 109°36 | Aug. 1 | 130°49 | July 3 11 | 123°62 | ^{1846.} May 21 14 | 112°44 |
| 31 | 102°87 | 6 | 131°23 | 8 11 | 125°60 | 26 13 | 114°91 |
| Feb. 15 | 100°59 | 7 | 131°77 | 16 10 | 128°19 | 29 13 | 113°02 |
| 22 | 100°55 | 8 | 131°47 | 21 10 | 129°58 | June 1 13 | 113°28 |
| 27 | 97°47 | 16 | 132°83 | 28 10 | 130°77 | 2 13 | 115°05 |
| March 5 | 97°90 | 17 | 133°25 | Aug. 1 9 | 133°90 | 13 12 | 117°86 |
| 12 | 96°86 | 28 | 134°92 | 8 8 | 134°10 | 16 12 | 118°90 |
| 20 | 96°32 | 29 | 134°32 | 20 8 | 136°07 | 17 12 | 120°99 |
| 25 | 96°68 | 31 | 135°45 | 22 7 | 137°45 | 19 12 | 120°12 |
| April 3 | 97°13 | Sept. 2 | 136°09 | 23 7 | 136°83 | 25 12 | 122°42 |
| 8 | 97°64 | 4 | 135°94 | 26 7 | 138°44 | 27 11 | 123°78 |
| 9 | 97°90 | 7 | 136°21 | 28 7 | 137°38 | 29 11 | 124°73 |
| 10 | 97°09 | 10 | 135°86 | 30 7 | 138°27 | July 3 11 | 125°55 |
| 16 | 98°52 | 25 | 137°59 | Sept. 1 7 | 138°19 | 4 11 | 125°26 |
| 17 | 99°67 | 26 | 137°23 | 6 7 | 139°34 | 10 11 | 128°42 |
| 24 | 100°77 | Oct. 31 | 133°76 | 8 7 | 139°42 | 14 10 | 128°12 |
| 25 | 101°26 | Nov. 26 | 127°65 | 9 7 | 138°58 | 15 10 | 129°14 |
| 29 | 102°00 | Dec. 5 | 123°82 | 12 7 | 139°58 | 20 10 | 130°77 |
| May 1 | 103°01 | 6 | 123°28 | Oct. 8 5 | 138°56 | | |

Constants of Nutation and Aberration, &c.

159

Observed Apparent North Zenith Distances of γ Draconis (concluded).

| Day. | Observed Apparent N.Z.D. | Day. | Observed Apparent N.Z.D. | Day. | Observed Apparent N.Z.D. | Day. | Observed Apparent N.Z.D. |
|-----------------------------|--------------------------------|--------------------|--------------------------------|--------------------|--------------------------------|------------------------------|--------------------------------|
| ^{1846.} h | " | ^{1847.} h | " | ^{1847.} h | " | ^{1847.} h | " |
| July 23 10 | 130°69 | Jan. 14 22 | 114°67 | May 25 14 | 114°50 | July 29 9 | 135°05 |
| 29 9 | 130°86 | 29 21 | 107°67 | 26 14 | 114°54 | Aug. 3 9 | 133°64 |
| 30 9 | 131°83 | Mar. 10 19 | 99°83 | 29 13 | 117°75 | 6 9 | 135°18 |
| 31 9 | 133°34 | 14 18 | 100°76 | 30 13 | 118°45 | 12 9 | 136°76 |
| Aug. 5 9 | 135°58 | 15 18 | 103°09 | 31 13 | 113°20 | 13 8 | 135°62 |
| 7 9 | 134°92 | 17 18 | 101°62 | June 1 13 | 116°66 | 14 8 | 138°45 |
| 12 9 | 136°14 | 18 18 | 101°26 | 2 13 | 117°11 | 20 8 | 137°95 |
| 13 8 | 136°61 | 21 18 | 101°66 | 7 13 | 118°41 | 27 8 | 139°60 |
| 14 8 | 137°09 | 22 18 | 102°04 | 8 13 | 120°00 | 31 7 | 140°01 |
| 17 8 | 138°97 | 28 17 | 101°05 | 22 12 | 123°67 | Sept. 4 7 | 141°72 |
| 22 8 | 138°98 | 29 17 | 101°03 | July 5 11 | 127°80 | 10 7 | 139°60 |
| Sept. 2 7 | 138°22 | 30 17 | 103°06 | 6 11 | 127°76 | 11 7 | 142°56 |
| 15 6 | 140°23 | April 9 17 | 102°60 | 7 11 | 129°02 | 22 6 | 142°22 |
| 18 6 | 138°28 | 13 16 | 105°47 | 8 11 | 129°10 | 24 6 | 140°83 |
| 22 6 | 140°77 | 15 16 | 105°30 | 10 11 | 129°07 | 29 5 | 140°77 |
| Nov. 11 3 | 134°93 | 20 16 | 104°52 | 12 11 | 129°25 | Nov. 29 1 | 130°10 |
| Dec. 14 0 | 123°90 | 23 16 | 104°82 | 15 10 | 129°55 | Dec. 13 0 | 124°94 |
| 30 23 | 118°21 | May 5 15 | 105°77 | 16 10 | 130°38 | ^{1848.} April 12 16 | 102°87 |
| ^{1847.} Jan. 10 23 | 114°55 | 11 15 | 107°56 | 21 10 | 130°39 | 14 16 | 104°25 |
| 11 22 | 113°79 | 12 15 | 109°07 | 22 10 | 133°55 | May 1 15 | 107°71 |
| 13 22 | 113°56 | 24 14 | 114°91 | 27 10 | 133°09 | | |

TABLE II.

Means of the Observed Apparent Zenith Distances of γ Draconis deduced from Groups of Short Intervals.

| No. of Group. | Extent of Group. | Mean Day and Hour. | Mean of Observed Zen. Dist. | Number of Obs. in Group. |
|---------------|--------------------------|--------------------------------------|-----------------------------|--------------------------|
| 1 | 1837, June 7 to 24 | June 18 ^d 23 ^h | 111°20' | 6 |
| 2 | June 26 to July 1 | 29 0 | 114°61' | 6 |
| 3 | July 4 to 13 | July 9 18 | 118°42' | 7 |
| 4 | July 15 to 26 | 22 1 | 121°72' | 7 |
| 5 | August 3 to 18 | Aug. 12 15 | 126°68' | 10 |
| 6 | August 24 to 31 | 27 22 | 128°02' | 4 |
| 7 | Sept. 2 to 15 | Sept. 9 7 | 130°11' | 4 |
| 8 | Sept. 20 to 30 | 25 0 | 130°34' | 8 |
| 9 | Oct. 3 to 9 | Oct. 5 17 | 129°42' | 4 |
| 10 | Oct. 14 to 27 | 20 12 | 127°70' | 3 |
| 11 | Nov. 2 to 17 | Nov. 9 21 | 123°39' | 7 |
| 12 | Nov. 20 to 29 | 25 8 | 119°62' | 4 |
| 13 | Dec. 1 to 1838, Jan. 2 | Dec. 16 12 | 112°80' | 6 |
| 14 | 1838, March 5 to 8 | March 7 3 | 90°21' | 3 |
| 15 | March 20 to 27 | 25 2 | 90°84' | 3 |
| 16 | April 1 to 11 | April 7 9 | 90°75' | 3 |
| 17 | April 27 to May 4 | May 1 15 | 95°18' | 3 |
| 18 | May 11 to 22 | 17 3 | 100°70' | 4 |
| 19 | May 31 to June 7 | June 4 23 | 104°61' | 5 |
| 20 | June 13 to 29 | 20 16 | 110°06' | 16 |
| 21 | July 4 to 12 | July 9 11 | 115°36' | 4 |
| 22 | July 13 to 24 | 19 4 | 118°97' | 4 |
| 23 | August 6 to 15 | Aug. 11 17 | 123°37' | 6 |
| 24 | August 21 to 31 | 27 4 | 126°16' | 6 |
| 25 | Sept. 2 to 11 | Sept. 6 12 | 127°22' | 5 |
| 26 | Sept. 12 to 28 | 19 6 | 128°37' | 4 |

Constants of Nutation and Aberration, &c.

161

Means of the Observed Apparent Zenith Distances, &c. (continued).

| No. of Group. | Extent of Group. | Mean Day and Hour. | Mean of Observed Zen. Dist. | Number of Obs. in Group. |
|---------------|--------------------------|--------------------------------------|-----------------------------|--------------------------|
| 27 | 1838, Oct. 3 to 19 | Oct. 11 ^d 12 ^h | 128 ^{''} ·41 | 3 |
| 28 | Oct. 24 to 31 | 28 15 | 126 ^{''} ·79 | 4 |
| 29 | Nov. 7 to 13 | Nov. 10 18 | 122 ^{''} ·63 | 3 |
| 30 | Nov. 26 to Dec. 8 | Dec. 2 19 | 115 ^{''} ·97 | 4 |
| 31 | Dec. 10 to 30 | 20 6 | 111 ^{''} ·41 | 4 |
| 32 | 1839, Jan. 7 to 21 | Jan. 12 4 | 101 ^{''} ·78 | 4 |
| 33 | Feb. 27 to March 3 .. | March 1 19 | 87 ^{''} ·86 | 2 |
| 34 | March 20 | 20 18 | 89 ^{''} ·67 | 1 |
| 35 | April 19 to 31 | April 26 5 | 92 ^{''} ·79 | 5 |
| 36 | May 15 to 29 | May 22 22 | 100 ^{''} ·52 | 6 |
| 37 | June 5 to 11 | June 8 6 | 103 ^{''} ·67 | 4 |
| 38 | June 12 to 19 | 16 12 | 108 ^{''} ·95 | 4 |
| 39 | July 1 to 10 | July 7 6 | 114 ^{''} ·78 | 5 |
| 40 | July 13 to 22 | 17 15 | 117 ^{''} ·31 | 5 |
| 41 | August 1 to 12 | Aug. 6 23 | 124 ^{''} ·07 | 5 |
| 42 | August 17 to 23 | 20 14 | 126 ^{''} ·49 | 4 |
| 43 | Sept. 4 to 18 | Sept. 8 19 | 128 ^{''} ·43 | 4 |
| 44 | Sept. 21 to 30 | 26 18 | 128 ^{''} ·40 | 6 |
| 45 | Oct. 9 to 18 | Oct. 13 10 | 127 ^{''} ·58 | 4 |
| 46 | Nov. 23 to 26 | Nov. 24 14 | 118 ^{''} ·89 | 2 |
| 47 | Dec. 17 to 20 | Dec. 18 12 | 111 ^{''} ·52 | 2 |
| 48 | 1840, Jan. 1 to 15 | Jan. 8 23 | 104 ^{''} ·07 | 7 |
| 49 | April 1 to 15 | April 9 14 | 90 ^{''} ·54 | 7 |
| 50 | April 17 to 29 | 24 22 | 93 ^{''} ·23 | 6 |
| 51 | May 22 to June 3 | May 29 23 | 103 ^{''} ·13 | 7 |
| 52 | June 10 to 22 | June 16 17 | 108 ^{''} ·42 | 6 |
| 53 | July 31 to Aug. 5 | Aug. 2 23 | 122 ^{''} ·89 | 5 |
| 54 | August 8 to 17 | 13 8 | 124 ^{''} ·77 | 6 |
| 55 | August 21 to Sept. 1.. | 27 12 | 126 ^{''} ·10 | 6 |
| 56 | Sept. 3 to 11 | Sept. 7 12 | 126 ^{''} ·50 | 5 |
| 57 | Sept. 15 to 29 | 21 6 | 127 ^{''} ·33 | 4 |
| 58 | Oct. 8 to 21 | Oct. 12 9 | 126 ^{''} ·79 | 5 |
| 59 | Nov. 12 to 27 | Nov. 19 20 | 120 ^{''} ·61 | 4 |

ROYAL ASTRON. SOC. VOL. XXIV.

