VI. *On the Value of the Constant of Aberration as deduced from Eight Years' Observations of γ Draconis, from* 1852 *to* 1859 *inclusive, made with the Reflex Zenith Tube at the Royal Observatory, Greenwich.* By the Rev. Robert Main, M.A., President.

Read May 11, 1860.

The paper which I now offer to the Society may be considered as a supplement to that which is printed in the twenty-fourth volume of the *Memoirs*, on the *Values of the Constants of Nutation and Aberration*, as deduced from the observations of γ *Draconis* made with the twenty-five foot zenith-tube, which was dismounted in the year 1848. The readers of the *Memoirs* will remember that the results deduced from the observations in that paper were unsatisfactory, the constant of aberration being $20''{\cdot}058$, or less by about three-tenths of a second than the received value, and the deduced parallax being negative and amounting to nearly four-tenths of a second. Those results having up to the present time received no satisfactory elucidation, I have thought it desirable to discuss the observations made since with the new or reflex zenith tube, which extend with tolerable continuity from the year 1852 to the present time, especially as the instrument with which they were made is so simple in construction and so nearly perfect in theory, that the only errors which apparently can exist are those of a fluctuating character arising from the bad definition of the star, the casual disturbances of the surface of the mercury, or the bad state of the atmosphere at the time of the star's transit, all of which in their effects ought to be perfectly eliminated in the course of a long series of observations.

For a description of the reflex zenith tube I beg to refer to the first Appendix to the volume of the *Greenwich Observations* for 1854, merely giving in this place such an account of its general construction as may serve to convey to those persons who have not an opportunity of studying the detailed account given by Mr. AIRY, an adequate idea of its fitness for the observations here under discussion. It consists mainly of an object-glass fitted firmly into a cell connected with a tube placed vertical and sliding within another tube screwed down to a platform raised several feet above the floor of the small apartment containing it; of a mercury trough quite independent of the tube, and placed at the distance of nearly half the focal length of the object-glass beneath it; and of a double micrometer firmly connected with the cell of the object-glass and immediately above it. This micrometer, for the ordinary observations of the star, γ *Draconis*, has two declination wires placed at nearly double the angular distance of the star from the zenith, so that, means being provided for the rotation of the object-glass round a vertical axis, two observations may be made in reversed positions of the instrument, with a very trifling motion of the screw.

The image of the star, after being reflected from the surface of the mercury, is formed a little above the outer surface of the object-glass, in the plane of the wires of the micrometer, and is viewed by the observer conveniently by means of an apparatus consisting of a prism to reflect the rays into a horizontal direction, and of an eye-piece to convey them to the eye of the observer. A level placed parallel to the meridian, and which rotates with the rest of the apparatus, is read for the purpose of correcting for the trifling effect of shift of zero due to the want of horizontality of the object-glass, and the obstructions which the micrometer-frame in front of the object-glass offers to the pencil of light proceeding from the star are rendered perfectly symmetrical to prevent any injurious effects on the image. This explanation of the instrument may be sufficient for our present purpose.

It is, however, necessary to advert to the principal, and indeed the only source of difficulty which has been experienced in the use of the instrument, namely, that of finding a perfectly firm support for the mercury-trough, or one through which tremors arising from casual disturbances in the neighbourhood of the tube should not be transmitted to the surface of the mercury. In the year 1852, when the instrument was first used, it was placed in a small apartment to the east of the transit-circle room, but which now forms the lobby to that apartment, and there it remained till the year 1856. During this period, the mercury-trough was supported on a bed of sand heaped up to a considerable height above the level of the floor of the transit-room, but considerably below that of the observing platform to which the outer tube was screwed. This position is very near to the porter's gate of the observatory, and the effect of disturbance on the mercury was so great that the star could not be observed at all in the business hours of the day. In 1856 it was removed to its present position, but for some time the effect of disturbance through the transmission of tremor to the mercury continued as bad as before, till, in the year 1857, a caoutchouc suspension was devised for the mercury-trough, which was perfectly successful, and since that time the observations have been made at every transit of the star (except on Sundays) with no more interruptions than are due to the unfavourable state of the weather, or to accidental omissions.

For the method used in the discussion of the observations I would refer entirely to my memoir before quoted (*Mem. Roy. Ast. Soc.* vol. xxiv. pp. 147, &c.), as the tables therein given, (with the exception of a very trifling change in that for the aberration, depending on the precessional motion of the star between the middle epoch of the observations there discussed and that of the observations now before us), are perfectly applicable for this investigation.

It is of little importance that the value of the assumed mean north zenith distance of the star employed in the investigation should be absolutely correct, since its error can be determined, together with the error of the assumed constant of aberration, by means of the observations; but, on account of the shift in the position of the instrument which took place in 1856, it is necessary that the differences of north zenith distances corresponding to the old and the new positions should be accurate. By measurement on the plan of the observatory, I have found that the first position of the reflex zenith tube (near the porter's gate) was 53 feet south of that of the 25-foot zenith tube, and the new position, to which it was removed in 1856, was 75 feet south of the same. These quantities correspond respectively to $0''\cdot52$ and $0''\cdot73$ increase of north zenith distance. Hence, assuming from my former memoir that the north zenith distance of γ *Draconis*, for 1840, Jan. 1, was $117''\cdot827$; that the yearly geometrical precessional motion for 1850 is $-0''\cdot601$; and the annual proper motion, $-0''\cdot40$; we have:

for	1852, Jan. 1,	Mean N.Z.D. =	$110''\cdot56$
„	1853	„	109·92
„	1854	„	109·29
„	1855	„	108·66
„	1856	„	108·24
„	1857	„	107·61
„	1858	„	106·98
„	1859	„	106·36

By means of these numbers, together with the table following Table III., in my memoir before cited (with a trifling modification), the mean of the north zenith distances corresponding to the mean of the days of observation in each group is easily formed.

