VII. *On the parallax of α Lyræ.* *By* John Pond, *Esq. Astronomer Royal, F. R. S.*

Read November 14, 1822.

My former experiments with a fixed telescope upon α Cygni have always appeared to me so decisive, as to render hopeless any farther attempt to discover its parallax; but respecting that of α Lyræ, my observations with the mural circle were not equally satisfactory; for among the observations of this star we may find occasional discordances that admit of being interpreted in favour of parallax. And although I have been inclined myself to attribute these irregularities to other causes, yet their existence made it desirable to institute new experiments. The method with a fixed telescope, which I had contrived for α Cygni, could not here, I found, be applied successfully; there being no star of nearly the same altitude but opposite in right ascension sufficiently bright to be observed throughout the year, a circumstance quite essential to that mode of observation. I have employed therefore the mural circle to investigate, 1st, the difference of parallax between γ Draconis and α Lyræ: 2dly, the absolute parallax of the latter star; the Dublin observations indicating, it may be remembered, that the parallax of γ Draconis is insensible, but that of α Lyræ a very perceptible quantity. The processes employed in these two investigations being very different, I shall consider each of them separately.

On the difference of parallax between γ Draconis and α Lyræ.

It is impossible to conceive a more simple process than that of determining with the mural circle the difference of polar distance between these stars. From their proximity in right ascension, the operation is the same as that of measuring the angular distance of two terrestrial objects, about 12° asunder, with a theodolite surrounded by six microscopes: for the mural circle, in principle, exactly resembles a vertical theodolite; with this difference, that its microscopes, instead of being placed on a frame-work of brass, are securely fixed on a stone pier. Now I find that the angular distance thus measured in winter does not differ one-tenth of a second from the same angular distance measured in summer; and therefore, that the difference of parallax between the two stars is absolutely a quantity too small to be measured. In this investigation, it is to be considered that any constant error in the determination of the absolute polar distances has nothing to do with the question, it being the difference only of those distances at opposite seasons that is required. To render all errors throughout the whole course of observation as constant as possible, the telescope remained fixed to the same part of the limb of the instrument, and the utmost pains were taken to reduce the temperature in the Observatory to that of the outer air; the difference throughout the year not exceeding one degree. The winter of 1821-1822 was extremely favourable for astronomical observation; there were an unusual number of fine nights, and the weather was so mild and uniform, that we were enabled to equalize the temperature, so as to make it of no importance whether the observations were computed by the outer or inner thermometer; and it is to this circumstance, in a great measure, that I attribute the perfect coincidence between the observations at different seasons.

It has been objected, however, that perhaps some unexpected effect of temperature deranges the instrument by the exact quantity of the difference of parallax attributed to these stars by Dr. Brinkley; if we suppose a derangement from temperature so considerable as to give a sensible error, even after being diminished by the effect of six microscopes, we should expect the error to be much greater when the experiment is tried with two microscopes only; for to suppose the contrary, would be to deny the tendency of six microscopes to correct the errors of two. Now I find the same difference of polar distance whether I employ two microscopes or six; temperature, therefore, cannot materially have vitiated the results by causing derangement in the form of the instrument.

In the whole of the above process I do not see one objectionable point, and if called upon to invent an instrument for this particular experiment, I could not devise one more perfect in principle than the mural circle.

Whoever will compare the above simple process with the more complicated one necessarily employed in using an instrument with two microscopes, turning freely in azimuth, will not hesitate, I think, in deciding upon which of the two instruments temperature is likely to produce the greatest error.

On the absolute parallax of α Lyræ.

The preceding observations only indicate that γ Draconis and α Lyræ have the same parallax, or that their difference of parallax is zero; but they have no tendency to show what is the actual magnitude of the parallax that the two stars have in common. If indeed we admit it to be proved, by the observations of Bradley, and the more recent ones of Dr. Brinkley, that the parallax of γ Draconis is insensible, we may then infer from the observed difference what is the parallax of the other star. But the method of investigation that we are now about to consider, does not depend on such an admission.