Y

Rev. R. MAIN, *on the Values of the**Means of the Observed Apparent Zenith Distances, &c. (continued).*

| No. of Group. | Extent of Group. | Mean Day and Hour. | Mean of Observed Zen. Dist. | Number of Obs. in Group. |
|---------------|----------------------------|-------------------------------------|-----------------------------|--------------------------|
| 60 | 1840, Dec. 9 to 23 | Dec. 17 ^d 6 ^h | 112 ["] 28 | 4 |
| 61 | 1841, March 11 to 25 | Mar. 18 7 | 92 ["] 59 | 7 |
| 62 | April 15 to 30 | April 25 6 | 94 ["] 57 | 5 |
| 63 | May 13 to 26 | May 19 1 | 100 ["] 50 | 7 |
| 64 | May 28 to June 10 .. | June 3 13 | 104 ["] 76 | 5 |
| 65 | June 15 to 22 | 18 17 | 110 ["] 37 | 5 |
| 66 | July 26 to Aug. 12 .. | Aug. 4 12 | 124 ["] 03 | 7 |
| 67 | Aug. 14 to 28 | 20 18 | 126 ["] 15 | 7 |
| 68 | Aug. 30 to Sept. 13 .. | Sept. 6 1 | 128 ["] 94 | 4 |
| 69 | Sept. 15 to 25 | 20 12 | 128 ["] 97 | 4 |
| 70 | Oct. 5 to 7 | Oct. 6 5 | 129 ["] 86 | 2 |
| 71 | Nov. 8 to 12 | Nov. 10 10 | 122 ["] 31 | 3 |
| 72 | Dec. 7 to 21 | Dec. 14 14 | 111 ["] 97 | 7 |
| 73 | 1842, Jan. 2 to 27 | Jan. 16 4 | 100 ["] 49 | 4 |
| 74 | March 8 to 25 | Mar. 20 6 | 93 ["] 82 | 4 |
| 75 | April 5 to 19 | April 10 22 | 94 ["] 08 | 4 |
| 76 | April 20 to May 2 .. | 27 2 | 96 ["] 23 | 10 |
| 77 | May 10 to 24 | May 16 2 | 101 ["] 81 | 4 |
| 78 | June 2 to 14 | June 8 23 | 108 ["] 74 | 9 |
| 79 | June 15 to 29 | 22 7 | 112 ["] 60 | 5 |
| 80 | July 2 to 15 | July 9 14 | 117 ["] 94 | 9 |
| 81 | July 21 to 29 | 25 18 | 122 ["] 65 | 6 |
| 82 | Aug. 1 to 16 | Aug. 8 15 | 126 ["] 37 | 12 |
| 83 | Aug. 20 to 31 | 25 8 | 128 ["] 25 | 4 |
| 84 | Sept. 2 to 9 | Sept. 5 1 | 129 ["] 87 | 4 |
| 85 | Sept. 13 to 28 | 19 12 | 131 ["] 61 | 4 |
| 86 | Oct. 11 to 19 | Oct. 15 4 | 131 ["] 18 | 2 |
| 87 | Nov. 28 to Dec. 14 .. | Dec. 8 9 | 117 ["] 95 | 3 |
| 88 | Dec. 15 to 27 | 21 0 | 113 ["] 16 | 3 |
| 89 | 1843, Jan. 10 | Jan. 10 23 | 106 ["] 44 | 1 |
| 90 | Feb. 12 to 16 | Feb. 14 20 | 97 ["] 99 | 2 |
| 91 | March 6 to 16 | Mar. 12 3 | 94 ["] 52 | 3 |
| 92 | March 29 to April 5 .. | April 3 1 | 95 ["] 62 | 3 |
| 93 | April 17 to 30 | 24 8 | 98 ["] 84 | 3 |

Constants of Nutation and Aberration, &c.

163

Means of the Observed Apparent Zenith Distances, &c. (continued).

| No. of Group. | Extent of Group. | Mean Day and Hour. | Mean of Observed Zen. Dist. | Number of Obs. in Group. |
|---------------|--------------------------|------------------------------------|-----------------------------|--------------------------|
| 94 | 1843, May 4 to 19 | May ^d 12 ^h 3 | " 103°75 | 2 |
| 95 | May 25 to 29 | 27 14 | 107°56 | 3 |
| 96 | June 3 to 16 | June 8 13 | 111°18 | 3 |
| 97 | June 22 to 28 | 25 20 | 116°62 | 3 |
| 98 | July 8 to 19 | July 13 23 | 121°16 | 2 |
| 99 | July 24 to 29 | 26 10 | 126°23 | 3 |
| 100 | August 1 to 12 | Aug. 7 5 | 128°82 | 6 |
| 101 | August 16 to 31 | 21 13 | 131°19 | 5 |
| 102 | Sept. 5 to 16 | Sept. 11 10 | 133°86 | 7 |
| 103 | Sept. 20 to 23 | 21 18 | 134°39 | 4 |
| 104 | Oct. 13 to 23 | Oct. 18 12 | 134°02 | 3 |
| 105 | Nov. 20 to Dec. 6.... | Nov. 26 20 | 124°32 | 4 |
| 106 | 1844, Jan. 9 to 31 | Jan. 20 22 | 106°12 | 2 |
| 107 | Feb. 15 to 27 | Feb. 22 4 | 99°54 | 3 |
| 108 | March 5 to 20 | Mar. 13 2 | 97°03 | 3 |
| 109 | March 25 to April 10. | April 5 12 | 97°29 | 5 |
| 110 | April 16 to 29 | 22 21 | 100°44 | 5 |
| 111 | May 1 to 6 | May 4 3 | 103°40 | 2 |
| 112 | June 10 to 22 | June 15 13 | 115°85 | 3 |
| 113 | July 9 to 24 | July 19 7 | 126°50 | 7 |
| 114 | July 27 to Aug. 8 .. | Aug. 2 16 | 130°42 | 7 |
| 115 | Aug. 16 to 31 | 24 13 | 134°15 | 5 |
| 116 | Sept. 2 to 10 | Sept. 6 1 | 136°03 | 4 |
| 117 | Sept. 25 to 26 | 26 0 | 137°41 | 2 |
| 118 | Oct. 31 | Oct. 31 3 | 133°76 | 1 |
| 119 | Nov. 26 | Nov. 26 1 | 127°65 | 1 |
| 120 | Dec. 5 to 6 | Dec. 5 12 | 123°55 | 2 |
| 121 | 1845, Jan. 27 | Jan. 27 21 | 105°30 | 1 |
| 122 | Feb. 14 to 20 | Feb. 18 12 | 101°95 | 3 |
| 123 | March 5 | Mar. 5 19 | 100°46 | 1 |
| 124 | March 31 to April 13. | April 5 12 | 100°85 | 5 |
| 125 | June 9 to 14 | June 12 4 | 118°66 | 3 |
| 126 | June 28 to July 16 .. | July 6 17 | 124°90 | 4 |
| 127 | July 21 to Aug. 1 .. | 27 10 | 131°42 | 3 |

Means of the Observed Apparent Zenith Distances, &c. (concluded).

| No. of Group. | Extent of Group. | Mean Day and Hour. | Mean of Observed Zen. Dist. | Number of Obs. in Group. |
|---------------|-----------------------------|------------------------------------|-----------------------------|--------------------------|
| 128 | 1845, August 8 | Aug. 8 ^d 8 ^h | 134°10' | 1 |
| 129 | August 20 to Sept. 1.. | 26 4 | 137°52' | 7 |
| 130 | Sept. 6 to 22 | Sept. 9 1 | 139°23' | 4 |
| 131 | Oct. 8 to 21 | Oct. 16 9 | 137°65' | 5 |
| 132 | Oct. 29 to Nov. 15 .. | Nov. 6 7 | 133°94' | 5 |
| 133 | Nov. 24 to Dec. 10 .. | Dec. 3 6 | 126°72' | 5 |
| 134 | 1846, May 21 to June 2 | May 28 18 | 113°74' | 5 |
| 135 | June 13 to 19 | June 16 18 | 119°47' | 4 |
| 136 | June 25 to July 4.... | 30 2 | 124°35' | 5 |
| 137 | July 10 to 23..... | July 16 20 | 129°43' | 5 |
| 138 | July 29 to Aug. 7.... | Aug. 2 4 | 133°31' | 5 |
| 139 | August 12 to 22 | 15 23 | 137°56' | 5 |
| 140 | Sept. 2 to 15 | Sept. 8 19 | 139°23' | 2 |
| 141 | Sept. 18 to 22 | 20 6 | 139°53' | 2 |
| 142 | November 11..... | Nov. 11 3 | 134°93' | 1 |
| 143 | Dec. 14 to 30..... | Dec. 22 12 | 121°06' | 2 |
| 144 | 1847, Jan. 10 to 14..... | Jan. 12 22 | 114°14' | 4 |
| 145 | Jan. 29 | 29 21 | 107°67' | 1 |
| 146 | March 10 to 18 | Mar. 5 13 | 101°31' | 5 |
| 147 | March 21 to 30 | 26 17 | 101°77' | 5 |
| 148 | April 9 to 23 | April 16 16 | 104°54' | 5 |
| 149 | May 5 to 12 | May 9 23 | 107°47' | 3 |
| 150 | May 24 to June 2 | 29 7 | 115°89' | 8 |
| 151 | June 7 to 22 | June 12 21 | 120°69' | 3 |
| 152 | July 5 to 16 | July 10 8 | 128°99' | 8 |
| 153 | July 21 to Aug. 6.... | 28 17 | 133°48' | 6 |
| 154 | Aug. 12 to 20 | Aug. 15 2 | 137°20' | 4 |
| 155 | Aug. 27 to Sept. 4 ... | 31 7 | 140°44' | 3 |
| 156 | Sept. 10 to 11 | Sept. 10 19 | 141°08' | 2 |
| 157 | Sept. 22 to 29 | 25 6 | 141°27' | 3 |
| 158 | Nov. 29 | Nov. 29 1 | 130°10' | 1 |
| 159 | Dec. 13 | Dec. 13 0 | 124°94' | 1 |
| 160 | 1848, April 12 to 14 | April 13 16 | 103°56' | 2 |
| 161 | May 1 | May 1 15 | 107°71' | 1 |

TABLE III.

Values of the Sun's Longitude, Moon's Longitude, and of the Longitude of the Moon's Node for the Days of Observation.

| No. of Series. | ☉ | ☾ | ♁ | No. of Series. | ☉ | ☾ | ♁ |
|----------------|---------|------|---------|----------------|----------|------|--------|
| 1 | 87° 44' | 277° | 28° 39' | 26 | 176° 19' | 186° | 4° 26' |
| 2 | 97 27 | 59 | 28 7 | 27 | 198 14 | 126 | 3 15 |
| 3 | 107 41 | 189 | 27 33 | 28 | 215 16 | 341 | 2 20 |
| 4 | 119 24 | 3 | 26 54 | 29 | 228 27 | 162 | 1 39 |
| 5 | 140 5 | 276 | 25 45 | 30 | 250 44 | 94 | 0 29 |
| 6 | 154 50 | 125 | 24 57 | 31 | 268 29 | 315 | 359 54 |
| 7 | 166 50 | 281 | 24 17 | 32 | 291 50 | 255 | 358 21 |
| 8 | 182 11 | 134 | 23 27 | 33 | 341 2 | 182 | 355 46 |
| 9 | 192 44 | 269 | 22 53 | 34 | 359 57 | 78 | 354 46 |
| 10 | 207 24 | 113 | 22 6 | 35 | 35 44 | 193 | 352 51 |
| 11 | 227 46 | 20 | 21 1 | 36 | 61 32 | 186 | 351 25 |
| 12 | 243 24 | 215 | 20 12 | 37 | 77 11 | 37 | 350 33 |
| 13 | 264 55 | 141 | 19 5 | 38 | 85 4 | 153 | 350 7 |
| 14 | 346 38 | 126 | 14 49 | 39 | 104 51 | 62 | 349 1 |
| 15 | 4 29 | 0 | 13 52 | 40 | 114 45 | 199 | 348 28 |
| 16 | 17 36 | 173 | 13 9 | 41 | 134 12 | 110 | 347 23 |
| 17 | 41 14 | 137 | 11 52 | 42 | 147 18 | 279 | 346 41 |
| 18 | 56 12 | 336 | 11 4 | 43 | 165 53 | 181 | 345 39 |
| 19 | 74 16 | 221 | 10 3 | 44 | 183 26 | 58 | 344 42 |
| 20 | 89 16 | 78 | 9 13 | 45 | 199 53 | 269 | 343 49 |
| 21 | 107 12 | 319 | 8 14 | 46 | 242 10 | 117 | 341 36 |
| 22 | 116 27 | 94 | 7 43 | 47 | 266 28 | 65 | 340 20 |
| 23 | 139 0 | 44 | 6 27 | 48 | 288 20 | 342 | 339 11 |
| 24 | 153 53 | 236 | 5 39 | 49 | 20 16 | 121 | 334 20 |
| 25 | 163 54 | 22 | 5 6 | 50 | 35 14 | 310 | 333 30 |

Longitudes of the Sun and Moon and of the Moon's Node (continued).

| No. of Series. | ☉ | ☽ | ♁ | No. of Series. | ☉ | ☽ | ♁ |
|----------------|--------|-----|----------|----------------|----------|------|----------|
| 51 | 69° 2' | 57° | 331° 40' | 84 | 162° 30' | 171° | 287° 49' |
| 52 | 86 0 | 289 | 330 43 | 85 | 176 35 | 359 | 287 3 |
| 53 | 131 5 | 201 | 328 13 | 86 | 201 54 | 340 | 285 42 |
| 54 | 141 2 | 327 | 327 41 | 87 | 256 26 | 335 | 282 49 |
| 55 | 154 42 | 164 | 326 55 | 88 | 269 17 | 137 | 282 9 |
| 56 | 165 22 | 300 | 326 20 | 89 | 290 39 | 50 | 281 2 |
| 57 | 178 47 | 128 | 325 37 | 90 | 326 2 | 153 | 279 12 |
| 58 | 199 36 | 41 | 324 30 | 91 | 351 25 | 121 | 277 51 |
| 59 | 238 8 | 196 | 322 27 | 92 | 13 8 | 52 | 276 42 |
| 60 | 265 57 | 198 | 321 0 | 93 | 33 58 | 341 | 275 33 |
| 61 | 358 2 | 308 | 316 11 | 94 | 51 12 | 212 | 274 38 |
| 62 | 35 20 | 91 | 314 11 | 95 | 66 4 | 52 | 273 49 |
| 63 | 58 19 | 39 | 312 55 | 96 | 77 31 | 214 | 273 11 |
| 64 | 73 11 | 252 | 312 6 | 97 | 94 0 | 77 | 272 15 |
| 65 | 87 41 | 86 | 311 17 | 98 | 111 17 | 324 | 271 18 |
| 66 | 132 20 | 341 | 308 49 | 99 | 123 11 | 119 | 270 38 |
| 67 | 147 57 | 206 | 307 57 | 100 | 134 29 | 284 | 270 1 |
| 68 | 163 43 | 48 | 307 6 | 101 | 148 15 | 102 | 269 15 |
| 69 | 177 49 | 250 | 306 19 | 102 | 168 28 | 23 | 268 9 |
| 70 | 193 16 | 88 | 305 30 | 103 | 178 34 | 155 | 267 36 |
| 71 | 228 23 | 199 | 303 38 | 104 | 204 58 | 145 | 266 11 |
| 72 | 263 0 | 288 | 301 50 | 105 | 244 28 | 318 | 264 6 |
| 73 | 296 12 | 350 | 300 6 | 106 | 300 32 | 321 | 261 11 |
| 74 | 359 45 | 100 | 296 45 | 107 | 333 11 | 23 | 259 28 |
| 75 | 21 6 | 26 | 295 36 | 108 | 353 7 | 289 | 258 26 |
| 76 | 36 52 | 250 | 294 45 | 109 | 16 18 | 234 | 257 11 |
| 77 | 55 15 | 133 | 293 45 | 110 | 33 17 | 95 | 256 16 |
| 78 | 78 8 | 85 | 292 29 | 111 | 44 12 | 252 | 255 40 |
| 79 | 90 51 | 269 | 291 47 | 112 | 84 55 | 85 | 253 25 |
| 80 | 107 20 | 132 | 290 52 | 113 | 117 7 | 167 | 251 38 |
| 81 | 122 47 | 344 | 290 0 | 114 | 130 51 | 8 | 250 52 |
| 82 | 136 3 | 164 | 289 16 | 115 | 151 53 | 294 | 249 43 |
| 83 | 152 8 | 24 | 288 23 | 116 | 163 59 | 92 | 249 3 |

Constants of Nutation and Aberration, &c.