The constant of aberration I have assumed to be $20''\cdot4 + x$, and the numerical part of this, or the values of $-20''\cdot4 \times \cos(1^\circ\, 23' + \odot)$, is easily computed from Table IV. of my previous memoir by adding one fiftieth part to the values therein given. I may add that to make the tables for the aberration given in that memoir strictly applicable to the middle epoch of the observations discussed at present, or to 1855 nearly, I have subtracted $3'$ from the values of $\odot$ corresponding to the means of groups throughout.

No more explanation is requisite before proceeding to the tabular arrangement, excepting that both in the present memoir and in the other which has been referred to, in the formation of the coefficients of annual parallax, the earth's orbit has been supposed to be circular.

Table I.

Observed Meridian Apparent North Zenith Distances of γ Draconis.

Day and Hour.	Observed Apparent N.Z.D.	Day and Hour.	Observed Apparent N.Z.D.	Day and Hour.	Observed Apparent N.Z.D.
1852. h	″	1852. h	″	1853. h	″
May 31 13	105·11	Aug. 3 9	124·13	May 20 14	99·98
June 3 13	108·46	4 9	125·33	25 14	99·81
4 13	105·27	5 9	124·90	26 14	101·06
10 12	108·97	6 9	125·48	June 3 13	104·90
14 12	110·25	9 9	125·09	7 13	105·57
15 12	111·72	18 8	126·91	11 12	106·74
19 12	112·57	19 8	128·14	16 12	108·11
21 12	112·67	21 8	127·23	17 12	108·31
23 12	112·99	25 8	128·54	23 12	111·35
24 12	114·75	26 8	129·00	29 11	111·48
26 11	114·31	27 8	128·71	July 5 11	114·38
July 1 11	115·83	28 7	129·03	12 11	115·35
5 11	117·07	30 7	128·38	22 10	120·01
6 11	117·72	31 7	128·29	25 10	118·90
7 11	117·20	Sept. 1 7	128·95	Aug. 4 9	121·45
9 11	118·82	2 7	129·39	8 9	123·65
10 11	118·26	3 7	128·58	10 9	123·15
14 10	119·35	8 7	130·09	12 8	123·95
15 10	119·60	15 6	130·62	20 8	124·20
19 10	121·26	25 5	131·07	24 8	124·19
21 10	120·96	29 5	129·51	Sept. 10 7	126·97
22 10	121·78	Oct. 7 5	129·85	19 6	126·54
23 10	123·52	20 4	128·61	1854.	
27 9	123·56	1853.		Jan. 24 22	95·39
29 9	122·38	April 10 17	90·69	Mar. 14 18	88·63
30 9	123·76	26 16	92·97	April 19 16	89·57

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

Day and Hour.	Observed Apparent N.Z.D.	Day and Hour.	Observed Apparent N.Z.D.	Day and Hour.	Observed Apparent N.Z.D.
1854. h	″	1854. h	″	1855. h	″
April 23 16	89·65	Sept. 2 7	123·03	July 19 10	113·18
May 8 15	92·31	4 7	123·03	21 10	111·77
16 14	95·97	5 7	122·75	31 9	114·22
19 14	95·44	6 7	123·91	Aug. 9 9	117·60
26 14	98·78	8 7	122·91	13 8	116·00
27 14	98·16	9 7	123·87	15 8	117·66
30 13	99·10	11 7	123·39	16 8	117·79
31 13	99·47	12 6	124·01	20 8	117·62
June 3 13	100·92	26 6	125·13	25 8	118·16
10 13	103·01	27 6	123·43	27 8	118·99
12 13	102·93	1855.		29 7	119·62
17 12	104·07	Mar. 26 18	82·48	30 7	118·49
20 12	102·61	April 17 16	85·27	31 7	117·55
28 11	109·14	19 16	84·37	Sept. 1 7	119·65
29 11	108·95	20 16	86·08	3 7	120·29
July 18 10	113·18	25 16	86·44	7 7	119·32
19 10	114·52	May 8 15	88·76	12 6	121·19
20 10	114·70	June 1 13	96·67	25 6	120·26
21 10	116·17	2 13	98·72	26 6	121·05
22 10	115·25	5 13	97·91	1856.	
24 10	118·03	9 13	99·64	May 22 14	90·77
28 10	117·03	19 12	101·72	23 14	91·81
29 9	115·47	20 12	103·01	June 2 13	94·52
Aug. 1 9	115·83	21 12	102·89	3 13	93·76
10 9	119·72	27 12	106·08	5 13	93·07
12 9	119·37	28 11	106·22	6 13	96·69
14 8	120·22	30 11	105·71	11 12	96·52
18 8	121·47	July 4 11	108·00	14 12	98·95
22 8	120·77	5 11	106·95	16 12	97·87
28 7	122·60	12 11	108·86	17 12	99·66
29 7	123·00	13 10	107·62	26 12	102·41
30 7	123·39	14 10	109·61	28 11	103·09