Having successfully adopted the method of observing by reflection, I was desirous of employing it in a series of observations upon α Lyræ, with a view to determine this question. This series began on the 1st of July, 1822, and has been continued to the present time.* Although this period embraces only half the interval in which the greatest change or double parallax is affected, a circumstance which at first may appear very disadvantageous, yet that is more than compensated, in my opinion, by the number of observations, and by a uniformity of temperature, such as never can be expected in the extreme seasons of winter and summer.

In observations of this nature the effects of temperature upon the instrument itself, and the uncertain refractions of the ray of light when brought into the lower part of the room, may produce errors of no inconsiderable magnitude, with reference to a question of so much nicety as the present. I can show however in the present as in the former process, that no error from temperature, affecting the instrument, has

* Since the date of this paper, the observations have been continued throughout the winter, and the results will be found in the subjoined Table.

introduced itself into this series of observations; for I obtain the same result from the readings with two microscopes as from those made with six.

In the case of two microscopes, the angular distance is measured upon two arcs only. Now it cannot be for a moment contended that an error from temperature, so great as not to be corrected by six microscopes, will not be much exaggerated by employing only two. The errors then, if any, must arise from the effects of temperature on refraction, and not from the changes it occasions in the instrument. But from the season which I have chosen for this investigation, and from the care that has been taken to equalize the temperature, the errors arising from the latter cause must be almost insensible. My observations, thus conducted, indicate in the most decided manner, that the parallax of α Lyræ cannot exceed a very small fraction of a second. The advantages and disadvantages of the Dublin and Greenwich methods are in this process much more nearly balanced than in the former. The Dublin instrument has the great advantage of determining the zenith distance in the course of a few minutes, whereas at Greenwich twenty-four hours at least, and frequently several days elapse, before a complete observation of the double altitude can be obtained by the method of reflection. This disadvantage attending the Greenwich method could only be remedied by employing two mural circles for observing a star on the same night, both by direct vision and by reflection.

I have now to consider that argument on which the greatest reliance in favour of parallax has been placed, namely, that founded on the actual determination of the solar equation from the observations made with the Dublin instrument.

This argument may, I think, be thus stated. By a series of observations made with a given instrument two equations have been disengaged, previously considered as unknown in amount, but known only as to the law of their variation. Of these one is much smaller than the other. Hence it is inferred, that as the instrument has faithfully disengaged the smaller equation (respecting which there is no dispute), it must be admitted with equal fidelity to have disengaged the larger, which might be supposed the easier operation of the two. This reasoning is strictly logical, as proving the disengagement of two equations, but it by no means proves the larger equation to be caused by parallax. The larger equation here to be disengaged is after all so small, that it is impossible, in different points of its period, to show that the law assumed coincides with observation; it is only a rude agreement at the points of the greatest and least variation that can be demonstrated. The disengagement of the larger equation only proves therefore the existence of some regularly recurring cause, acting with greatest effect at the extreme seasons.

The reason, I conceive, why Dr. Brinkley does not find parallax in γ Draconis is, that with respect to the zenith point, his instrument, like every one of a similar construction, is a perfect instrument. No portion of the arc is employed, nor can temperature here occasion any errors by its changes. As the star to be examined recedes from the zenith, the instrument becomes less and less perfect; and he finds a small parallax in α Cygni, a larger in α Lyræ, and oftentimes a still larger in stars more remote from the zenith. An additional reason for suspecting that the discordances observed arise from temperature is this: the greatest supposed parallax is found in those stars whose maximum and minimum of parallax would fall in the extreme seasons, and it is not at all improbable that irregular refraction, arising from the unequal state of the temperature within and without the Observatory, may have had a considerable share in occasioning the Dublin discordances, combined, perhaps, with the effect of the changes of temperature upon the instrument itself. It is a circumstance not hitherto sufficiently noticed by astronomers, that there are many cases where the smallest disturbing cause will produce an error quadruple of its own amount; and consequently, that the greatest error to which we are liable from such a cause at any one observation will be only one-fourth of the difference that we can detect between the most discordant of them. Of such a nature are those disturbances which, like refraction for instance, introduce errors, both positive and negative, into the determination of either extremity of the arc that measures the distance between two stars.