167

Longitudes of the Sun and Moon and of the Moon's Node (concluded).

| No. of Series. | ☉ | ☾ | Ω | No. of Series. | ☉ | ☾ | Ω |
|----------------|----------|-----|---------|----------------|----------|-----|----------|
| 117 | 183° 29' | 3° | 248° 0' | 140 | 166° 11' | 38° | 210° 15' |
| 118 | 218 19 | 97 | 246 8 | 141 | 177 22 | 178 | 209 38 |
| 119 | 244 26 | 81 | 244 46 | 142 | 228 53 | 146 | 206 54 |
| 120 | 254 2 | 201 | 244 16 | 143 | 270 50 | 331 | 204 42 |
| 121 | 308 23 | 184 | 241 26 | 144 | 292 40 | 246 | 203 34 |
| 122 | 330 16 | 112 | 240 18 | 145 | 309 54 | 119 | 202 40 |
| 123 | 345 36 | 319 | 239 29 | 146 | 344 52 | 207 | 200 50 |
| 124 | 16 3 | 6 | 237 51 | 147 | 5 55 | 135 | 199 40 |
| 125 | 81 28 | 166 | 234 16 | 148 | 26 31 | 52 | 198 36 |
| 126 | 104 52 | 133 | 232 58 | 149 | 49 8 | 352 | 197 22 |
| 127 | 124 38 | 55 | 231 52 | 150 | 67 44 | 244 | 196 21 |
| 128 | 136 4 | 200 | 231 15 | 151 | 81 40 | 86 | 195 35 |
| 129 | 153 12 | 84 | 230 18 | 152 | 107 52 | 88 | 194 7 |
| 130 | 166 38 | 261 | 229 34 | 153 | 125 25 | 323 | 193 9 |
| 131 | 203 21 | 41 | 227 35 | 154 | 142 4 | 192 | 192 14 |
| 132 | 224 15 | 315 | 226 29 | 155 | 157 42 | 53 | 191 22 |
| 133 | 251 30 | 310 | 225 3 | 156 | 167 54 | 185 | 190 49 |
| 134 | 67 27 | 114 | 215 42 | 157 | 182 2 | 18 | 190 3 |
| 135 | 85 36 | 8 | 214 42 | 158 | 246 44 | 155 | 186 37 |
| 136 | 98 20 | 174 | 214 0 | 159 | 260 55 | 330 | 185 53 |
| 137 | 114 17 | 46 | 213 7 | 160 | 24 19 | 156 | 179 23 |
| 138 | 129 55 | 247 | 212 15 | 161 | 41 48 | 25 | 178 26 |
| 139 | 143 8 | 82 | 211 31 | | | | |

Table of Corrections for Annual Variation of γ Draconis in North Zenith Distance, for every 100 days from 1840, Jan. 1.

| Days. | Variation. | Days. | Variation. | Days. | Variation. | Days. | Variation. |
|-------|----------------------|-------|----------------------|-------|----------------------|-------|----------------------|
| 1 | —0 ^{''} 002 | 10 | —0 ^{''} 018 | 100 | —0 ^{''} 181 | 1600 | —2 ^{''} 898 |
| 2 | 0 ^{''} 003 | 20 | 0 ^{''} 036 | 200 | 0 ^{''} 362 | 1700 | 3 ^{''} 079 |
| 3 | 0 ^{''} 005 | 30 | 0 ^{''} 054 | 300 | 0 ^{''} 543 | 1800 | 3 ^{''} 260 |
| 4 | 0 ^{''} 007 | 40 | 0 ^{''} 072 | 400 | 0 ^{''} 724 | 1900 | 3 ^{''} 441 |
| 5 | 0 ^{''} 009 | 50 | 0 ^{''} 091 | 500 | 0 ^{''} 906 | 2000 | 3 ^{''} 622 |
| 6 | 0 ^{''} 011 | 60 | 0 ^{''} 109 | 600 | 1 ^{''} 087 | 2100 | 3 ^{''} 803 |
| 7 | 0 ^{''} 013 | 70 | 0 ^{''} 127 | 700 | 1 ^{''} 268 | 2200 | 3 ^{''} 984 |
| 8 | 0 ^{''} 014 | 80 | 0 ^{''} 145 | 800 | 1 ^{''} 449 | 2300 | 4 ^{''} 165 |
| 9 | —0 ^{''} 016 | 90 | —0 ^{''} 163 | 900 | 1 ^{''} 630 | 2400 | 4 ^{''} 346 |
| | | | | 1000 | 1 ^{''} 811 | 2500 | 4 ^{''} 527 |
| | | | | 1100 | 1 ^{''} 992 | 2600 | 4 ^{''} 708 |
| | | | | 1200 | 2 ^{''} 173 | 2700 | 4 ^{''} 889 |
| | | | | 1300 | 2 ^{''} 354 | 2800 | 5 ^{''} 070 |
| | | | | 1400 | 2 ^{''} 535 | 2900 | 5 ^{''} 251 |
| | | | | 1500 | —2 ^{''} 717 | 3000 | —5 ^{''} 432 |

For observations before 1840 change the sign.

TABLE IV.

*Tabulated Values of the Aberration, assuming the Constant to be 20''
(for 1840).*

[When the Argument is on the right-hand side of the Value, change the sign.]

| ⊙ | Value. | ⊙ | ⊙ | Value. | ⊙ | ⊙ | Value. | ⊙ |
|----|----------------------|------|-----|----------------------|------|-----|---------------------|------|
| 0° | -19'32 | 180° | 27° | -16'98 | 207° | 54° | -10'95 | 234° |
| 1 | 19'30 ² | 181 | 28 | 16'82 ¹⁶ | 208 | 55 | 10'68 ²⁷ | 235 |
| 2 | 19'28 ² | 182 | 29 | 16'66 ¹⁶ | 209 | 56 | 10'40 ²⁸ | 236 |
| 3 | 19'26 ² | 183 | 30 | 16'48 ¹⁸ | 210 | 57 | 10'12 ²⁸ | 237 |
| 4 | 19'23 ² | 184 | 31 | 16'30 ¹⁸ | 211 | 58 | 9'83 ²⁹ | 238 |
| 5 | 19'20 ³ | 185 | 32 | 16'12 ¹⁸ | 212 | 59 | 9'54 ²⁹ | 239 |
| 6 | 19'16 ⁴ | 186 | 33 | 15'94 ¹⁸ | 213 | 60 | 9'24 ³⁰ | 240 |
| 7 | 19'11 ⁵ | 187 | 34 | 15'76 ¹⁹ | 214 | 61 | 8'94 ³⁰ | 241 |
| 8 | 19'06 ⁵ | 188 | 35 | 15'55 ²⁰ | 215 | 62 | 8'64 ³⁰ | 242 |
| 9 | 19'00 ⁶ | 189 | 36 | 15'34 ²¹ | 216 | 63 | 8'34 ³⁰ | 243 |
| 10 | 18'94 ⁶ | 190 | 37 | 15'13 ²¹ | 217 | 64 | 8'04 ³⁰ | 244 |
| 11 | 18'86 ⁸ | 191 | 38 | 14'92 ²¹ | 218 | 65 | 7'73 ³¹ | 245 |
| 12 | 18'78 ⁸ | 192 | 39 | 14'70 ²² | 219 | 66 | 7'42 ³¹ | 246 |
| 13 | 18'70 ⁸ | 193 | 40 | 14'48 ²² | 220 | 67 | 7'10 ³² | 247 |
| 14 | 18'61 ⁹ | 194 | 41 | 14'26 ²² | 221 | 68 | 6'78 ³² | 248 |
| 15 | 18'52 ⁹ | 195 | 42 | 14'02 ²⁴ | 222 | 69 | 6'46 ³² | 249 |
| 16 | 18'42 ¹⁰ | 196 | 43 | 13'79 ²³ | 223 | 70 | 6'14 ³² | 250 |
| 17 | 18'32 ¹⁰ | 197 | 44 | 13'56 ²³ | 224 | 71 | 5'82 ³² | 251 |
| 18 | 18'22 ¹⁰ | 198 | 45 | 13'32 ²⁴ | 225 | 72 | 5'50 ³² | 252 |
| 19 | 18'11 ¹¹ | 199 | 46 | 13'07 ²⁵ | 226 | 73 | 5'18 ³² | 253 |
| 20 | 17'99 ¹² | 200 | 47 | 12'82 ²⁵ | 227 | 74 | 4'86 ³² | 254 |
| 21 | 17'86 ¹³ | 201 | 48 | 12'56 ²⁶ | 228 | 75 | 4'54 ³² | 255 |
| 22 | 17'73 ¹³ | 202 | 49 | 12'30 ²⁶ | 229 | 76 | 4'22 ³² | 256 |
| 23 | 17'60 ¹³ | 203 | 50 | 12'04 ²⁶ | 230 | 77 | 3'88 ³⁴ | 257 |
| 24 | 17'45 ¹⁵ | 204 | 51 | 11'78 ²⁶ | 231 | 78 | 3'55 ³³ | 258 |
| 25 | 17'30 ¹⁵ | 205 | 52 | 11'51 ²⁷ | 232 | 79 | 3'22 ³³ | 259 |
| 26 | 17'14 ¹⁶ | 206 | 53 | 11'23 ²⁸ | 233 | 80 | 2'88 ³⁴ | 260 |
| 27 | -16'98 ¹⁶ | 207 | 54 | -10'95 ²⁸ | 234 | 81 | -2'55 ³³ | 261 |

ROYAL ASTRON. SOC. VOL. XXIV.

Z

Tabulated Values of the Aberration, &c. (continued).