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

Day and Hour.		Observed Apparent N.Z.D.	Day and Hour.		Observed Apparent N.Z.D.	Day and Hour.		Observed Apparent N.Z.D.
1856.	h	″	1856.	h	″	1857.	h	″
July 1	11	105·57	Sept. 20	6	119·33	April 20	16	80·51
3	11	103·73	23	6	118·76	29	15	82·45
5	11	104·04	30	5	119·08	May 3	15	85·29
16	10	109·13	Oct. 1	5	118·65	6	15	84·46
17	10	108·71	20	4	116·52	7	15	86·21
18	10	109·46	22	4	115·28	8	15	85·62
22	10	109·61	23	4	116·06	11	15	86·86
23	10	109·92	25	4	114·24	14	14	86·66
24	10	110·15	27	3	114·12	25	14	90·76
25	10	109·90	Nov. 4	3	113·88	26	14	90·35
26	10	111·30	6	3	112·46	27	14	91·06
28	9	111·84	24	2	108·32	June 2	13	93·51
29	9	111·36	Dec. 11	1	102·82	4	13	94·30
30	9	112·64	15	0	102·30	8	13	94·85
31	9	112·27	19	0	98·95	10	13	95·93
Aug. 1	9	113·08	23	23	98·20	11	13	96·57
2	9	111·91	1857.			12	12	97·76
4	9	114·47	Jan. 1	23	94·67	13	12	96·66
5	9	113·21	Feb. 9	21	82·80	15	12	96·22
6	9	113·80	10	21	82·97	17	12	98·08
7	9	114·28	12	20	82·06	18	12	98·37
9	9	114·03	15	20	81·81	23	12	100·49
12	8	115·00	16	20	82·10	24	12	100·56
13	8	115·17	Mar. 12	18	77·61	25	12	99·05
14	8	115·05	15	18	78·17	26	12	101·33
23	8	115·08	16	18	79·90	27	11	100·95
28	8	117·68	17	18	78·17	30	11	102·18
Sept. 2	7	117·70	April 14	16	82·18	July 7	11	104·43
3	7	117·71	15	16	79·98	8	11	104·76
4	7	117·27	16	16	80·46	9	11	104·40
5	7	118·90	17	16	81·04	11	11	105·31
10	7	118·56	19	16	80·96	13	10	107·55

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

Day and Hour.		Observed Apparent N.Z.D.	Day and Hour.		Observed Apparent N.Z.D.	Day and Hour.		Observed Apparent N.Z.D.
1857.	h	″	1857.	h	″	1858.	h	″
July 14	10	106·73	Oct. 1	5	117·61	Mar. 22	18	79·90
15	10	106·12	5	5	117·52	23	18	77·08
17	10	107·01	6	5	117·12	26	17	78·45
18	10	107·73	14	4	116·10	April 13	16	79·41
20	10	108·82	26	4	115·59	18	16	81·12
23	10	108·32	28	3	114·65	19	16	79·91
24	10	108·60	30	3	113·55	21	16	80·90
25	10	108·84	Nov. 11	3	111·14	May 4	15	84·09
28	9	111·29	27	1	106·33	5	15	84·12
29	9	110·52	28	1	105·97	6	15	85·94
31	9	111·35	Dec. 4	1	104·97	7	15	84·62
Aug. 5	9	112·31	10	1	102·10	8	15	85·00
12	8	113·37	11	1	102·37	12	14	87·15
14	8	114·95	31	23	95·63	13	14	86·51
17	8	113·70	1858.			18	14	87·66
22	8	115·52	Jan. 6	23	93·23	19	14	87·88
24	8	115·22	11	23	91·29	20	14	87·94
25	8	115·16	13	22	90·61	25	14	90·06
26	8	116·10	25	22	86·01	29	13	91·77
27	7	116·85	26	22	86·64	June 3	13	92·09
Sept. 3	7	116·32	27	21	86·75	5	13	94·66
4	7	115·70	31	21	86·27	9	13	94·90
5	7	116·93	Feb. 18	20	82·21	10	13	94·78
8	7	117·30	19	20	80·22	12	13	95·65
9	7	116·59	21	20	80·35	14	13	96·93
16	6	117·76	23	20	80·06	15	13	96·19
17	6	117·64	24	20	78·79	16	13	96·75
18	6	118·83	25	20	79·07	17	13	97·29
23	6	118·14	Mar. 8	19	78·73	18	13	97·14
24	6	117·96	9	19	77·71	19	13	97·32
29	5	118·06	10	19	79·33	22	12	99·11
30	5	117·05	21	18	79·25	25	12	100·76