By a singular combination of circumstances, not probable certainly when considered *a priori*, but by no means impossible, the variation caused by change of temperature may follow an annual law so little differing from that of parallax, as to bring out the assumed parallax, and to leave the solar nutation disengaged.

Notwithstanding the importance of these investigations to the history of astronomy, and to our forming a correct notion of the system of the universe, yet our decision ultimately turns upon so very small a quantity, that our having reduced the enquiry to these narrow limits, rather tends to show the perfection of each instrument than the defect of either.

On former occasions I considered the question of parallax in the particular case of α Lyræ as undecided, and as perfectly open to future investigation; but the observations of the present year have produced, on my mind, a conviction approaching to moral certainty. The history of annual parallax appears to me to be this: in proportion as instruments have been imperfect in their construction, they have misled observers into the belief of the existence of sensible parallax. This has happened in Italy to astronomers of the very first reputation. The Dublin instrument is superior to any of a similar construction on the Continent; and accordingly, it shows a much less parallax than the Italian astronomers imagined they had detected. Conceiving that I have established, beyond a doubt, that the Greenwich instrument approaches still nearer to perfection, I can come to no other conclusion than that this is the reason why it discovers no parallax at all.

TABLE I.

	Names of Stars.	Predicted N. P. D. 1823.			Observed N. P. D. 1823.			Diff. South.	
		°	′	″	°	′	″	″	
1	Polaris								
2	β Urs. Min.	15	7	16,38	15	7	15,7	— 0,7	
3	β Cephei	20	12	53,78	20	12	54,1	+ 0,3	
4	α Urs. Maj.	27	17	44,16	27	17	43,6	— 0,6	
5	α Cephei	28	9	42,20	28	9	42,8	+ 0,6	
6	α Cassiop.	34	26	4,23	34	26	5,8	+ 1,6	} 1
7	γ Urs. Maj.	35	19	15,18	35	19	14,8	— 0,4	
8	γ Draconis	38	29	10,31	38	29	10,5	+ 0,2	
9	η Urs. Maj.	39	47	59,55	39	47	59,6	— 0,1	
10	α Persei	40	46	38,34	40	46	39,0	+ 0,7	
11	Capella	44	11	35,11	44	11	36,9	+ 1,8	
12	α Cygni	45	20	50,80	45	20	52,4	+ 1,6	
13	α Lyræ	51	22	30,37	51	22	31,2	+ 0,9	
14	Castor	57	43	58,08	57	43	59,1	+ 1,0	
15	Pollux	61	33	16,76	61	33	17,0	+ 0,3	
16	β Tauri	61	33	5,74	61	33	6,7	+ 1,0	
17	α Androm.	61	53	10,75	61	53	12,4	+ 1,7	
18	α Cor. Bor.	62	41	0,07	62	41	0,6	+ 0,5	
19	α Arietis	67	22	42,60	67	22	44,4	+ 1,8	
20	Arcturus	69	53	28,83	69	53	29,2	+ 0,4	} 2
21	Aldebaran	73	51	16,17	73	51	17,7	+ 1,5	
22	β Leonis	74	26	17,73	74	26	18,1	+ 0,4	
23	α Herculis	75	23	59,70	75	24	0,0	+ 0,3	
24	α Pegasi	75	44	38,52	75	44	41,7	+ 3,2	} 3
25	Regulus	77	10	15,00	77	10	15,4	+ 0,4	
26	α Ophiuchi	77	18	9,74	77	18	10,6	+ 0,9	
27	α Aquilæ	81	35	28,31	81	35	29,4	+ 1,1	
28	α Orionis	82	38	2,11	82	38	4,2	+ 2,1	
29	α Serpentis	84	0	36,52	84	0	36,6	+ 0,1	} 4
30	Procyon	84	19	40,75	84	19	43,2	+ 2,5	
31	α Ceti	86	36	34,86	86	36	36,9	+ 2,1	
32	α Aquarii	91	10	28,85	91	10	31,3	+ 2,5	
33	α Hydræ	97	53	43,20	97	53	44,5	+ 1,3	
34	Rigel	98	24	46,44	98	24	48,5	+ 2,0	
35	Spica Virg.	100	14	0,73	100	14	0,7	0,0	} 5
36	Sirius	106	28	45,35	106	28	48,9	+ 3,5	
37	Antares	116	1	42,50	116	1	44,1	+ 1,6	

TABLE II.