| ☉ | Value. | ☉ | ☉ | Value. | ☉ | ☉ | Value. | ☉ |
|-----------------|-----------------------------------|------------------|------------------|-----------------------------------|------------------|------------------|-----------------------------------|------------------|
| 81 ⁰ | -2 ^{''} 55 | 261 ⁰ | 114 ⁰ | +8 ^{''} 30 | 294 ⁰ | 147 ⁰ | +16 ^{''} 46 | 327 ⁰ |
| 82 | 2 ^{''} 22 ³³ | 262 | 115 | 8 ^{''} 60 ³⁰ | 295 | 148 | 16 ^{''} 63 ¹⁷ | 328 |
| 83 | 1 ^{''} 88 ³⁴ | 263 | 116 | 8 ^{''} 90 ³⁰ | 296 | 149 | 16 ^{''} 80 ¹⁷ | 329 |
| 84 | 1 ^{''} 54 ³⁴ | 264 | 117 | 9 ^{''} 20 ³⁰ | 297 | 150 | 16 ^{''} 96 ¹⁶ | 330 |
| 85 | 1 ^{''} 20 ³⁴ | 265 | 118 | 9 ^{''} 50 ³⁰ | 298 | 151 | 17 ^{''} 12 ¹⁶ | 331 |
| 86 | 0 ^{''} 86 ³⁴ | 266 | 119 | 9 ^{''} 79 ²⁹ | 299 | 152 | 17 ^{''} 27 ¹⁵ | 332 |
| 87 | 0 ^{''} 52 ³⁴ | 267 | 120 | 10 ^{''} 08 ²⁹ | 300 | 153 | 17 ^{''} 42 ¹⁵ | 333 |
| 88 | -0 ^{''} 19 ³⁴ | 268 | 121 | 10 ^{''} 36 ²⁸ | 301 | 154 | 17 ^{''} 56 ¹⁴ | 334 |
| 89 | +0 ^{''} 14 ³³ | 269 | 122 | 10 ^{''} 64 ²⁸ | 302 | 155 | 17 ^{''} 70 ¹⁴ | 335 |
| 90 | 0 ^{''} 48 ³⁴ | 270 | 123 | 10 ^{''} 92 ²⁸ | 303 | 156 | 17 ^{''} 84 ¹⁴ | 336 |
| 91 | 0 ^{''} 82 ³⁴ | 271 | 124 | 11 ^{''} 20 ²⁸ | 304 | 157 | 17 ^{''} 96 ¹² | 337 |
| 92 | 1 ^{''} 16 ³⁴ | 272 | 125 | 11 ^{''} 47 ²⁷ | 305 | 158 | 18 ^{''} 08 ¹² | 338 |
| 93 | 1 ^{''} 50 ³⁴ | 273 | 126 | 11 ^{''} 74 ²⁷ | 306 | 159 | 18 ^{''} 20 ¹² | 339 |
| 94 | 1 ^{''} 83 ³³ | 274 | 127 | 12 ^{''} 00 ²⁶ | 307 | 160 | 18 ^{''} 31 ¹¹ | 340 |
| 95 | 2 ^{''} 16 ³³ | 275 | 128 | 12 ^{''} 26 ²⁶ | 308 | 161 | 18 ^{''} 42 ¹¹ | 341 |
| 96 | 2 ^{''} 49 ³³ | 276 | 129 | 12 ^{''} 52 ²⁶ | 309 | 162 | 18 ^{''} 52 ¹⁰ | 342 |
| 97 | 2 ^{''} 82 ³³ | 277 | 130 | 12 ^{''} 78 ²⁶ | 310 | 163 | 18 ^{''} 61 ⁹ | 343 |
| 98 | 3 ^{''} 16 ³⁴ | 278 | 131 | 13 ^{''} 03 ²⁵ | 311 | 164 | 18 ^{''} 70 ⁹ | 344 |
| 99 | 3 ^{''} 49 ³³ | 279 | 132 | 13 ^{''} 28 ²⁵ | 312 | 165 | 18 ^{''} 78 ⁸ | 345 |
| 100 | 3 ^{''} 82 ³³ | 280 | 133 | 13 ^{''} 52 ²⁴ | 313 | 166 | 18 ^{''} 85 ⁷ | 346 |
| 101 | 4 ^{''} 14 ³² | 281 | 134 | 13 ^{''} 76 ²⁴ | 314 | 167 | 18 ^{''} 92 ⁷ | 347 |
| 102 | 4 ^{''} 47 ³³ | 282 | 135 | 14 ^{''} 00 ²⁴ | 315 | 168 | 18 ^{''} 98 ⁶ | 348 |
| 103 | 4 ^{''} 80 ³³ | 283 | 136 | 14 ^{''} 23 ²³ | 316 | 169 | 19 ^{''} 04 ⁶ | 349 |
| 104 | 5 ^{''} 13 ³³ | 284 | 137 | 14 ^{''} 46 ²³ | 317 | 170 | 19 ^{''} 09 ⁵ | 350 |
| 105 | 5 ^{''} 46 ³³ | 285 | 138 | 14 ^{''} 68 ²² | 318 | 171 | 19 ^{''} 14 ⁵ | 351 |
| 106 | 5 ^{''} 78 ³² | 286 | 139 | 14 ^{''} 90 ²² | 319 | 172 | 19 ^{''} 18 ⁴ | 352 |
| 107 | 6 ^{''} 10 ³² | 287 | 140 | 15 ^{''} 11 ²¹ | 320 | 173 | 19 ^{''} 22 ⁴ | 353 |
| 108 | 6 ^{''} 42 ³² | 288 | 141 | 15 ^{''} 32 ²¹ | 321 | 174 | 19 ^{''} 26 ⁴ | 354 |
| 109 | 6 ^{''} 74 ³² | 289 | 142 | 15 ^{''} 52 ²⁰ | 322 | 175 | 19 ^{''} 28 ² | 355 |
| 110 | 7 ^{''} 06 ³² | 290 | 143 | 15 ^{''} 71 ¹⁹ | 323 | 176 | 19 ^{''} 30 ² | 356 |
| 111 | 7 ^{''} 38 ³¹ | 291 | 144 | 15 ^{''} 90 ¹⁹ | 324 | 177 | 19 ^{''} 32 ⁰ | 357 |
| 112 | 7 ^{''} 69 ³⁰ | 292 | 145 | 16 ^{''} 09 ¹⁹ | 325 | 178 | 19 ^{''} 32 ⁰ | 358 |
| 113 | 7 ^{''} 99 ³¹ | 293 | 146 | 16 ^{''} 28 ¹⁹ | 326 | 179 | 19 ^{''} 32 ⁰ | 359 |
| 114 | +8 ^{''} 30 | 294 | 147 | +16 ^{''} 46 | 327 | 180 | +19 ^{''} 32 | 0 |

TABLE V.

*Tabulated Values of the Factor of Aberration for γ Draconis.*Argument \odot = Sun's True Longitude at Greenwich Transit.

[When the argument is on the right-hand side of the factor, change the sign.]

| \odot | Factor. | \odot | \odot | Factor. | \odot | \odot | Factor. | \odot |
|-------------|-------------------|---------------|--------------|--------------------|---------------|--------------|----------------------|---------------|
| 0° | -0.966 | 180° | 27° | -0.849 | 207° | 54° | -0.548 | 234° |
| 1 | .965 ¹ | 181 | 28 | .841 ⁸ | 208 | 55 | .534 ¹⁴ | 235 |
| 2 | .964 ¹ | 182 | 29 | .833 ⁸ | 209 | 56 | .520 ¹⁴ | 236 |
| 3 | .963 ¹ | 183 | 30 | .824 ⁹ | 210 | 57 | .506 ¹⁴ | 237 |
| 4 | .962 ¹ | 184 | 31 | .815 ⁹ | 211 | 58 | .492 ¹⁴ | 238 |
| 5 | .960 ² | 185 | 32 | .806 ⁹ | 212 | 59 | .477 ¹⁵ | 239 |
| 6 | .958 ² | 186 | 33 | .797 ⁹ | 213 | 60 | .462 ¹⁵ | 240 |
| 7 | .956 ² | 187 | 34 | .788 ⁹ | 214 | 61 | .447 ¹⁵ | 241 |
| 8 | .953 ³ | 188 | 35 | .778 ¹⁰ | 215 | 62 | .432 ¹⁵ | 242 |
| 9 | .950 ³ | 189 | 36 | .767 ¹¹ | 216 | 63 | .417 ¹⁵ | 243 |
| 10 | .947 ³ | 190 | 37 | .757 ¹⁰ | 217 | 64 | .402 ¹⁵ | 244 |
| 11 | .943 ⁴ | 191 | 38 | .746 ¹¹ | 218 | 65 | .387 ¹⁵ | 245 |
| 12 | .939 ⁴ | 192 | 39 | .735 ¹¹ | 219 | 66 | .371 ¹⁶ | 246 |
| 13 | .935 ⁴ | 193 | 40 | .724 ¹¹ | 220 | 67 | .355 ¹⁶ | 247 |
| 14 | .931 ⁴ | 194 | 41 | .713 ¹¹ | 221 | 68 | .339 ¹⁶ | 248 |
| 15 | .926 ⁵ | 195 | 42 | .701 ¹² | 222 | 69 | .323 ¹⁶ | 249 |
| 16 | .921 ⁵ | 196 | 43 | .690 ¹¹ | 223 | 70 | .307 ¹⁶ | 250 |
| 17 | .916 ⁵ | 197 | 44 | .678 ¹² | 224 | 71 | .291 ¹⁶ | 251 |
| 18 | .911 ⁵ | 198 | 45 | .666 ¹² | 225 | 72 | .275 ¹⁶ | 252 |
| 19 | .905 ⁶ | 199 | 46 | .654 ¹² | 226 | 73 | .259 ¹⁶ | 253 |
| 20 | .899 ⁶ | 200 | 47 | .641 ¹³ | 227 | 74 | .243 ¹⁶ | 254 |
| 21 | .893 ⁶ | 201 | 48 | .628 ¹³ | 228 | 75 | .227 ¹⁶ | 255 |
| 22 | .887 ⁶ | 202 | 49 | .615 ¹³ | 229 | 76 | .211 ¹⁶ | 256 |
| 23 | .880 ⁷ | 203 | 50 | .602 ¹³ | 230 | 77 | .194 ¹⁷ | 257 |
| 24 | .872 ⁸ | 204 | 51 | .589 ¹³ | 231 | 78 | .177 ¹⁷ | 258 |
| 25 | .865 ⁷ | 205 | 52 | .576 ¹³ | 232 | 79 | .161 ¹⁶ | 259 |
| 26 | .857 ⁸ | 206 | 53 | .562 ¹⁴ | 233 | 80 | .144 ¹⁷ | 260 |
| 27 | -0.849 | 207 | 54 | -0.548 | 234 | 81 | -0.127 ¹⁷ | 261 |

Tabulated Values of the Factor of Aberration for γ Draconis (continued).

| ⊙ | Factor. | ⊙ | ⊙ | Factor. | ⊙ | ⊙ | Factor. | ⊙ |
|-----------------|----------------------|------------------|------------------|---------------------|------------------|------------------|---------------------|------------------|
| 81 ⁰ | -0.127 | 261 ⁰ | 114 ⁰ | +0.415 | 294 ⁰ | 147 ⁰ | +0.823 | 327 ⁰ |
| 82 | .111 ¹⁶ | 262 | 115 | .430 ¹⁵ | 295 | 148 | .832 ⁹ | 328 |
| 83 | .094 ¹⁷ | 263 | 116 | .445 ¹⁵ | 296 | 149 | .840 ⁸ | 329 |
| 84 | .077 ¹⁷ | 264 | 117 | .460 ¹⁵ | 297 | 150 | .848 ⁸ | 330 |
| 85 | .060 ¹⁷ | 265 | 118 | .475 ¹⁵ | 298 | 151 | .856 ⁸ | 331 |
| 86 | .043 ¹⁷ | 266 | 119 | .490 ¹⁵ | 299 | 152 | .864 ⁸ | 332 |
| 87 | .026 ¹⁷ | 267 | 120 | .504 ¹⁴ | 300 | 153 | .871 ⁷ | 333 |
| 88 | -0.010 ¹⁶ | 268 | 121 | .518 ¹⁴ | 301 | 154 | .878 ⁷ | 334 |
| 89 | +0.007 ¹⁷ | 269 | 122 | .532 ¹⁴ | 302 | 155 | .885 ⁷ | 335 |
| 90 | .024 ¹⁷ | 270 | 123 | .546 ¹⁴ | 303 | 156 | .892 ⁷ | 336 |
| 91 | .041 ¹⁷ | 271 | 124 | .560 ¹⁴ | 304 | 157 | .898 ⁶ | 337 |
| 92 | .058 ¹⁷ | 272 | 125 | .574 ¹³ | 305 | 158 | .904 ⁶ | 338 |
| 93 | .075 ¹⁶ | 273 | 126 | .587 ¹³ | 306 | 159 | .910 ⁶ | 339 |
| 94 | .091 ¹⁷ | 274 | 127 | .600 ¹³ | 307 | 160 | .916 ⁶ | 340 |
| 95 | .108 ¹⁷ | 275 | 128 | .613 ¹³ | 308 | 161 | .921 ⁵ | 341 |
| 96 | .125 ¹⁶ | 276 | 129 | .626 ¹³ | 309 | 162 | .926 ⁵ | 342 |
| 97 | .141 ¹⁷ | 277 | 130 | .639 ¹³ | 310 | 163 | .931 ⁵ | 343 |
| 98 | .158 ¹⁷ | 278 | 131 | .652 ¹³ | 311 | 164 | .935 ⁴ | 344 |
| 99 | .175 ¹⁶ | 279 | 132 | .664 ¹² | 312 | 165 | .939 ⁴ | 345 |
| 100 | .191 ¹⁶ | 280 | 133 | .676 ¹² | 313 | 166 | .943 ⁴ | 346 |
| 101 | .207 ¹⁷ | 281 | 134 | .688 ¹² | 314 | 167 | .946 ³ | 347 |
| 102 | .224 ¹⁶ | 282 | 135 | .700 ¹² | 315 | 168 | .949 ³ | 348 |
| 103 | .240 ¹⁶ | 283 | 136 | .712 ¹¹ | 316 | 169 | .952 ³ | 349 |
| 104 | .256 ¹⁷ | 284 | 137 | .723 ¹¹ | 317 | 170 | .955 ³ | 350 |
| 105 | .273 ¹⁶ | 285 | 138 | .734 ¹¹ | 318 | 171 | .957 ² | 351 |
| 106 | .289 ¹⁶ | 286 | 139 | .745 ¹¹ | 319 | 172 | .959 ² | 352 |
| 107 | .305 ¹⁶ | 287 | 140 | .756 ¹⁰ | 320 | 173 | .961 ² | 353 |
| 108 | .321 ¹⁶ | 288 | 141 | .766 ¹⁰ | 321 | 174 | .963 ¹ | 354 |
| 109 | .337 ¹⁶ | 289 | 142 | .776 ¹⁰ | 322 | 175 | .964 ¹ | 355 |
| 110 | .353 ¹⁶ | 290 | 143 | .786 ⁹ | 323 | 176 | .965 ¹ | 356 |
| 111 | .369 ¹⁵ | 291 | 144 | .795 ¹⁰ | 324 | 177 | .966 ⁰ | 357 |
| 112 | .384 ¹⁵ | 292 | 145 | .805 ⁹ | 325 | 178 | .966 ⁰ | 358 |
| 113 | .399 ¹⁶ | 293 | 146 | .814 ⁹ | 326 | 179 | .966 ⁰ | 350 |
| 114 | +0.415 | 294 | 147 | +0.823 ⁹ | 327 | 180 | +0.966 ⁰ | 360 |

TABLE VI.

*Tabulated Values of the Factor of Parallax for γ Draconis.*Argument = \odot 's True Longitude at Greenwich Transit.