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

Day and Hour.		Observed Apparent N.Z.D.	Day and Hour.		Observed Apparent N.Z.D.	Day and Hour.		Observed Apparent N.Z.D.
1858.	h	"	1858.	h	"	1859.	h	"
June 28	11	102·33	Sept. 15	6	117·34	April 4	17	80·92
29	11	101·40	16	6	117·44	6	17	80·34
July 1	11	102·32	17	6	116·95	10	17	80·44
8	11	103·21	18	6	117·10	22	16	82·29
12	11	105·39	20	6	115·77	May 5	15	85·96
13	11	106·62	24	5	119·17	6	15	86·95
14	10	105·74	Oct. 5	5	117·00	12	15	88·85
16	10	105·99	6	5	117·09	13	14	86·96
17	10	106·64	12	4	116·58	14	14	87·17
19	10	107·78	30	3	113·37	23	14	91·09
21	10	108·59	Nov. 3	3	113·90	26	14	91·42
26	10	109·04	11	3	110·51	June 7	13	96·81
28	10	109·68	18	2	109·20	16	12	99·63
30	9	110·48	Dec. 1	1	106·47	17	12	99·77
31	9	110·63	3	1	105·20	24	12	101·37
Aug. 2	9	110·59	20	0	99·03	29	11	103·52
3	9	110·48	23	0	97·72	30	11	103·25
5	9	110·54	1859.			July 1	11	104·75
6	9	112·94	Jan. 23	22	87·23	4	11	104·02
7	9	112·96	Feb. 2	22	86·19	5	11	105·37
10	9	112·53	6	21	83·17	6	11	104·01
11	9	113·66	17	20	80·87	7	11	103·81
12	8	112·25	22	20	79·84	9	11	106·13
13	8	113·10	24	20	80·78	11	11	106·57
19	8	113·81	25	20	80·49	12	11	106·27
26	8	115·20	27	19	78·34	13	10	107·80
28	7	115·64	Mar. 7	19	79·49	14	10	107·11
30	7	116·27	8	19	78·91	15	10	107·52
Sept. 1	7	116·25	9	19	79·39	16	10	107·89
8	7	117·36	10	18	78·74	19	10	110·81
13	6	117·68	18	18	80·05	28	9	111·43
14	6	117·30	31	17	79·20	Aug. 2	9	111·71

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

Day and Hour.			Observed Apparent N.Z.D.	Day and Hour.			Observed Apparent N.Z.D.	Day and Hour.			Observed Apparent N.Z.D.
1859.		h	″	1859.		h	″	1859.		h	″
Aug.	4	9	112·90	Sept.	3	7	117·34	Nov.	10	3	113·48
	5	9	112·56		6	7	117·29		17	2	109·77
	16	8	114·24		18	6	119·19		19	2	110·05
	19	8	114·73		21	6	118·12		21	2	109·68
	20	8	115·91		24	6	118·65		23	2	109·21
	22	8	115·63	Oct.	3	5	118·90		24	2	109·31
	23	8	115·09		6	5	117·36		30	1	106·83
	24	8	115·95		14	4	115·96	Dec.	8	1	103·30
	26	8	115·95		22	4	115·14		10	1	104·09
	30	7	118·29		27	4	114·96		26	0	98·52
Sept.	1	7	117·28	Nov.	3	3	114·13				

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.
				d	h	″	
1	1852,	May 31 to June 4 ..	June	2	21	106·28	3
2		June 10 to 21		16	7	111·24	5
3		June 23 to July 10 ..	July	2	19	116·33	9
4		July 14 to 23		19	10	121·08	6
5		July 27 to August 9	Aug.	2	21	124·33	8
6		August 18 to Sept. 3		27	8	128·43	12
7		September 8 to 29 ..	Sept.	19	12	130·32	4
8		October 7 to 20	Oct.	13	17	129·23	2
9	1853,	April 10 to 26	April	18	17	91·83	2
10		May 20 to June 3 ..	May	26	20	101·44	4
11		June 7 to 29........	June	17	16	108·59	6
12		July 5 to 25........	July	14	11	117·16	4
13		August 4 to 12......	Aug.	8	21	123·05	4
14		August 20 to 24		22	8	124·20	2
15		September 10 to 19..	Sept.	14	19	126·76	2
16	1854,	January 24	Jan.	24	22	95·39	1
17		March 14	Mar.	14	18	88·63	1
18		April 19 to 23	April	21	16	89·61	2
19		May 8 to 19........	May	14	22	94·57	3
20		May 26 to June 3 ..		30	4	99·29	5
21		June 10 to 20	June	15	6	103·15	4
22		June 28 to 29		28	23	109·05	2
23		July 18 to August 1	July	24	2	115·58	9
24		August 10 to 22	Aug.	15	13	120·31	5
25		August 28 to Sept. 12	Sept.	4	22	123·26	11
26		September 26 to 27..		26	18	124·28	2

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.
				d	h	"	
27	1855,	March 26	Mar.	26	18	82·48	1
28		April 17 to 25	April	20	22	85·54	4
29		May 8	May	8	15	88·76	1
30		June 1 to 9	June	4	19	98·24	4
31		June 19 to 30		24	16	104·27	6
32		July 4 to 14........	July	10	1	108·21	5
33		July 19 to 31		24	2	113·06	3
34		August 9 to 20	Aug.	14	23	117·33	5
35		August 25 to Sept. 7		31	1	119·01	8
36		September 12 to 26..	Sept.	21	6	120·83	3
37	1856,	May 22 to 23	May	23	2	91·29	2
38		June 2 to 11	June	5	22	94·91	5
39		June 14 to 17		16	4	98·83	3
40		June 26 to July 5 ..	July	1	2	103·77	5
41		July 16 to 26		21	19	109·77	8
42		July 28 to August 2		30	21	112·18	6
43		August 4 to 14	Aug.	9	3	114·38	8
44		August 23 to Sept. 10	Sept.	2	4	117·56	7
45		Sept. 20 to Oct. 1 ..		26	6	118·96	4
46		Oct. 20 to 27	Oct.	23	13	115·24	5
47		November 4 to 6	Nov.	5	3	113·17	2
48		November 24		24	2	108·32	1
49		December 11 to 23 ..	Dec.	17	6	100·57	4
50	1857,	January 1..........	Jan.	1	23	94·67	1
51		February 9 to 16....	Feb.	13	6	82·35	5
52		March 12 to 17	Mar.	15	18	78·46	4
53		April 14 to 20	April	17	12	80·86	6
54		April 29 to May 14..	May	7	11	85·36	7
55		May 25 to June 8 ..		31	10	92·47	6
56		June 10 to 18	June	14	6	97·08	7
57		June 23 to 30......		26	8	100·43	6
58		July 7 to 18........	July	12	21	106·00	9
59		July 20 to August 5		27	10	110·01	8