	Names of Stars.	Predicted N. P. D. 1823.	Observed N. P. D. 1823.	Diff. South.
		° ′ ″	° ′ ″	″
1	α Cassiopeiæ	34 26 4,23	34 26 5,8	+ 1,6
2	Polaris			
3	α Arietis	67 22 42,60	67 22 44,4	+ 1,8
4	α Ceti	86 36 34,86	86 36 36,9	+ 2,0
5	α Persei	40 46 38,34	40 46 39,0	+ 0,7
6	Aldebaran	73 51 16,17	73 51 17,7	+ 1,5
7	Capella	44 11 35,11	44 11 36,9	+ 1,8
8	Rigel	98 24 46,44	98 24 48,5	+ 2,0
9	β Tauri	61 33 5,74	61 33 6,5	+ 0,8
10	α Orionis	82 38 2,11	82 38 4,2	+ 2,1
11	Sirius	106 28 45,35	106 28 48,9	+ 3,5
12	Castor	57 43 58,08	57 43 59,1	+ 1,0
13	Procyon	84 19 40,75	84 19 43,2	+ 2,5
14	Pollux	61 33 16,76	61 33 17,0	+ 0,2
15	α Hydræ	97 53 43,20	97 53 44,5	+ 1,3
16	Regulus	77 10 15,00	77 10 15,6	+ 0,4
17	α Urs. Maj.	27 17 44,16	27 17 43,4	— 0,6
18	β Leonis	74 26 17,73	74 26 18,1	+ 0,4
19	γ Urs. Maj.	35 19 15,18	35 19 14,4	— 0,4
20	Spica Virg.	100 14 0,73	100 14 0,7	0,0
21	η Urs. Maj.	39 47 59,60	39 47 59,5	— 0,1
22	Arcturus	69 53 28,83	69 53 29,2	+ 0,4
23	β Urs Min.	15 7 16,38	15 7 15,6	— 0,8
24	α Cor. Bor.	62 41 0,07	62 41 0,6	+ 0,5
25	α Serpentis	84 0 36,52	84 0 36,6	+ 0,1
26	Antares	116 1 42,50	116 1 44,1	+ 1,6
27	α Herculis	75 23 59,70	75 24 0,0	+ 0,3
28	α Ophiuchi	77 18 9,74	77 18 10,6	+ 0,9
29	γ Draconis	38 29 10,31	38 29 10,5	+ 0,2
30	α Lyræ	51 22 30,37	51 22 30,2	+ 0,9
31	α Aquilæ	81 35 28,31	81 35 29,4	+ 1,1
32	α Cygni	45 20 50,80	45 20 52,4	+ 1,6
33	α Cephei	28 9 42,20	28 9 42,9	+ 0,7
34	β Cephei	20 12 53,78	20 12 54,1	+ 0,3
35	α Aquarii	91 10 28,85	91 10 31,3	+ 2,5
36	α Pegasi	75 44 38,52	75 44 41,7	+ 3,2
37	α Androm.	61 53 10,75	61 53 12,4	+ 1,7

TABLE III.