[When the Argument is on the right-hand side of the Factor, change the sign.]

| \odot | Factor. | \odot | \odot | Factor. | \odot | \odot | Factor. | \odot |
|---------|--------------------|---------|---------|--------------------|---------|---------|--------------------|---------|
| 0° | +0.024 | 180° | 27° | +0.460 | 207° | 54° | +0.795 | 234° |
| 1 | .041 ¹⁷ | 181 | 28 | .475 ¹⁵ | 208 | 55 | .805 ¹¹ | 235 |
| 2 | .058 ¹⁷ | 182 | 29 | .490 ¹⁵ | 209 | 56 | .814 ⁹ | 236 |
| 3 | .075 ¹⁷ | 183 | 30 | .504 ¹⁴ | 210 | 57 | .823 ⁹ | 237 |
| 4 | .091 ¹⁷ | 184 | 31 | .518 ¹⁴ | 211 | 58 | .832 ⁹ | 238 |
| 5 | .108 ¹⁷ | 185 | 32 | .532 ¹⁴ | 212 | 59 | .840 ⁸ | 239 |
| 6 | .125 ¹⁷ | 186 | 33 | .546 ¹⁴ | 213 | 60 | .848 ⁸ | 240 |
| 7 | .141 ¹⁷ | 187 | 34 | .560 ¹⁴ | 214 | 61 | .856 ⁸ | 241 |
| 8 | .158 ¹⁷ | 188 | 35 | .574 ¹⁴ | 215 | 62 | .864 ⁸ | 242 |
| 9 | .175 ¹⁷ | 189 | 36 | .587 ¹³ | 216 | 63 | .871 ⁷ | 243 |
| 10 | .191 ¹⁶ | 190 | 37 | .600 ¹³ | 217 | 64 | .878 ⁷ | 244 |
| 11 | .207 ¹⁷ | 191 | 38 | .613 ¹³ | 218 | 65 | .885 ⁷ | 245 |
| 12 | .224 ¹⁶ | 192 | 39 | .626 ¹³ | 219 | 66 | .892 ⁷ | 246 |
| 13 | .240 ¹⁶ | 193 | 40 | .639 ¹³ | 220 | 67 | .898 ⁶ | 247 |
| 14 | .256 ¹⁷ | 194 | 41 | .652 ¹² | 221 | 68 | .904 ⁶ | 248 |
| 15 | .273 ¹⁶ | 195 | 42 | .664 ¹² | 222 | 69 | .910 ⁶ | 249 |
| 16 | .289 ¹⁶ | 196 | 43 | .676 ¹² | 223 | 70 | .916 ⁶ | 250 |
| 17 | .305 ¹⁶ | 197 | 44 | .688 ¹² | 224 | 71 | .921 ⁵ | 251 |
| 18 | .321 ¹⁶ | 198 | 45 | .700 ¹² | 225 | 72 | .926 ⁵ | 252 |
| 19 | .337 ¹⁶ | 199 | 46 | .712 ¹¹ | 226 | 73 | .931 ⁴ | 253 |
| 20 | .353 ¹⁶ | 200 | 47 | .723 ¹¹ | 227 | 74 | .935 ⁴ | 254 |
| 21 | .369 ¹⁵ | 201 | 48 | .734 ¹¹ | 228 | 75 | .939 ⁴ | 255 |
| 22 | .384 ¹⁵ | 202 | 49 | .745 ¹¹ | 229 | 76 | .943 ³ | 256 |
| 23 | .399 ¹⁶ | 203 | 50 | .756 ¹⁰ | 230 | 77 | .946 ³ | 257 |
| 24 | .415 ¹⁵ | 204 | 51 | .766 ¹⁰ | 231 | 78 | .949 ³ | 258 |
| 25 | .430 ¹⁵ | 205 | 52 | .776 ¹⁰ | 232 | 79 | .952 ³ | 259 |
| 26 | .445 ¹⁵ | 206 | 53 | .786 ⁹ | 233 | 80 | .955 ² | 260 |
| 27 | +0.460 | 207 | 54 | +0.795 | 234 | 81 | +0.957 | 261 |

Tabulated Values of the Factor of Parallax for γ Draconis (continued).

| ⊙ | Factor. | ⊙ | ⊙ | Factor. | ⊙ | ⊙ | Factor. | ⊙ |
|-----------------|-------------------|------------------|------------------|----------------------|------------------|------------------|----------------------|------------------|
| 81 ⁰ | +0.957 | 261 ⁰ | 114 ⁰ | +0.872 | 294 ⁰ | 147 ⁰ | +0.506 | 327 ⁰ |
| 82 | .959 ² | 262 | 115 | .865 ⁷ | 295 | 148 | .492 ¹⁴ | 328 |
| 83 | .961 ² | 263 | 116 | .857 ⁸ | 296 | 149 | .477 ¹⁵ | 329 |
| 84 | .963 ² | 264 | 117 | .849 ⁸ | 297 | 150 | .462 ¹⁵ | 330 |
| 85 | .964 ¹ | 265 | 118 | .841 ⁸ | 298 | 151 | .447 ¹⁵ | 331 |
| 86 | .965 ¹ | 266 | 119 | .833 ⁸ | 299 | 152 | .432 ¹⁵ | 332 |
| 87 | .966 ¹ | 267 | 120 | .824 ⁹ | 300 | 153 | .417 ¹⁵ | 333 |
| 88 | .966 ⁰ | 268 | 121 | .815 ⁹ | 301 | 154 | .402 ¹⁵ | 334 |
| 89 | .966 ⁰ | 269 | 122 | .806 ⁹ | 302 | 155 | .387 ¹⁵ | 335 |
| 90 | .966 ⁰ | 270 | 123 | .797 ⁹ | 303 | 156 | .371 ¹⁶ | 336 |
| 91 | .965 ¹ | 271 | 124 | .788 ⁹ | 304 | 157 | .355 ¹⁶ | 337 |
| 92 | .964 ¹ | 272 | 125 | .778 ¹⁰ | 305 | 158 | .339 ¹⁶ | 338 |
| 93 | .963 ¹ | 273 | 126 | .767 ¹⁰ | 306 | 159 | .323 ¹⁶ | 339 |
| 94 | .962 ¹ | 274 | 127 | .757 ¹⁰ | 307 | 160 | .307 ¹⁶ | 340 |
| 95 | .960 ² | 275 | 128 | .746 ¹¹ | 308 | 161 | .291 ¹⁶ | 341 |
| 96 | .958 ² | 276 | 129 | .735 ¹¹ | 309 | 162 | .275 ¹⁶ | 342 |
| 97 | .956 ² | 277 | 130 | .724 ¹¹ | 310 | 163 | .259 ¹⁶ | 343 |
| 98 | .953 ³ | 278 | 131 | .713 ¹¹ | 311 | 164 | .243 ¹⁶ | 344 |
| 99 | .950 ³ | 279 | 132 | .701 ¹² | 312 | 165 | .227 ¹⁶ | 345 |
| 100 | .947 ³ | 280 | 133 | .690 ¹¹ | 313 | 166 | .211 ¹⁶ | 346 |
| 101 | .943 ⁴ | 281 | 134 | .678 ¹² | 314 | 167 | .194 ¹⁷ | 347 |
| 102 | .939 ⁴ | 282 | 135 | .666 ¹² | 315 | 168 | .177 ¹⁷ | 348 |
| 103 | .935 ⁴ | 283 | 136 | .654 ¹² | 316 | 169 | .161 ¹⁶ | 349 |
| 104 | .931 ⁴ | 284 | 137 | .641 ¹³ | 317 | 170 | .144 ¹⁷ | 350 |
| 105 | .926 ⁵ | 285 | 138 | .628 ¹³ | 318 | 171 | .127 ¹⁷ | 351 |
| 106 | .921 ⁵ | 286 | 139 | .615 ¹³ | 319 | 172 | .111 ¹⁶ | 352 |
| 107 | .916 ⁵ | 287 | 140 | .602 ¹³ | 320 | 173 | .094 ¹⁷ | 353 |
| 108 | .911 ⁵ | 288 | 141 | .589 ¹³ | 321 | 174 | .077 ¹⁷ | 354 |
| 109 | .905 ⁶ | 289 | 142 | .576 ¹³ | 322 | 175 | .060 ¹⁷ | 355 |
| 110 | .899 ⁶ | 290 | 143 | .562 ¹⁴ | 323 | 176 | .043 ¹⁷ | 356 |
| 111 | .893 ⁶ | 291 | 144 | .548 ¹⁴ | 324 | 177 | .026 ¹⁷ | 357 |
| 112 | .887 ⁶ | 292 | 145 | .534 ¹⁴ | 325 | 178 | +0.010 ¹⁶ | 358 |
| 113 | .880 ⁷ | 293 | 146 | .520 ¹⁴ | 326 | 179 | -0.007 ¹⁷ | 359 |
| 114 | +0.872 | 294 | 147 | +0.506 ¹⁴ | 327 | 180 | -0.024 ¹⁷ | 0 |

TABLE VII.

*Tabular Values of the Principal Term of Lunar Nutation, $-9''\cdot2208$
 $\times \cos (\Omega + 1^{\circ}19')$, to be applied to Mean N.Z.D. of γ Draconis.*

| Ω | | $[\Omega]$ | Ω | | $[\Omega]$ | Ω | | $[\Omega]$ |
|-------------|-------------|---------------------------------|-------------|-------------|----------------------------------|-------------|-------------|-------------------------------------------------|
| $-^{\circ}$ | $+^{\circ}$ | " | $-^{\circ}$ | $+^{\circ}$ | " | $-^{\circ}$ | $+^{\circ}$ | " |
| 0 | 180 | 9 ² 19 | 27 | 207 | 8 ¹ 117 | 54 | 234 | 5 ² 247 |
| 1 | 181 | 9 ² 14 ⁵ | 28 | 208 | 8 ⁰ 040 | 55 | 235 | 5 ¹ 114 ¹³³ |
| 2 | 182 | 9 ² 06 ⁸ | 29 | 209 | 7 ⁹ 60 ⁷⁷ | 56 | 236 | 4 ⁹ 79 ⁸⁰ ¹³⁵ |
| 3 | 183 | 9 ¹ 95 ¹¹ | 30 | 210 | 7 ⁸ 77 ⁸³ | 57 | 237 | 4 ⁸ 43 ⁸⁵ ¹³⁶ |
| 4 | 184 | 9 ¹ 83 ¹² | 31 | 211 | 7 ⁷ 92 ⁸⁷ | 58 | 238 | 4 ⁷ 05 ⁸⁹ ¹³⁸ |
| 5 | 185 | 9 ¹ 66 ¹⁷ | 32 | 212 | 7 ⁷ 05 ⁹² | 59 | 239 | 4 ⁵ 66 ⁹⁴ ¹³⁹ |
| 6 | 186 | 9 ¹ 46 ²⁰ | 33 | 213 | 7 ⁶ 16 ⁹⁷ | 60 | 240 | 4 ⁴ 26 ⁹⁸ ¹⁴⁰ |
| 7 | 187 | 9 ¹ 24 ²² | 34 | 214 | 7 ⁵ 24 ¹⁰¹ | 61 | 241 | 4 ² 84 ¹⁰³ ¹⁴² |
| 8 | 188 | 9 ¹ 00 ²⁴ | 35 | 215 | 7 ⁴ 30 ¹⁰⁵ | 62 | 242 | 4 ¹ 41 ¹⁰⁷ ¹⁴³ |
| 9 | 189 | 9 ⁰ 72 ²⁸ | 36 | 216 | 7 ³ 33 ¹¹⁰ | 63 | 243 | 3 ⁹ 96 ¹¹² ¹⁴⁵ |
| 10 | 190 | 9 ⁰ 42 ³⁰ | 37 | 217 | 7 ² 35 ¹¹⁵ | 64 | 244 | 3 ⁸ 50 ¹¹⁷ ¹⁴⁶ |
| 11 | 191 | 9 ⁰ 10 ³² | 38 | 218 | 7 ¹ 34 ¹²¹ | 65 | 245 | 3 ⁷ 03 ¹²³ ¹⁴⁷ |
| 12 | 192 | 8 ⁹ 74 ³⁶ | 39 | 219 | 7 ⁰ 31 ¹²⁵ | 66 | 246 | 3 ⁵ 56 ¹²⁷ ¹⁴⁷ |
| 13 | 193 | 8 ⁹ 35 ³⁹ | 40 | 220 | 6 ⁹ 26 ¹³⁰ | 67 | 247 | 3 ⁴ 07 ¹³⁵ ¹⁴⁹ |
| 14 | 194 | 8 ⁸ 94 ⁴¹ | 41 | 221 | 6 ⁸ 19 ¹³⁷ | 68 | 248 | 3 ² 57 ¹⁴⁰ ¹⁵⁰ |
| 15 | 195 | 8 ⁸ 50 ⁴⁴ | 42 | 222 | 6 ⁷ 09 ¹⁴⁰ | 69 | 249 | 3 ¹ 06 ¹⁴⁵ ¹⁵¹ |
| 16 | 196 | 8 ⁸ 04 ⁴⁶ | 43 | 223 | 6 ⁵ 97 ¹⁴⁵ | 70 | 250 | 2 ⁹ 54 ¹⁵⁰ ¹⁵² |
| 17 | 197 | 8 ⁷ 55 ⁴⁹ | 44 | 224 | 6 ⁴ 84 ¹⁵⁰ | 71 | 251 | 2 ⁸ 01 ¹⁵⁵ ¹⁵³ |
| 18 | 198 | 8 ⁷ 02 ⁵³ | 45 | 225 | 6 ³ 69 ¹⁵⁵ | 72 | 252 | 2 ⁶ 47 ¹⁶⁰ ¹⁵⁴ |
| 19 | 199 | 8 ⁶ 47 ⁵⁵ | 46 | 226 | 6 ² 52 ¹⁶⁰ | 73 | 253 | 2 ⁴ 93 ¹⁶⁵ ¹⁵⁴ |
| 20 | 200 | 8 ⁵ 90 ⁵⁷ | 47 | 227 | 6 ¹ 33 ¹⁶⁵ | 74 | 254 | 2 ³ 37 ¹⁷⁰ ¹⁵⁶ |
| 21 | 201 | 8 ⁵ 30 ⁶⁰ | 48 | 228 | 6 ⁰ 11 ¹⁷⁰ | 75 | 255 | 2 ¹ 81 ¹⁷⁵ ¹⁵⁶ |
| 22 | 202 | 8 ⁴ 68 ⁶² | 49 | 229 | 5 ⁸ 88 ¹⁷⁵ | 76 | 256 | 2 ⁰ 25 ¹⁸⁰ ¹⁵⁶ |
| 23 | 203 | 8 ⁴ 03 ⁶⁵ | 50 | 230 | 5 ⁷ 63 ¹⁸⁰ | 77 | 257 | 1 ⁸ 67 ¹⁸⁵ ¹⁵⁸ |
| 24 | 204 | 8 ³ 35 ⁶⁸ | 51 | 231 | 5 ⁶ 37 ¹⁸⁵ | 78 | 258 | 1 ⁷ 09 ¹⁹⁰ ¹⁵⁸ |
| 25 | 205 | 8 ² 65 ⁷⁰ | 52 | 232 | 5 ⁵ 09 ¹⁹⁰ | 79 | 259 | 1 ⁵ 51 ¹⁹⁵ ¹⁵⁸ |
| 26 | 206 | 8 ¹ 92 ⁷³ | 53 | 233 | 5 ³ 79 ¹⁹⁵ | 80 | 260 | 1 ³ 92 ²⁰⁰ ¹⁵⁹ |
| 27 | 207 | 8 ¹ 17 ⁷⁵ | 54 | 234 | 5 ² 47 ²⁰⁰ | 81 | 261 | 1 ² 33 ²⁰⁵ ¹⁵⁹ |
| — | + | | — | + | | — | + | |