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.
				d	h	"	
60	1857,	August 12 to 27	Aug.	21	5	115·11	8
61		September 3 to 9	Sept.	6	2	116·57	5
62		Sept. 16 to Oct. 1 ..		23	18	117·88	8
63		October 5 to 14	Oct.	8	13	116·91	3
64		October 26 to 30		28	3	114·60	3
65		November 11	Nov.	11	3	111·14	1
66		Nov. 27 to Dec. 4 ..		29	17	105·76	3
67		December 10 to 11 ..	Dec.	10	13	102·24	2
68		December 31		31	23	95·63	1
69	1858,	January 6 to 13	Jan.	10	23	91·71	3
70		January 25 to 31		28	4	86·42	4
71		February 18 to 25 ..	Feb.	22	12	80·12	6
72		March 8 to 10	Mar.	9	19	78·59	3
73		March 21 to 26		23	18	78·67	4
74		April 13 to 21	April	18	10	80·34	4
75		May 4 to 13	May	8	11	85·35	7
76		May 18 to 29		22	19	89·06	5
77		June 3 to 19	June	13	2	95·79	11
78		June 22 to July 8 ..		29	8	101·52	6
79		July 12 to 21	July	16	10	106·68	7
80		July 26 to August 7	Aug.	1	22	110·82	9
81		August 10 to 19		13	8	113·07	5
82		August 26 to Sept. 8		31	7	116·14	5
83		September 13 to 24 ..	Sept.	17	9	117·34	8
84		October 5 to 12	Oct.	7	21	116·89	3
85		Oct. 30 to Nov. 11 ..	Nov.	4	11	112·59	3
86		November 18		18	2	109·20	1
87		December 1 to 3	Dec.	2	1	105·84	2
88		December 20 to 23 ..		21	12	98·38	2
89	1859,	January 23 to Feb. 6	Jan.	31	22	85·53	3
90		February 17 to 27 ..	Feb.	23	20	80·06	5
91		March 7 to 18	Mar.	11	4	79·32	5
92		March 31 to April 10	April	5	17	80·23	4

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.
		d h	″	
93	1859, April 22	April 22 16	82·29	1
94	May 5 to 14........	May 10 15	87·18	5
95	May 23 to June 7 ..	29 14	93·11	3
96	June 16 to July 1 ..	June 25 0	102·85	6
97	July 4 to 19........	July 11 9	106·44	12
98	July 28 to August 5	Aug. 2 9	112·15	4
99	August 16 to 26	21 18	115·36	7
100	August 30 to Sept. 6	Sept. 2 13	117·55	4
101	September 18 to 24..	21 6	118·65	3
102	October 3 to 14	Oct. 7 21	117·41	3
103	Oct. 22 to Nov. 3 ..	27 20	114·74	3
104	November 10 to 21 ..	Nov. 16 20	110·75	4
105	Nov. 23 to Dec. 10 ..	Dec. 1 1	106·55	5
106	December 26	26 0	98·52	1

TABLE III.

Values of the Sun's Longitude ☉, *Moon's Longitude* ☽, *and Longitude of the Moon's Node* ☊, *for the Times corresponding to the Means of the Times of Observation in each Group.*

No. of Series.	☉	☽	☊	No. of Series.	☉	☽	☊
	° ′	° ′	° ′		° ′	° ′	° ′
1	72 48	267 40	99 22	25	162 25	322 15	55 43
2	85 38	75 6	98 37	26	183 44	244 20	54 34
3	101 22	302 6	97 46	27	5 58	115 30	44 59
4	117 14	152 29	96 53	28	30 40	89 12	43 39
5	131 3	349 28	96 7	29	47 50	317 52	42 42
6	154 31	313 42	94 49	30	73 58	316 52	41 16
7	177 6	260 7	93 36	31	92 57	211 14	40 12
8	200 58	214 0	92 19	32	107 36	66 16	39 24
9	29 0	149 11	82 25	33	121 0	237 58	38 40
10	65 50	306 4	80 24	34	141 57	171 5	37 30
11	86 43	223 24	79 15	35	157 29	32 41	36 39
12	112 16	215 48	77 50	36	178 7	300 12	35 32
13	136 34	190 36	76 29	37	62 31	285 49	22 33
14	149 30	17 5	75 46	38	75 46	118 45	21 50
15	172 16	325 53	74 32	39	85 33	243 30	21 18
16	305 7	259 25	67 32	40	99 47	89 42	20 30
17	354 18	180 36	64 57	41	119 33	358 39	19 24
18	31 38	329 34	62 56	42	128 13	122 20	18 55
19	54 9	272 27	61 42	43	137 5	233 58	18 26
20	68 52	110 22	60 54	44	160 16	195 15	17 9
21	84 10	330 36	60 37	45	183 47	157 34	15 53
22	97 13	140 32	59 21	46	210 47	158 6	14 26
23	121 14	115 14	58 0	47	223 23	312 12	13 46
24	142 45	58 3	56 48	48	242 29	208 32	12 47