	Names of Stars.	Interpolated N. P. D. 1813. from 1756 & 1823.	Difference. Dublin.	Difference. Greenwich.
		° ′ ″	″	″
1	Polaris			
2	β Ursæ Min.	15 4 48,2	— 1,1	— 0,8
3	β Cephei	20 15 31,0	+ 0,1	+ 0,4
4	α Ursæ Maj.	27 14 31,0	— 0,7	— 0,6
5	α Cephei	28 12 13,6	+ 0,3	+ 1,0
6	α Cassiop.	34 29 24,1	+ 2,2	+ 1,3
7	γ Ursæ Maj.	35 15 54,8	— 0,7	— 0,5
8	γ Draconis	38 29 3,7	+ 0,7	+ 0,1
9	η Ursæ Maj.	39 44 58,1	+ 0,5	+ 0,2
10	α Persei	40 48 53,2	+ 2,6	+ 0,7
11	Capella	44 12 22,0	+ 2,1	+ 1,5
12	α Cygni	45 22 58,4	+ 0,9	+ 1,3
13	α Lyræ	51 23 1,2	+ 1,3	+ 0,6
14	Castor	57 42 47,9	+ 1,3	+ 1,1
15	Pollux	61 31 57,1	+ 2,0	+ 0,6
16	β Tauri	61 33 44,8	+ 1,6	+ 1,0
17	α Androm.	61 56 31,6	+ 2,3	+ 1,3
18	α Cor. Bor.	62 38 55,9	+ 1,5	+ 0,4
19	α Arietis	67 25 38,4	+ 2,7	+ 1,8
20	Arcturus	69 50 19,3	+ 1,1	+ 0,2
21	Aldebaran	73 52 36,7	+ 1,9	+ 1,4
22	β Leonis	74 22 57,5	+ 2,3	+ 0,2
23	α Herculis	75 23 14,3	+ 1,1	+ 0,3
24	α Pegasi	75 47 54,2	+ 2,5	+ 2,5
25	Regulus	77 7 23,0	+ 1,2	+ 0,3
26	α Ophiuchi	77 17 39,6	+ 0,4	+ 0,6
27	α Aquilæ	81 36 59,7	+ 1,2	+ 0,8
28	α Orionis	82 38 17,4	+ 2,8	+ 1,7
29	α Serpentis	82 58 39,4	+ 2,0	+ 0,1
30	Procyon	84 18 16,7	+ 2,8	+ 2,3
31	α Ceti	86 39 2,5	+ 1,9	+ 1,7
32	α Aquarii	91 13 24,0	+ 3,8	+ 2,4
33	α Hydræ	97 51 12,4	+ 3,0	+ 1,1
34	Rigel	98 25 35,5	+ 2,8	+ 1,7
35	Spica Virg.	100 10 51,3	+ 1,7	+ 0,5
36	Sirius.	106 28 4,2	+ 1,9	+ 2,7

TABLE IV.

	Names of Stars.	N. P. D. 1822. I.	No. of Obs.	N. P. D. 1822. II.	No. of Obs. D.	No. of Obs. R.	N. P. D. 1822. III.	No. of Obs. D.	No. of Obs. R.	N. P. D. 1822. IV.	No. of Obs.
		° ′ ″		° ′ ″			° ′ ″			° ′ ″	
1	Polaris	1 38 27,0	300							1 38 26,8	300
2	β Ursæ Min.	15 7 0,8	91	15 7 1,0	22	18	15 7 0,5	22	18	15 7 0,4	92
3	β Cephei	20 13 9,7	44	9,7	21	18	9,8	21	18	9,2	46
4	α Ursa Maj.	27 17 24,6	53	24,4	14	13	23,9	12	10	24,1	53
5	α Cephei	28 9 57,5	37	57,9	25	20	58,1	25	20	57,7	41
6	α Cassiopeiæ	34 26 25,6	51	26,0	12	8	25,9	12	8	25,3	56
7	γ Ursa Maj.	35 18 54,8	45							55,0	45
8	γ Draconis	38 29 9,8	120							9,7	120
9	η Ursæ Maj.	39 47 41,5	95							40,7	95
10	α Persei	40 46 52,5	48							53,1	51
31	Capella	44 11 41,4	75	41,4	25	20	41,5	25	20	41,6	75
12	α Cygni	45 21 5,0	80	5,1	40	40	5,4	40	40	5,1	84
13	α Lyræ	51 22 34,5	87	34,0	60	60	34,2	60	60	34,8	89
14	Castor	57 43 52,2	60	52,0	20	18	52,3	20	18	52,2	52
15	Pollux	61 33 9,1	60	8,8	15	15	8,8	15	15	8 9	50
16	β Tauri	61 33 10,5	50	10,3	16	16	10,5	16	16	10,2	46
17	α Androm.	61 53 32,6	30	32,6	12	10	32,4	12	10	32,4	37
18	α Cor. Bor.	62 40 48,3	26	48,1	16	16	48,1	22	18	48,3	32
19	α Arietis	67 23 1,6	44	1,8	24	17	2,0	24	17	1,6	49
20	Arcturus	69 53 10,2	84	10,2	21	22	10,5	21	22	10,0	84
21	Aldebaran	73 51 25,6	58	25,5	20	16	25,6	20	16	25,4	66
22	β Leonis	74 25 58,5	16	58,1	16	16	58,3	16	16	58,7	16
23	α Herculis	75 23 55,5	17	55,6	10	13	56,3	21	24	55,7	31
24	α Pegasi	75 45 1,0	30	1,1	24	20	1,4	24	20	1,4	34
25	Regulus	77 9 57,8	54	58,5	33	25	59,1	33	22	58,7	54
26	α Ophiuchi	77 18 7,6	20	7,8	10	12	7,6	21	25	7,3	34
27	α Aquilæ	81 35 38,7	70	38,6	44	42	38,9	44	42	39,0	86
28	α Orionis	82 38 5,7	48	5,6	12	12	6,1	14	14	5,7	54
29	α Serpentis	83 0 25,3	31	24,7	17	14	25,4	17	14	25,5	37
30	Procyon	84 19 34,8	57	34,6	10	7	34,9	10	7	34,5	63
31	α Ceti	86 36 51,4	46							51,2	46
32	α Aquarii	91 10 48,6	40	48,7	26	15	48,9	27	15	49,0	40
33	α Hydræ	97 53 29,2	18	29,4	16	12	29,4	16	12	30,0	18
34	Rigel	98 24 53,3	11							53,8	19
35	Spica Virg.	100 13 41,6	22	41,8	22	24	41,2	22	24	41,6	21
36	Sirius.	106 28 44,4	75	44,3	7	7	43,9	7	7	44,5	75
37	Antares.	116 1 35,5	5	35,4	5	5	35,6	5	5	36,0	5