Tabular Values of the Principal Terms of Lunar Nutation, &c. (continued).

| Ω | $[\Omega]$ | Ω | $[\Omega]$ | Ω | $[\Omega]$ |
|-----------------------------------------------------------------|----------------------|------------------------------------------------------------------|----------------------|------------------------------------------------------------------|---------------------|
| $\begin{matrix} -^{\circ} & +^{\circ} \\ 81 & 261 \end{matrix}$ | " 1'233 | $\begin{matrix} +^{\circ} & -^{\circ} \\ 114 & 294 \end{matrix}$ | " 3'943 | $\begin{matrix} +^{\circ} & -^{\circ} \\ 147 & 327 \end{matrix}$ | " 7'847 |
| 82 262 | 1'074 ¹⁵⁹ | 115 295 | 4'088 ¹⁴⁵ | 148 328 | 7'930 ⁸³ |
| 83 263 | 0'914 ¹⁶⁰ | 116 296 | 4'231 ¹⁴³ | 149 329 | 8'011 ⁸¹ |
| 84 264 | 0'753 ¹⁶¹ | 117 297 | 4'374 ¹⁴³ | 150 330 | 8'089 ⁷⁸ |
| 85 265 | 0'592 ¹⁶¹ | 118 298 | 4'515 ¹⁴¹ | 151 331 | 8'165 ⁷⁶ |
| 86 266 | 0'432 ¹⁶⁰ | 119 299 | 4'655 ¹⁴⁰ | 152 332 | 8'239 ⁷⁴ |
| 87 267 | 0'271 ¹⁶¹ | 120 300 | 4'793 ¹³⁸ | 153 333 | 8'310 ⁷¹ |
| 88 268 | 0'110 ¹⁶¹ | 121 301 | 4'930 ¹³⁷ | 154 334 | 8'379 ⁶⁹ |
| $\begin{matrix} + & - \\ 89 & 269 \end{matrix}$ | 0'051 ¹⁶¹ | 122 302 | 5'065 ¹³⁵ | 155 335 | 8'445 ⁶⁶ |
| 90 270 | 0'212 ¹⁶¹ | 123 303 | 5'199 ¹³⁴ | 156 336 | 8'508 ⁶³ |
| 91 271 | 0'373 ¹⁶¹ | 124 304 | 5'331 ¹³² | 157 337 | 8'568 ⁶⁰ |
| 92 272 | 0'533 ¹⁶⁰ | 125 305 | 5'461 ¹³⁰ | 158 338 | 8'568 ⁵⁸ |
| 93 273 | 0'694 ¹⁶¹ | 126 306 | 5'590 ¹²⁹ | 159 339 | 8'626 ⁵⁶ |
| 94 274 | 0'855 ¹⁶¹ | 127 307 | 5'717 ¹²⁷ | 160 340 | 8'682 ⁵³ |
| 95 275 | 1'015 ¹⁶⁰ | 128 308 | 5'842 ¹²⁵ | 161 341 | 8'735 ⁵¹ |
| 96 276 | 1'174 ¹⁵⁹ | 129 309 | 5'966 ¹²⁴ | 162 342 | 8'786 ⁴⁷ |
| 97 277 | 1'333 ¹⁵⁹ | 130 310 | 6'088 ¹²² | 163 343 | 8'833 ⁴⁵ |
| 98 278 | 1'493 ¹⁶⁰ | 131 311 | 6'208 ¹²⁰ | 164 344 | 8'878 ⁴² |
| 99 279 | 1'651 ¹⁵⁸ | 132 312 | 6'326 ¹¹⁸ | 165 345 | 8'920 ³⁹ |
| 100 280 | 1'809 ¹⁵⁸ | 133 313 | 6'442 ¹¹⁶ | 166 346 | 8'959 ³⁷ |
| 101 281 | 1'967 ¹⁵⁸ | 134 314 | 6'556 ¹¹⁴ | 167 347 | 8'996 ³⁴ |
| 102 282 | 2'124 ¹⁵⁷ | 135 315 | 6'668 ¹¹² | 168 348 | 9'030 ³¹ |
| 103 283 | 2'281 ¹⁵⁷ | 136 316 | 6'778 ¹¹⁰ | 169 349 | 9'061 ²⁸ |
| 104 284 | 2'437 ¹⁵⁶ | 137 317 | 6'886 ¹⁰⁸ | 170 350 | 9'089 ²⁶ |
| 105 285 | 2'591 ¹⁵⁴ | 138 318 | 6'992 ¹⁰⁶ | 171 351 | 9'115 ²³ |
| 106 286 | 2'745 ¹⁵⁴ | 139 319 | 7'097 ¹⁰⁵ | 172 352 | 9'138 ²¹ |
| 107 287 | 2'898 ¹⁵³ | 140 320 | 7'199 ¹⁰² | 173 353 | 9'159 ¹⁷ |
| 108 288 | 3'050 ¹⁵² | 141 321 | 7'298 ⁹⁹ | 174 354 | 9'176 ¹⁴ |
| 109 289 | 3'201 ¹⁵¹ | 142 322 | 7'395 ⁹⁷ | 175 355 | 9'190 ¹² |
| 110 290 | 3'351 ¹⁵⁰ | 143 323 | 7'491 ⁹⁶ | 176 356 | 9'202 ⁹ |
| 111 291 | 3'501 ¹⁵⁰ | 144 324 | 7'583 ⁹² | 177 357 | 9'211 ⁶ |
| 112 292 | 3'649 ¹⁴⁸ | 145 325 | 7'673 ⁹⁰ | 178 358 | 9'217 ⁴ |
| 113 293 | 3'796 ¹⁴⁷ | 146 326 | 7'761 ⁸⁸ | 179 359 | 9'221 ⁰ |
| 114 294 | 3'943 ¹⁴⁷ | 147 327 | 7'847 ⁸⁶ | 180 0 | 9'221 ² |
| $\begin{matrix} + & - \\ & \end{matrix}$ | | $\begin{matrix} + & - \\ & \end{matrix}$ | | $\begin{matrix} + & - \\ & \end{matrix}$ | |

TABLE VIII.

Tabulated Values of the Solar Nutation, to be applied with proper Signs to Mean North Zenith Distance of γ Draconis.

| \odot | [2 \odot] | \odot | [2 \odot] | \odot | [2 \odot] |
|---------|----------------------|----------|----------------------|----------|---------------------|
| 0° 180° | -0'551 | 27° 207° | -0'311 | 54° 234° | +0'185 |
| 1 181 | '550 ¹ | 28 208 | '295 ¹⁶ | 55 235 | '203 ¹⁸ |
| 2 182 | '549 ² | 29 209 | '279 ¹⁶ | 56 236 | '221 ¹⁸ |
| 3 183 | '546 ³ | 30 210 | '262 ¹⁷ | 57 237 | '238 ¹⁷ |
| 4 184 | '543 ³ | 31 211 | '245 ¹⁷ | 58 238 | '255 ¹⁷ |
| 5 185 | '540 ³ | 32 212 | '228 ¹⁷ | 59 239 | '272 ¹⁷ |
| 6 186 | '535 ⁵ | 33 213 | '210 ¹⁸ | 60 240 | '289 ¹⁷ |
| 7 187 | '530 ⁵ | 34 214 | '192 ¹⁸ | 61 241 | '305 ¹⁶ |
| 8 188 | '525 ⁵ | 35 215 | '174 ¹⁸ | 62 242 | '321 ¹⁶ |
| 9 189 | '519 ⁶ | 36 216 | '155 ¹⁹ | 63 243 | '336 ¹⁵ |
| 10 190 | '513 ⁶ | 37 217 | '137 ¹⁸ | 64 244 | '351 ¹⁵ |
| 11 191 | '505 ⁸ | 38 218 | '118 ¹⁹ | 65 245 | '366 ¹⁵ |
| 12 192 | '497 ⁸ | 39 219 | '099 ¹⁹ | 66 246 | '380 ¹⁴ |
| 13 193 | '488 ⁹ | 40 220 | '080 ¹⁹ | 67 247 | '394 ¹⁴ |
| 14 194 | '479 ⁹ | 41 221 | '061 ¹⁹ | 68 248 | '408 ¹⁴ |
| 15 195 | '469 ¹⁰ | 42 222 | '042 ¹⁹ | 69 249 | '420 ¹² |
| 16 196 | '459 ¹⁰ | 43 223 | '022 ²⁰ | 70 250 | '432 ¹² |
| 17 197 | '448 ¹¹ | 44 224 | - '003 ¹⁹ | 71 251 | '444 ¹² |
| 18 198 | '436 ¹² | 45 225 | + '016 ¹⁹ | 72 252 | '455 ¹¹ |
| 19 199 | '424 ¹² | 46 226 | '035 ¹⁹ | 73 253 | '466 ¹¹ |
| 20 200 | '412 ¹² | 47 227 | '054 ¹⁹ | 74 254 | '476 ¹⁰ |
| 21 201 | '399 ¹³ | 48 228 | '073 ¹⁹ | 75 255 | '485 ⁹ |
| 22 202 | '386 ¹³ | 49 229 | '092 ¹⁹ | 76 256 | '494 ⁹ |
| 23 203 | '372 ¹⁴ | 50 230 | '111 ¹⁹ | 77 257 | '502 ⁸ |
| 24 204 | '357 ¹⁵ | 51 231 | '130 ¹⁹ | 78 258 | '509 ⁷ |
| 25 205 | '342 ¹⁵ | 52 232 | '149 ¹⁹ | 79 259 | '516 ⁷ |
| 26 206 | '327 ¹⁵ | 53 233 | '167 ¹⁸ | 80 260 | '522 ⁶ |
| 27 207 | -0'311 ¹⁶ | 54 234 | +0'185 ¹⁸ | 81 261 | +0'528 ⁶ |

ROYAL ASTRON. SOC. VOL. XXIV.