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

No. of Series.	☉	☽	☊	No. of Series.	☉	☽	☊
	° ′	° ′	° ′		° ′	° ′	° ′
49	266 1	159 9	11 32	78	97 39	315 44	341 56
50	282 2	358 26	10 42	79	113 57	192 58	341 1
51	325 0	198 46	8 28	80	129 42	37 27	340 9
52	355 34	236 29	6 51	81	140 39	200 10	339 33
53	27 50	303 53	5 7	82	157 59	66 51	338 35
54	47 14	214 58	4 3	83	174 36	293 38	337 42
55	70 16	175 44	2 48	84	194 45	210 18	336 37
56	83 29	346 35	2 4	85	222 13	213 36	335 9
57	95 1	158 16	1 25	86	235 56	22 8	334 26
58	110 47	5 44	0 33	87	250 4	217 42	333 42
59	124 39	204 8	359 46	88	269 51	110 38	332 40
60	148 29	172 44	358 28	89	312 1	294 25	330 28
61	163 50	15 22	357 37	90	335 10	242 13	329 15
62	181 4	247 46	356 41	91	350 32	73 45	328 26
63	195 39	89 59	355 54	92	15 49	50 27	327 5
64	215 7	335 37	354 52	93	32 24	280 20	326 11
65	229 10	173 49	354 7	94	49 49	158 18	325 14
66	247 57	50 7	353 8	95	68 3	38 43	324 14
67	258 57	200 9	352 34	96	93 17	25 37	322 50
68	280 46	122 22	351 26	97	108 55	253 52	321 58
69	290 58	249 15	350 54	98	129 56	185 2	320 48
70	308 28	118 53	350 0	99	148 32	67 5	319 47
71	334 4	90 4	348 39	100	159 56	236 43	319 9
72	349 24	287 17	347 50	101	178 8	112 3	318 10
73	3 16	118 26	347 6	102	193 31	333 41	317 17
74	28 31	96 22	345 44	103	214 20	243 36	316 14
75	47 58	349 40	344 41	104	234 26	141 42	315 10
76	61 45	191 55	343 55	105	248 49	327 42	314 25
77	82 10	110 16	342 48	106	274 12	299 36	313 5

TABLE IV.

Equations of Condition.

No. of Series.	Number of Obs.	Equations.		
1	3	$v - 0{\cdot}262 \times x$	$+ 0{\cdot}930 \times y$	$= -0{\cdot}82''$
2	5	$v - {\cdot}049$	$+ {\cdot}965$	$-0{\cdot}15$
3	9	$v + {\cdot}213$	$+ {\cdot}942$	$-0{\cdot}15$
4	6	$v + {\cdot}464$	$+ {\cdot}847$	$-0{\cdot}07$
5	8	$v + {\cdot}653$	$+ {\cdot}712$	$-0{\cdot}23$
6	12	$v + {\cdot}882$	$+ {\cdot}394$	$-0{\cdot}23$
7	4	$v + {\cdot}966$	$+ {\cdot}024$	$+0{\cdot}28$
8	2	$v + {\cdot}893$	$- {\cdot}369$	$+0{\cdot}89$
9	2	$v - {\cdot}833$	$+ {\cdot}490$	$+0{\cdot}51$
10	4	$v - {\cdot}374$	$+ {\cdot}891$	$+0{\cdot}40$
11	6	$v - {\cdot}030$	$+ {\cdot}966$	$+0{\cdot}65$
12	4	$v + {\cdot}388$	$+ {\cdot}885$	$+1{\cdot}11$
13	4	$v + {\cdot}718$	$+ {\cdot}646$	$+1{\cdot}03$
14	2	$v + {\cdot}844$	$+ {\cdot}470$	$-0{\cdot}04$
15	2	$v + {\cdot}959$	$+ {\cdot}107$	$+0{\cdot}62$
16	1	$v - {\cdot}575$	$- {\cdot}777$	$+1{\cdot}01$
17	1	$v - {\cdot}963$	$- {\cdot}072$	$(+3{\cdot}52)$
18	2	$v - {\cdot}809$	$+ {\cdot}527$	$+1{\cdot}37$
19	3	$v - {\cdot}546$	$+ {\cdot}797$	$+0{\cdot}60$
20	5	$v - {\cdot}325$	$+ {\cdot}909$	$+0{\cdot}75$
21	4	$v - {\cdot}074$	$+ {\cdot}963$	$-0{\cdot}45$
22	2	$v + {\cdot}145$	$+ {\cdot}955$	$+1{\cdot}16$
23	9	$v + {\cdot}521$	$+ {\cdot}813$	$+0{\cdot}46$
24	5	$v + {\cdot}784$	$+ {\cdot}566$	$+0{\cdot}48$
25	11	$v + {\cdot}928$	$+ {\cdot}269$	$+1{\cdot}01$
26	2	$v + {\cdot}962$	$- {\cdot}087$	$+1{\cdot}53$
27	1	$v - {\cdot}958$	$+ {\cdot}125$	$+0{\cdot}37$
28	4	$v - 0{\cdot}818 \times x$	$+ 0{\cdot}513 \times y$	$= +0{\cdot}45$

Equations of Condition (continued).