No. I, is computed in the usual manner by direct measurement from the Pole.

No. II, by the angular distance of the stars from their reflected images in an artificial horizon, co-latitude assumed 38° 31′ 21″.

No. III, computed in the same manner as No. II, but from observations with two microscopes only.

No. IV, computed from observations with two microscopes in the same manner as No. I.

TABLE V.

		Error of Catalogue. I.	Error of Catalogue. II.	Error of Catalogue. III.	Error of Catalogue. IV.	
		″	″	″	″	
1	Polaris					
2	β Ursæ Min.	0,0	+ 0, 2	− 0, 3	− 0, 4	
3	β Cephei	0,0	0, 0	+ 0, 1	− 0, 5	
4	α Ursæ Maj.	+ 0,2	− 0, 1	− 0, 5	− 0, 3	
5	α Cephei	− 0,3	+ 0, 1	+ 0, 3	− 0, 1	
6	α Cassiop.					This star was found to be too near the zenith to be observed accurately by reflection.
7	γ Ursæ Maj.					
8	γ Draconis					
9	η Ursæ Maj.					
10	α Persei					
11	Capella	+ 0, 1	0, 0	+ 0, 1	+ 0, 3	
12	α Cygni	− 0, 1	0, 0	+ 0, 3	0, 0	
13	α Lyræ	+ 0, 3	− 0, 2	0, 0	+ 0, 6	Discordant from error of division.
14	Castor	0, 0	+ 0, 1	+ 0, 1	0, 0	
15	Pollux	+ 0, 1	− 0, 2	− 0, 2	− 0, 1	
16	β Tauri	+ 0, 1	− 0, 1	+ 0, 2	− 0, 2	
17	α Androm.	+ 0, 1	+ 0, 1	− 0, 1	− 0, 1	
18	α Cor. Bor.	+ 0, 1	− 0, 1	− 0, 1	+ 0, 1	
19	α Arietis	− 0, 1	+ 0, 1	+ 0, 3	− 0, 1	
20	Arcturus	0, 0	0, 0	+ 0, 3	− 0, 2	
21	Aldebaran	0, 0	− 0, 1	+ 0, 0	− 0, 2	
22	β Leonis	+ 0, 2	− 0, 2	+ 0, 0	+ 0, 4	
23	α Herculis	− 0, 1	0, 0	+ 0, 7	+ 0, 1	No. III. discordant from the observs. having been made at different seasons.
24	α Pegasi	0, 0	− 0, 1	+ 0, 2	+ 0, 2	
25	Regulus	− 0, 4	+ 0, 3	+ 0, 4	+ 0, 5	This star is reserved for future examination.
26	α Ophiuchi	+ 0, 2	0, 0	+ 0, 5	+ 0, 1	
27	α Aquilæ	0, 0	− 0, 1	+ 0, 2	+ 0, 3	
28	α Orionis	+ 0, 1	+ 0, 0	+ 0, 4	0, 0	
29	α Serpentis	+ 0, 3	− 0, 3	+ 0, 4	+ 0, 5	Discordant from the different seasons of observation, and requiring examination.
30	Procyon	+ 0, 2	0, 0	+ 0, 3	− 0, 1	
31	α Ceti					
32	α Aquarii	− 0, 1	0, 0	+ 0, 3	+ 0, 4	
33	α Hydræ	− 0, 1	− 0, 0	0, 0	+ 0, 6	
34	Rigel					
35	Spica Virg.	− 0, 2	0, 0	− 0, 6	− 0, 2	
36	Sirius.	+ 0, 1	0, 0	− 0, 4	+ 0, 2	
37	Antares.	0, 0	0, 0	+ 0, 1	+ 0, 5	
	Sum of Errors	3, 8	2, 3	8, 0	7, 3	
	Mean Error	0,13	0,08	0,26	0,25	