A A

Tabulated Values of the Solar Nutation, &c. (continued).

| ⊙ | [2 ⊙] | ⊙ | [2 ⊙] | ⊙ | [2 ⊙] |
|----------|------------------------------------|-----------|------------------------------------|-----------|-----------------------------------|
| 81° 261° | +0 ^u .528 | 114° 294° | +0 ^u .357 | 147° 327° | -0 ^u .238 |
| 82 262 | .533 ⁵ | 115 295 | .342 ¹⁵ | 148 328 | .255 ¹⁷ |
| 83 263 | .538 ⁵ | 116 296 | .327 ¹⁵ | 149 329 | .272 ¹⁷ |
| 84 264 | .542 ⁴ | 117 297 | .311 ¹⁶ | 150 330 | .289 ¹⁷ |
| 85 265 | .545 ³ | 118 298 | .295 ¹⁶ | 151 331 | .305 ¹⁶ |
| 86 266 | .547 ² | 119 299 | .279 ¹⁶ | 152 332 | .321 ¹⁶ |
| 87 267 | .549 ² | 120 300 | .262 ¹⁷ | 153 333 | .336 ¹⁵ |
| 88 268 | .550 ¹ | 121 301 | .245 ¹⁷ | 154 334 | .351 ¹⁵ |
| 89 269 | .551 ¹ | 122 302 | .228 ¹⁷ | 155 335 | .366 ¹⁵ |
| 90 270 | .551 ⁰ | 123 303 | .210 ¹⁸ | 156 336 | .380 ¹⁴ |
| 91 271 | .550 ¹ | 124 304 | .192 ¹⁸ | 157 337 | .394 ¹⁴ |
| 92 272 | .549 ¹ | 125 305 | .174 ¹⁸ | 158 338 | .408 ¹⁴ |
| 93 273 | .546 ³ | 126 306 | .155 ¹⁹ | 159 339 | .420 ¹² |
| 94 274 | .543 ³ | 127 307 | .137 ¹⁸ | 160 340 | .432 ¹² |
| 95 275 | .540 ⁵ | 128 308 | .118 ¹⁹ | 161 341 | .444 ¹² |
| 96 276 | .535 ⁵ | 129 309 | .099 ¹⁹ | 162 342 | .455 ¹¹ |
| 97 277 | .530 ⁵ | 130 310 | .080 ²⁰ | 163 343 | .466 ¹¹ |
| 98 278 | .525 ⁵ | 131 311 | .061 ¹⁹ | 164 344 | .476 ¹⁰ |
| 99 279 | .519 ⁶ | 132 312 | .042 ¹⁹ | 165 345 | .485 ⁹ |
| 100 280 | .513 ⁶ | 133 313 | .022 ²⁰ | 166 346 | .494 ⁹ |
| 101 281 | .505 ⁸ | 134 314 | + .003 ¹⁹ | 167 347 | .502 ⁸ |
| 102 282 | .497 ⁸ | 135 315 | - .016 ¹⁹ | 168 348 | .509 ⁷ |
| 103 283 | .488 ⁹ | 136 316 | .035 ¹⁹ | 169 349 | .516 ⁷ |
| 104 284 | .479 ⁹ | 137 317 | .054 ¹⁹ | 170 350 | .522 ⁶ |
| 105 285 | .469 ¹⁰ | 138 318 | .073 ¹⁹ | 171 351 | .528 ⁶ |
| 106 286 | .459 ¹⁰ | 139 319 | .092 ¹⁹ | 172 352 | .533 ⁵ |
| 107 287 | .448 ¹¹ | 140 320 | .111 ¹⁹ | 173 353 | .538 ⁵ |
| 108 288 | .436 ¹² | 141 321 | .130 ²⁰ | 174 354 | .542 ⁴ |
| 109 289 | .424 ¹² | 142 322 | .149 ¹⁹ | 175 355 | .545 ³ |
| 110 290 | .412 ¹² | 143 323 | .167 ¹⁸ | 176 356 | .547 ² |
| 111 291 | .399 ¹³ | 144 324 | .185 ¹⁸ | 177 357 | .549 ² |
| 112 292 | .386 ¹³ | 145 325 | .203 ¹⁸ | 178 358 | .550 ¹ |
| 113 293 | .372 ¹⁴ | 146 326 | .221 ¹⁸ | 179 359 | .551 ¹ |
| 114 294 | +0 ^u .357 ¹⁵ | 147 327 | -0 ^u .238 ¹⁷ | 180 0 | -0 ^u .551 ⁰ |

TABLE IX.

Tabulated Values of Small Terms of Lunar Nutation, $+0''.090 \cos(2\Omega + 1^\circ 38')$ and $-0''.090 \cos(2\epsilon + 1^\circ 38')$, to be applied to Mean North Zenith Distance.

| Ω or ϵ | $\left[\cos \frac{2\Omega}{2\epsilon} \right]$ | Ω or ϵ | $\left[\cos \frac{2\Omega}{2\epsilon} \right]$ |
|------------------------|-------------------------------------------------|------------------------|-------------------------------------------------|
| $0^\circ 180^\circ$ | $+0''.090$ | $90^\circ 270^\circ$ | $-0''.090$ |
| 5 185 | $\cdot 088^2$ | 95 275 | $\cdot 088^2$ |
| 10 190 | $\cdot 084^4$ | 100 280 | $\cdot 084^4$ |
| 15 195 | $\cdot 077^7$ | 105 285 | $\cdot 077^7$ |
| 20 200 | $\cdot 067^{10}$ | 110 290 | $\cdot 067^{10}$ |
| 25 205 | $\cdot 056^{11}$ | 115 295 | $\cdot 056^{11}$ |
| 30 210 | $\cdot 043^{13}$ | 120 300 | $\cdot 043^{13}$ |
| 35 215 | $\cdot 028^{15}$ | 125 305 | $\cdot 028^{15}$ |
| 40 220 | $+ \cdot 013^{15}$ | 130 310 | $- \cdot 013^{15}$ |
| 45 225 | $- \cdot 003^{16}$ | 135 315 | $+ \cdot 003^{16}$ |
| 50 230 | $\cdot 018^{15}$ | 140 320 | $\cdot 018^{15}$ |
| 55 235 | $\cdot 033^{15}$ | 145 325 | $\cdot 033^{15}$ |
| 60 240 | $\cdot 047^{14}$ | 150 330 | $\cdot 047^{14}$ |
| 65 245 | $\cdot 060^{13}$ | 155 335 | $\cdot 060^{13}$ |
| 70 250 | $\cdot 071^{11}$ | 160 340 | $\cdot 071^{11}$ |
| 75 255 | $\cdot 079^8$ | 165 345 | $\cdot 079^8$ |
| 80 260 | $\cdot 085^6$ | 170 350 | $\cdot 085^6$ |
| 85 265 | $\cdot 089^4$ | 175 355 | $\cdot 089^4$ |
| 90 270 | $-0''.090$ | 180 0 | $+0''.090$ |

Change signs for $[z \epsilon]$.

TABLE X.
Equations of Condition.

| No. of Series. | Number of Obs. | |
|----------------|----------------|----------------------------------------------------------------|
| 1 | 6 | $v - 0.014 \times x + 0.966 \times y - 0.909 \times z = -0.89$ |
| 2 | 6 | $v + .149 \quad + .955 \quad .908 \quad -0.61$ |
| 3 | 7 | $v + .316 \quad + .912 \quad .906 \quad +0.13$ |
| 4 | 7 | $v + .496 \quad + .829 \quad .875 \quad +0.08$ |
| 5 | 10 | $v + .757 \quad + .601 \quad .773 \quad +0.15$ |
| 6 | 4 | $v + .884 \quad + .390 \quad .740 \quad -0.66$ |
| 7 | 4 | $v + .946 \quad + .197 \quad .709 \quad +0.34$ |
| 8 | 8 | $v + .964 \quad - .061 \quad .713 \quad +0.42$ |
| 9 | 4 | $v + .936 \quad - .236 \quad .720 \quad -0.03$ |
| 10 | 3 | $v + .846 \quad - .466 \quad .768 \quad -0.03$ |
| 11 | 7 | $v + .631 \quad - .731 \quad .867 \quad -0.18$ |
| 12 | 4 | $v + .411 \quad - .874 \quad .928 \quad +0.21$ |
| 13 | 6 | $v + .061 \quad - .964 \quad .977 \quad +0.25$ |
| 14 | 3 | $v - .945 \quad - .200 \quad .768 \quad -0.85$ |
| 15 | 3 | $v - .961 \quad + .099 \quad .774 \quad +0.34$ |
| 16 | 3 | $v - .913 \quad + .315 \quad .798 \quad -0.76$ |
| 17 | 3 | $v - .710 \quad + .655 \quad 0.878 \quad -0.77$ |
| 18 | 4 | $v - .517 \quad + .816 \quad 1.047 \quad +0.72$ |
| 19 | 5 | $v - .239 \quad + .936 \quad 1.000 \quad -1.14$ |
| 20 | 8 | $v + .011 \quad + .966 \quad 1.009 \quad -0.84$ |
| 21 | 4 | $v + .308 \quad + .915 \quad 0.999 \quad -1.19$ |
| 22 | 4 | $v + .452 \quad + .853 \quad .962 \quad -0.41$ |
| 23 | 6 | $v + .745 \quad + .615 \quad .885 \quad -1.31$ |
| 24 | 6 | $v + .877 \quad + .404 \quad .828 \quad -0.90$ |
| 25 | 5 | $v + .935 \quad + .245 \quad .811 \quad -0.73$ |
| 26 | 4 | $v + .965 \quad + .038 \quad .799 \quad -0.07$ |
| 27 | 3 | $v + .910 \quad - .325 \quad .814 \quad +0.92$ |
| 28 | 4 | $v + .775 \quad - .577 \quad .883 \quad +1.87$ |
| 29 | 3 | $v + 0.622 \times x - 0.739 \times y - 0.937 \times z = +0.54$ |

20. The number of obs. is 16, but it is better to give the weight of half the number of observations.

Constants of Nutation and Aberration, &c.

181

Equations of Condition (continued).

| No. of Series. | Number of Obs. | |
|----------------|----------------|----------------------------------------------------------------|
| 30 | 4 | $v + 0.295 \times x - 0.920 \times y - 0.999 \times z = -0.05$ |
| 31 | 4 | $v + .002 \quad - .966 \quad 1.032 \quad + 1.29$ |
| 32 | 4 | $v - .382 \quad - .888 \quad 0.989 \quad - 0.54$ |
| 33 | 2 | $v - .921 \quad - .291 \quad .825 \quad - 2.62$ |
| 34 | 1 | $v - .966 \quad + .024 \quad .784 \quad + 0.05$ |
| 35 | 5 | $v - .770 \quad + .584 \quad .882 \quad - 0.96$ |
| 36 | 6 | $v - .439 \quad + .860 \quad 0.982 \quad - 0.26$ |
| 37 | 4 | $v - .191 \quad + .947 \quad 1.015 \quad - 2.33$ |
| 38 | 4 | $v - .059 \quad + .964 \quad 1.026 \quad + 0.31$ |
| 39 | 5 | $v + .270 \quad + .927 \quad 0.997 \quad - 0.47$ |
| 40 | 5 | $v + .426 \quad + .867 \quad .980 \quad - 0.81$ |
| 41 | 5 | $v + .690 \quad + .676 \quad .889 \quad + 0.88$ |
| 42 | 4 | $v + .826 \quad + .502 \quad .833 \quad + 0.84$ |
| 43 | 4 | $v + .943 \quad + .213 \quad .793 \quad + 0.88$ |
| 44 | 6 | $v + .963 \quad - .082 \quad .765 \quad + 0.35$ |
| 45 | 4 | $v + .900 \quad - .351 \quad .785 \quad + 0.59$ |
| 46 | 2 | $v + .430 \quad - .865 \quad .939 \quad + 0.60$ |
| 47 | 2 | $v + .035 \quad - .965 \quad .980 \quad + 0.87$ |
| 48 | 7 | $v - .326 \quad - .909 \quad .963 \quad + 0.87$ |
| 49 | 7 | $v - .897 \quad + .357 \quad .742 \quad - 0.61$ |
| 50 | 6 | $v - .775 \quad + .577 \quad .792 \quad - 0.61$ |
| 51 | 7 | $v - .323 \quad + .910 \quad .903 \quad - 0.45$ |
| 52 | 6 | $v - .043 \quad + .965 \quad .921 \quad - 0.93$ |
| 53 | 5 | $v + .653 \quad + .712 \quad .810 \quad + 0.14$ |
| 54 | 6 | $v + .766 \quad + .589 \quad .762 \quad - 0.12$ |
| 55 | 6 | $v + .883 \quad + .391 \quad .710 \quad - 0.89$ |
| 56 | 5 | $v + .940 \quad + .221 \quad .665 \quad - 1.65$ |
| 57 | 4 | $v + .966 \quad - .003 \quad .649 \quad - 1.28$ |
| 58 | 5 | $v + .901 \quad - .348 \quad .670 \quad - 0.71$ |
| 59 | 4 | $v + .490 \quad - .833 \quad .804 \quad + 0.63$ |
| 60 | 4 | $v + .043 \quad - .965 \quad .853 \quad + 0.83$ |
| 61 | 7 | $v - .966 \quad - .010 \quad .558 \quad + 2.03$ |
| 62 | 5 | $v - .775 \quad + .578 \quad .613 \quad - 0.42$ |
| 63 | 7 | $v - 0.487 \times x + 0.835 \times y - 0.701 \times z = -0.67$ |

Equations of Condition (continued).

| No. of Series. | Number of Obs. | |
|----------------|----------------|----------------------------------------------------------------|
| 64 | 5 | $v - 0.256 \times x + 0.932 \times y - 0.728 \times z = -1.38$ |
| 65 | 5 | $v - .015 + .966 \quad .735 \quad -0.77$ |
| 66 | 7 | $v + .668 + .697 \quad .611 \quad -0.28$ |
| 67 | 7 | $v + .832 + .492 \quad .536 \quad -1.23$ |
| 68 | 4 | $v + .934 + .248 \quad .472 \quad -0.42$ |
| 69 | 4 | $v + .966 + .013 \quad .439 \quad -1.08$ |
| 70 | 2 | $v + .934 - .244 \quad .441 \quad +0.30$ |
| 71 | 3 | $v + .623 - .738 \quad .555 \quad -1.62$ |
| 72 | 7 | $v + .094 - .961 \quad .617 \quad -2.15$ |
| 73 | 4 | $v - .448 - .855 \quad .563 \quad -2.59$ |
| 74 | 4 | $v - .966 + .020 \quad .312 \quad +1.47$ |
| 75 | 4 | $v - .892 + .371 \quad .342 \quad +0.11$ |
| 76 | 10 | $v - .758 + .598 \quad .374 \quad -0.90$ |
| 77 | 4 | $v - .530 + .807 \quad .441 \quad -0.24$ |
| 78 | 9 | $v - .175 + .949 \quad .480 \quad -0.96$ |
| 79 | 5 | $v + .038 + .565 \quad .478 \quad -1.49$ |
| 80 | 9 | $v + .310 + .914 \quad .450 \quad -1.50$ |
| 81 | 6 | $v + .543 + .799 \quad .396 \quad -1.24$ |
| 82 | 8 | $v + .712 + .654 \quad .331 \quad -0.73$ |
| 83 | 4 | $v + .865 + .430 \quad .254 \quad -1.73$ |
| 84 | 4 | $v + .929 + .267 \quad .218 \quad -1.29$ |
| 85 | 4 | $v + .966 + .033 \quad .189 \quad -0.28$ |
| 86 | 2 | $v + .888 - .382 \quad .201 \quad +0.51$ |
| 87 | 3 | $v + .203 - .944 \quad .347 \quad -0.28$ |
| 88 | 2 | $v - .012 - .966 \quad .343 \quad -0.94$ |
| 89 | 1 | $v - .364 - .895 \quad .290 \quad -0.66$ |
| 90 | 2 | $v - .816 - .520 \quad .134 \quad +0.38$ |
| 91 | 3 | $v - .958 - .120 \quad .038 \quad -0.16$ |
| 92 | 3 | $v - .935 + .242 \quad .029 \quad +0.29$ |
| 93 | 3 | $v - .788 + .560 \quad .085 \quad +0.24$ |
| 94 | 2 | $v - .586 + .768 \quad .137 \quad +0.65$ |
| 95 | 3 | $v - 0.370 \times x + 0.892 \times y - 0.171 \times z = -0.28$ |

82. The number of observations is 12.

Constants of Nutation and Aberration, &c.