No. of Series.	Number of Obs.	Equations.		
29	1	$v - 0.630 \times x$	$+ 0.732 \times y$	$= -0''.25$
30	4	$v - .243$	$+ .935$	$+1.12$
31	6	$v + .075$	$+ .963$	$+0.80$
32	5	$v + .315$	$+ .913$	-0.06
33	3	$v + .518$	$+ .815$	$+0.96$
34	5	$v + .776$	$+ .577$	$+0.64$
35	8	$v + .901$	$+ .347$	$+0.07$
36	3	$v + .966$	$+ .008$	$+0.79$
37	2	$v - .424$	$+ .868$	-0.07
38	5	$v - .215$	$+ .942$	-0.79
39	3	$v - .051$	$+ .965$	-0.23
40	5	$v + .188$	$+ .948$	-0.09
41	8	$v + .497$	$+ .826$	$+0.12$
42	6	$v + .616$	$+ .743$	$+0.19$
43	8	$v + .723$	$+ .640$	$+0.39$
44	7	$v + .917$	$+ .303$	$+0.23$
45	4	$v + .962$	$- .088$	$+0.92$
46	5	$v + .817$	$- .515$	-0.03
47	2	$v + .686$	$- .681$	$+0.33$
48	1	$v + .425$	$- .867$	$+0.58$
49	4	$v + .043$	$- .965$	$+0.51$
50	1	$v - .224$	$- .939$	$+0.16$
51	5	$v - .805$	$- .534$	$+0.50$
52	4	$v - .965$	$- .050$	$+0.20$
53	6	$v - .842$	$+ .473$	-0.03
54	7	$v - .638$	$+ .725$	$+0.05$
55	6	$v - .303$	$+ .917$	$+0.07$
56	7	$v - .086$	$+ .962$	$+0.17$
57	6	$v + .108$	$+ .960$	-0.43
58	9	$v + .366$	$+ .894$	$+0.08$
59	8	$v + .569$	$+ .781$	$+0.15$
60	8	$v + 0.836 \times x$	$+ 0.485 \times y$	$= +0.34$

Equations of Condition (continued).

No. of Series.	Number of Obs.	Equations.
61	5	$v + 0{\cdot}934 \times x + 0{\cdot}246 \times y = +0''{\cdot}02$
62	8	$v + {\cdot}965 \quad - {\cdot}042 \quad +0{\cdot}66$
63	3	$v + {\cdot}923 \quad - {\cdot}284 \quad +0{\cdot}47$
64	3	$v + {\cdot}777 \quad - {\cdot}575 \quad +1{\cdot}02$
65	1	$v + {\cdot}613 \quad - {\cdot}747 \quad +0{\cdot}67$
66	3	$v + {\cdot}339 \quad - {\cdot}904 \quad +0{\cdot}47$
67	2	$v + {\cdot}161 \quad - {\cdot}952 \quad +0{\cdot}57$
68	1	$v - {\cdot}203 \quad - {\cdot}944 \quad +1{\cdot}32$
69	3	$v - {\cdot}369 \quad - {\cdot}893 \quad +0{\cdot}84$
70	4	$v - {\cdot}619 \quad - {\cdot}741 \quad +0{\cdot}99$
71	6	$v - {\cdot}878 \quad - {\cdot}401 \quad +0{\cdot}41$
72	3	$v - {\cdot}953 \quad - {\cdot}154 \quad +0{\cdot}59$
73	4	$v - {\cdot}963 \quad + {\cdot}079 \quad +0{\cdot}91$
74	4	$v - {\cdot}837 \quad + {\cdot}483 \quad -0{\cdot}27$
75	7	$v - {\cdot}628 \quad + {\cdot}734 \quad +0{\cdot}29$
76	5	$v - {\cdot}436 \quad + {\cdot}862 \quad -0{\cdot}18$
77	11	$v - {\cdot}098 \quad + {\cdot}959 \quad -0{\cdot}51$
78	6	$v + {\cdot}152 \quad + {\cdot}954 \quad -0{\cdot}01$
79	7	$v + {\cdot}414 \quad + {\cdot}872 \quad +0{\cdot}03$
80	9	$v + {\cdot}635 \quad + {\cdot}727 \quad -0{\cdot}14$
81	5	$v + {\cdot}763 \quad + {\cdot}593 \quad -0{\cdot}24$
82	5	$v + {\cdot}904 \quad + {\cdot}339 \quad +0{\cdot}07$
83	8	$v + {\cdot}964 \quad + {\cdot}067 \quad +0{\cdot}18$
84	3	$v + {\cdot}927 \quad - {\cdot}269 \quad +0{\cdot}48$
85	3	$v + {\cdot}699 \quad - {\cdot}667 \quad +0{\cdot}36$
86	1	$v + {\cdot}521 \quad - {\cdot}814 \quad +0{\cdot}34$
87	2	$v + {\cdot}307 \quad - {\cdot}916 \quad +1{\cdot}09$
88	2	$v - {\cdot}022 \quad - {\cdot}966 \quad +0{\cdot}07$
89	3	$v - {\cdot}664 \quad - {\cdot}701 \quad +0{\cdot}75$
90	5	$v - {\cdot}886 \quad - {\cdot}384 \quad +0{\cdot}17$
91	5	$v - {\cdot}956 \quad - {\cdot}135 \quad +0{\cdot}95$
92	4	$v - 0{\cdot}922 \times x + 0{\cdot}286 \times y = +1{\cdot}10$

Equations of Condition (continued).

No. of Series.	Number of Obs.	Equations.		
93	1	$v - 0.802 \times x$	$+ 0.538 \times y$	$= +0''.38$
94	5	$v - .604$	$+ .754$	$+1.00$
95	3	$v - .338$	$+ .904$	$+1.09$
96	6	$v + .080$	$+ .963$	$+1.34$
97	12	$v + .336$	$+ .906$	$+0.44$
98	4	$v + .638$	$+ .725$	$+0.41$
99	7	$v + .836$	$+ .484$	-0.29
100	4	$v + .916$	$+ .308$	$+0.44$
101	3	$v + .966$	$+ .008$	$+0.53$
102	3	$v + .933$	$- .248$	-0.03
103	3	$v + .785$	$- .564$	-0.16
104	4	$v + .542$	$- .799$	$+0.42$
105	5	$v + .326$	$- .909$	$+0.36$
106	1	$v - 0.094 \times x$	$- 0.962 \times y$	$= +0.60$

With regard to the equations above, I may remark that I have rejected No. 17, which depends on a single observation, evidently affected by an error amounting to 2″ or 3″.