From the exact coincidence of Catalogue I. and II. it may be inferred that the assumed co-lat. 38° 31′ 21″,0 is extremely near the truth.

TABLE VI.

		N. P. D. 1822. Greenwich.	N. P. D. 1822. Dublin.	Difference in 1822.		Difference in 1812.		Difference between Bessel and Greenwich.	
		° ′ ″	″	″		″		″	
1	Polaris	1 38 26,9	26,7	— 0,2					
2	β Ursæ Min.	15 7 0,8	1,8	+ 1,0					
3	β Cephei	20 13 9,8	9,8	0,0					
4	α Ursa Maj.	27 17 24,3	24,1	— 0,2		— 1,2			
5	α Cephei	28 9 58,0	57,2	— 0,8		+ 0,8			
6	α Cassiop.	34 26 25,8	23,3	— 2,5	—0,6	— 0,8	—0,3		
7	γ Ursæ Maj.	35 18 54,4	54,5	— 0,1		+ 0,3			
8	γ Draconis	38 29 9,8	8,9	+ 1,0		— 0,6			
9	η Ursæ Maj.	39 47 41,6	41,0	— 0,6		— 0,3			
10	α Persei	40 46 52,5		— 1,1					
11	Capella	44 11 41,4	39,8	— 1,6		- 0,6		+ 0,5	
12	α Cygni	45 21 5,0	3,7	— 1,3		+ 0,4		+ 1,8	
13	α Lyræ	51 22 34,2	32,9	— 1,3		— 0,5		+ 2,2	
14	Castor	57 43 52,0	50,7	— 1,3		— 0,1		+ 1,3	
15	Pollux	61 33 9,0	8,2	— 0,8		— 1,2		+ 1,5	
16	β Tauri	61 33 10,4	9,4	— 1,0		— 0,5		+ 1,7	+1,5
17	α Androm.	61 53 32,5	30,9	— 1,6	—1,3	0,3	—0,7	+ 1,0	
18	α Cor. Bor.	62 40 48,2	46,8	— 1,4		— 1,0		+ 2,3	
19	α Arietis	67 23 1,7	0,2	— 1,5		— 0,7		+ 1,1	
20	Arcturus	69 53 10,2	9,5	— 0,7		— 0,9		+ 2,3	
21	Aldebaran	73 51 25,6	24,2	— 1,4		— 0,7		+ 1,4	
22	β Leonis	74 25 58,1	56,6	— 1,5		— 2,0		+ 2,0	
23	α Herculis	75 23 55,5						+ 3,3	
24	α Pegasi	75 45 1,0						+ 1,3	
25	Regulus	77 9 58,2	58,1	— 0,1		— 0,9		+ 2,8	
26	α Ophiuchi	77 18 7,4	6,2	— 1,4		0,0		+ 3,2	
27	α Aquilæ	81 35 38,5	36,6	— 1,9		— 0,4		+ 2,7	
28	α Orionis	82 38 5,6	4,0	— 1,6		— 1,1		+ 1,0	
29	α Serpentis	83 0 24,9	23,5	— 1,4	—1,9	— 1,9	—0,8	+ 3,7	+2,4
30	Procyon	84 19 34,6	32,9	— 1,7		— 0,5		+ 2,3	
31	α Ceti	86 36 51,4	49,5	— 1,9		— 0,1		+ 1,7	
32	α Aquarii	91 10 48,6	45,7	— 2,9		— 1,7		+ 2,3	
33	α Hydræ	97 53 29,3						+ 2,8	
34	Rigel	98 24 53,2						+ 1,5	
35	Spica Virg.	100 13 41,8	40,9	— 0,9				+ 3,8	+2,4
36	Sirius.	106 28 44,3	42,3	— 2,0	—2,0			+ 1,7	