183

Equations of Condition (continued).

| No. of Series. | Number of Obs. | |
|----------------|----------------|----------------------------------------------------------------|
| 96 | 3 | $v - 0.185 \times x + 0.948 \times y - 0.194 \times z = -0.50$ |
| 97 | 3 | $v + .091 + .962 - .176 - 0.86$ |
| 98 | 2 | $v + .373 + .891 - .140 - 1.82$ |
| 99 | 3 | $v + .549 + .795 - .080 - 0.23$ |
| 100 | 6 | $v + .694 + .672 - .021 - 0.45$ |
| 101 | 5 | $v + .834 + .488 + .046 - 0.71$ |
| 102 | 7 | $v + .950 + .169 + .104 - 0.12$ |
| 103 | 4 | $v + .966 + .001 + .122 + 0.05$ |
| 104 | 3 | $v + .865 - .430 + .102 + 1.29$ |
| 105 | 4 | $v + .395 - .881 - .013 + 0.01$ |
| 106 | 2 | $v - .511 - .819 + .055 - 0.33$ |
| 107 | 3 | $v - .872 - .414 + .206 + 0.74$ |
| 108 | 3 | $v - .961 - .092 + .279 - 0.07$ |
| 109 | 5 | $v - .919 + .294 + .306 - 0.83$ |
| 110 | 5 | $v - .794 + .550 + .243 - 0.60$ |
| 111 | 2 | $v - .676 + .690 + .207 - 0.29$ |
| 112 | 3 | $v - .061 + .964 + .126 - 0.95$ |
| 113 | 7 | $v + .462 + .848 + .188 - 0.58$ |
| 114 | 7 | $v + .650 + .715 + .253 - 0.26$ |
| 115 | 5 | $v + .863 + .434 + .368 - 0.69$ |
| 116 | 4 | $v + .935 + .243 + .414 - 0.21$ |
| 117 | 2 | $v + .963 - .083 + .428 + 0.73$ |
| 118 | 1 | $v + .743 - .617 + .380 + 0.66$ |
| 119 | 1 | $v + .396 - .881 + .299 + 0.86$ |
| 120 | 2 | $v + .243 - .935 + .266 - 0.20$ |
| 121 | 1 | $v - .618 - .742 + .385 - 1.18$ |
| 122 | 3 | $v - .850 - .458 + .504 + 0.24$ |
| 123 | 1 | $v - .941 - .217 + .549 + 0.77$ |
| 124 | 5 | $v - .921 + .289 + .559 + 0.61$ |
| 125 | 3 | $v - .119 + .958 + .396 + 1.02$ |
| 126 | 4 | $v + .271 + .927 + .434 - 0.72$ |
| 127 | 3 | $v + .568 + .782 + .515 + 0.01$ |
| 128 | 1 | $v + .713 + .653 + .559 + 0.07$ |
| 129 | 7 | $v + 0.872 \times x + 0.414 \times y + 0.652 \times z = +0.36$ |

Equations of Condition (concluded).

| No. of Series. | Number of Obs. | |
|----------------|----------------|------------------------------------------------------------------|
| 130 | 4 | $v + 0.945 \times x + 0.200 \times y + 0.697 \times z = +0.71''$ |
| 131 | 5 | $v + .877 \quad - .404 \quad .683 \quad +0.26$ |
| 132 | 5 | $v + .675 \quad - .691 \quad .619 \quad +0.10$ |
| 133 | 5 | $v + .283 \quad - .924 \quad .540 \quad +0.16$ |
| 134 | 5 | $v - .348 \quad + .901 \quad .659 \quad -0.93$ |
| 135 | 4 | $v - .050 \quad + .965 \quad .622 \quad -1.21$ |
| 136 | 5 | $v + .164 \quad + .952 \quad .634 \quad -0.61$ |
| 137 | 5 | $v + .419 \quad + .870 \quad .688 \quad -0.63$ |
| 138 | 5 | $v + .638 \quad + .725 \quad .761 \quad -0.95$ |
| 139 | 5 | $v + .787 \quad + .561 \quad .823 \quad +0.50$ |
| 140 | 2 | $v + .944 \quad + .208 \quad .894 \quad -0.59$ |
| 141 | 2 | $v + .966 \quad + .019 \quad .904 \quad -0.66$ |
| 142 | 1 | $v + .616 \quad - .744 \quad .795 \quad +0.91$ |
| 143 | 2 | $v - .038 \quad - .965 \quad .710 \quad -0.41$ |
| 144 | 4 | $v - .394 \quad - .882 \quad .767 \quad -0.18$ |
| 145 | 1 | $v - .638 \quad - .725 \quad .835 \quad -1.51$ |
| 146 | 5 | $v - .939 \quad - .229 \quad .960 \quad -1.24$ |
| 147 | 5 | $v - .958 \quad + .124 \quad .983 \quad -0.43$ |
| 148 | 5 | $v - .853 \quad + .453 \quad .945 \quad -0.02$ |
| 149 | 3 | $v - .613 \quad + .746 \quad .852 \quad -2.23$ |
| 150 | 8 | $v - .343 \quad + .902 \quad .804 \quad +0.33$ |
| 151 | 3 | $v - .116 \quad + .958 \quad .784 \quad +0.42$ |
| 152 | 8 | $v + .319 \quad + .912 \quad .811 \quad +0.09$ |
| 153 | 6 | $v + .579 \quad + .774 \quad .863 \quad -0.24$ |
| 154 | 4 | $v + .776 \quad + .575 \quad .929 \quad -0.11$ |
| 155 | 3 | $v + .902 \quad + .344 \quad 0.998 \quad +0.77$ |
| 156 | 2 | $v + .949 \quad + .179 \quad 1.011 \quad +0.70$ |
| 157 | 3 | $v + .964 \quad - .059 \quad 1.024 \quad +0.59$ |
| 158 | 1 | $v + .359 \quad - .896 \quad 0.832 \quad +0.60$ |
| 159 | 1 | $v + .128 \quad - .957 \quad 0.805 \quad -0.10$ |
| 160 | 2 | $v - .870 \quad + .420 \quad 1.001 \quad -0.46$ |
| 161 | 1 | $v - 0.703 \times x + 0.662 \times y + 0.936 \times z = +0.08$ |

The equations given above were then each multiplied by the square root of the number of observations to reduce them to the same degree of precision, and then solved by the method of least squares,—or, which amounts to the same thing, they were subjected to the following treatment. Supposing one of the equations to be represented by

$$v + ax + by + cz + d = 0,$$

and n to be the number of observations on which it depends, then the corresponding equation, after multiplying by \sqrt{n} , will be

$$\sqrt{n}v + a\sqrt{n} \cdot x + b\sqrt{n} \cdot y + c\sqrt{n} \cdot z + d\sqrt{n} = 0$$

and the ordinary treatment by least squares will finally lead to the final equations :

$$\begin{aligned} \Sigma(n) v + \Sigma(na) x + \Sigma(nb) y + \Sigma(nc) z + \Sigma(nd) &= 0 \\ \Sigma(na)v + \Sigma(na^2) x + \Sigma(nab) y + \Sigma(nac) z + \Sigma(nad) &= 0 \\ \Sigma(nb)v + \Sigma(nab) x + \Sigma(nb^2) y + \Sigma(nbc) z + \Sigma(nbd) &= 0 \\ \Sigma(nc)v + \Sigma(nac) x + \Sigma(nbc) y + \Sigma(nc^2) z + \Sigma(ncd) &= 0 \end{aligned}$$

By actually performing the operations here indicated, it was found that

$$\begin{array}{ll} \Sigma(n) = +689 & \Sigma(na^2) = +313\cdot995 \\ \Sigma(na) = +130\cdot694 & \Sigma(nb^2) = +328\cdot526 \\ \Sigma(nb) = +205\cdot572 & \Sigma(nc^2) = +343\cdot255 \\ \Sigma(nc) = -190\cdot961 & \Sigma(nab) = +23\cdot160 \\ \Sigma(nd) = +211\cdot700 & \Sigma(nac) = -52\cdot759 \\ & \Sigma(nad) = +19\cdot091 \\ & \Sigma(nbc) = -50\cdot850 \\ & \Sigma(nbd) = +164\cdot489 \\ & \Sigma(ncd) = -89\cdot799 \end{array}$$

Proceeding, then, with these numbers according to GAUSS'S method of elimination, the following values of the unknown quantities were found :—

$$\begin{aligned} v &= -0\cdot173; \text{ weight, } 528\cdot007; \text{ probable error, } 0\cdot047 \\ x &= +0\cdot058; \text{ weight, } 240\cdot192; \text{ probable error, } 0\cdot071 \\ y &= -0\cdot378; \text{ weight, } 266\cdot231; \text{ probable error, } 0\cdot067 \\ z &= +0\cdot118; \text{ weight, } 289\cdot281; \text{ probable error, } 0\cdot064 \end{aligned}$$

Hence, as the assumed mean zenith distance for 1840, Jan. 1, was $118''\cdot00 + v$, the constant of aberration $20'' + x$, and the constant of nutation for 1840, $9''\cdot224 \left(1 + \frac{z}{10}\right)$, we have, finally,—

| | | |
|-------------------------------------------------------------------------|-----|---------------------------------|
| Mean zenith distance north of γ <i>Draconis</i> for 1840, Jan. 1 | = | $117''\cdot827 \pm 0''\cdot047$ |
| Constant of aberration | = | $20\cdot058 \pm 0\cdot071$ |
| Constant of lunar nutation | = | $9\cdot323 \pm 0\cdot059$ |
| Constant of parallax | = - | $0\cdot378 \pm 0\cdot067$ |

The anomalous results here indicated for the aberration and the parallax seem to show that some cause of error of a periodical character has acted injuriously on the observations, but it is very difficult to imagine a source of error of this nature, since want of fixity of the object-glass, or of the grand micrometer, or of the plumb-line microscopes, would have exhibited itself in producing inconstancy in the zero and sudden irregularities in the observations; but, on the whole, the zero has through the whole series of the observations all desirable steadiness, and the observations are as consistent with each other as could be expected. The value of a revolution of the grand micrometer was determined by an exceedingly accurate method, twice in the interval of a few years, and these two results were almost identical. One determination was made in the winter of 1836 and the other in the spring of 1846, and it is probable that the average temperature was pretty nearly the same at each determination; but even if the result be affected with an unknown temperature-correction, the range of arc required for observations of γ *Draconis* is so small that no significant error is to be apprehended on this account. The only remaining supposition is that of some derangement or deflection of the plumb-line, and the chance of any disturbance of such magnitude and constancy as the case requires, having happened, appears to be very small. If the plumb-line should have been pulled out of the vertical by means of the auxiliary apparatus added in 1840 for the prevention of the twist caused by rapid rotation of the instrument, the deviation would be totally in the prime vertical, and the projection on the meridian plane would still be accurately vertical. It may be added also that any deviation of the plumb-line from the vertical would be eliminated by the double observations in reversed positions.

Still it is believed that, notwithstanding the doubt which to a certain

extent seems to rest on the results of the investigation on account of the anomalous values deduced for the aberration and the parallax, considerable weight may still be attached to the value deduced for the nutation constant, since, on the supposition of an unknown cause of error producing an inequality, having either an annual or a shorter period, its effect would be perfectly eliminated in so long a series of observations.

The labour bestowed upon the investigation in the endeavour to produce the best possible result from the observations by applying rigorously the method of least squares has been very great; and as the whole of the calculations have been performed by myself, I regret much that the results have not proved so unexceptionable as to warrant the amount of care and labour expended. Still a laborious work of this kind cannot be without its value, and it is hoped that additional scrutiny may afterwards throw some light upon the nature of the errors in the results of an investigation based upon observations made in an unexceptionable way with an instrument faultless in theory, and pursued by processes combining all the modern refinements.

For the present I leave this paper in the hands of astronomers, with the hope that some one interested in the subject may be able to offer some elucidation of the difficulty thus presented.

ROBERT MAIN.

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