Proceeding to solve the remaining 105 equations by the method of least squares, and using precisely the same method and the same notation as in my previous Memoir, I find

$$\Sigma(n) = +486 \qquad \Sigma(nd) = -144.24$$
$$\Sigma(na) = +113.510 \qquad \Sigma(nab) = +41.550$$
$$\Sigma(nb) = +201.696 \qquad \Sigma(nad) = -23.035$$
$$\Sigma(na^2) = +209.944 \qquad \Sigma(nbd) = -21.554$$
$$\Sigma(nb^2) = +243.474$$

and the final equations are

$$486\,v + 113.510\,x + 201.696\,y - 144.24 = 0$$
$$113.510\,v + 209.944\,x + 41.550\,y - 23.035 = 0$$
$$201.696\,v + 41.550\,x + 243.474\,y - 21.554 = 0$$

from which we derive

$$v = +\ 0''.412$$
$$x = -\ 0.065$$
$$y = -\ 0.242$$

Substituting these values in the equations, and calling Δ the residual error of each, we have for the values of Δ,—

No. of Series.	Δ.	No. of Series.	Δ.	No. of Series.	Δ.	No. of Series.	Δ.
1	−1''.03	29	−0''.52	56	−0''.02	83	−0''.15
2	−0.33	30	+0.92	57	−0.60	84	+0.06
3	−0.32	31	+0.63	58	−0.09	85	−0.16
4	−0.25	32	−0.23	59	−0.03	86	−0.24
5	−0.43	33	+0.78	60	+0.10	87	+0.48
6	−0.49	34	+0.42	61	−0.27	88	−0.57
7	−0.07	35	−0.20	62	+0.30	89	+0.12
8	+0.45	36	+0.44	63	+0.05	90	−0.39
9	+0.17	37	−0.30	64	+0.52	91	+0.45
10	+0.17	38	−0.98	65	+0.12	92	+0.70
11	+0.47	39	−0.41	66	−0.14	93	+0.05
12	+0.94	40	−0.26	67	−0.06	94	+0.73
13	+0.83	41	−0.06	68	+0.67	95	+0.88
14	−0.28	42	0.00	69	+0.19	96	+1.17
15	+0.30	43	+0.18	70	+0.36	97	+0.27
16	−0.37	44	−0.05	71	−0.16	98	+0.21
18	+1.04	45	+0.55	72	+0.08	99	−0.53
19	+0.34	46	−0.51	73	+0.46	100	+0.16
20	+0.54	47	−0.20	74	−0.61	101	+0.18
21	−0.64	48	−0.01	75	+0.02	102	−0.44
22	+0.99	49	−0.13	76	−0.41	103	−0.66
23	+0.28	50	−0.49	77	−0.70	104	−0.15
24	+0.26	51	−0.09	78	−0.18	105	−0.25
25	+0.72	52	−0.28	79	−0.14	106	−0.05
26	+1.16	53	−0.38	80	−0.33		
27	−0.07	54	−0.23	81	−0.46		
28	+0.11	55	−0.14	82	−0.20		

Hence, n being the number of observations in a group, we shall find $\Sigma\,(n\,\Delta^2) = 94{\cdot}468$.

And hence we shall find, by the usual mode of calculation,

$$\text{Probable error of } v = 0''{\cdot}014$$
$$\text{,, } \quad x = 0{\cdot}023$$
$$\text{,, } \quad y = 0{\cdot}024$$

In looking at the results above, the first point to be observed is the negative value of the parallax, $-0''{\cdot}24$, which is ten times as great as the probable error, and is therefore an indication of something having affected the observations injuriously, though not to so large an amount as in the case of the 25-foot zenith tube. The correction to the assumed value of the constant of aberration, $20''{\cdot}4$, is however small, and the value deduced from the observations is therefore in moderate agreement with the most recent determinations, and in this respect the result of the investigation is satisfactory. To submit this, however, to a further test, I have solved the equations again under the supposition that the parallax of the star is insensible; and I find the following values of v and x :—

$$v = +\,0''{\cdot}310$$
$$x = -\,0{\cdot}058$$

Here the value of x is so closely in agreement with its former value $-0''{\cdot}065$, that we may fairly assume that the value $-0''{\cdot}06$ is very near the truth, and that, consequently, the value of the constant of aberration is very nearly $20''{\cdot}34$, and that considerable credit is due to this determination.

Substituting, however, these latter values of v and x in the equations, we find that the value of $\Sigma\,(n\,\Delta^2)$ is larger than before, namely, its value is $105{\cdot}57$, and, therefore, that the former values of v, x, and y, on the whole, satisfy the equations better than the latter values of v and y. Assuming those values, we have finally,—

$$\text{Mean N.Z.D. of } \gamma \textit{ Draconis}, \text{ 1859, Jan. 1} = 106''{\cdot}77 \pm 0''{\cdot}014$$
$$\text{Constant of Aberration} \quad .. \quad = 20{\cdot}335 \pm 0{\cdot}023$$

Royal Observatory, Greenwich,
1860, *May* 7.

ROBERT MAIN.