6. α Cassiop. I suspect some mistake in the computations of this star; I have therefore in taking the mean, substituted α Persei for it, which Dr. BRINKLEY was so obliging as to send me a few days since.

25. Regulus. There is probably also some mistake relative to this star.

36. Sirius. By a number of observations made last year at the same period, and computed by the same equations: the two results differ exactly 2″. This seems therefore to be the quantity by which the two instruments differ in measuring an angle of 100°.

TABLE VII.

		Bradley's refract. N. P. D. 1820. Dr. Brinkley.	N.P. D 1820. Mr. Bessel.	Difference between Dr. Brinkley and Mr. Bessel.
		° ′ ″		
1	Polaris	1 39 5, 6		
2	β Ursæ Min.	15 6 32, 2		
3	β Cephei	20 13 41, 0		
4	α Ursæ Maj.	27 16 45, 8		
5	α Cephei	28 10 27, 3		
6	α Cassiopeiæ	34 27 3, 0		
7	γ Ursæ Maj.	35 18 14, 5		
8	γ Draconis	38 29 7, 5		
9	η Ursæ maj.	39 47 4, 8		
10	α Persei		° ′ ″	″
11	Capella	44 11 48, 8	50,88	2,1
12	α Cygni	45 21 28, 9	31,53	2,6
13	α Lyræ	51 22 39, 0	42,23	3,2
14	Castor	57 43 36, 3	38,95	2,6
15	Pollux	61 32 52, 0	54,46	2,5
16	β Tauri	61 33 16, 9	19,60	2,7
17	α Androm.	61 54 10, 7	13,41	2,7
18	α Cor Bor.	62 40 21, 9	25,51	3,7
19	α Arietis	67 23 34, 7	37,68	3,0
20	Arcturus	69 52 31, 5	34,57	3,0
21	Aldebaran	73 51 40, 1	42,84	2,7
22	β Leonis	74 25 16, 5	19,96	3,5
23	α Herculis			
24	α Pegasi			
25	Regulus	77 9 23, 5	26,42	2,9
26	α Ophiuchi	77 18 0, 0	4,34	4,3
27	α Aquilæ	81 35 54, 7	59,31	4,6
28	α Orionis	82 36 6, 5	9,34	2,8
29	α Serpentis	83 0 0, 0	5,16	5,2
30	Procyon	84 19 15, 5	19,68	4,2
31	α Ceti	86 37 18, 3	22,33	5,0
32	α Aquarii	91 11 20, 5	25,48	5,0
33	α Hydræ		97 53 1,68	
34	Rigel			
35	Spica Virg.	100 13 4, 4	7,69	3,3
36	Sirius	106 28 33, 1	37,15	4,0
37	Antares.			
	γ Aquilæ.	79 49 1, 6	6,03	4,4
	β	84 2 3, 3	9,16	5,9
	1 } α Capri.	103 3 19,60	25,59	6,0
	2 } α Capri.	103 5 37,03	43,49	6,5
	γ Pegasi.	75 48 59, 3	49 3,78	4,5

TABLE VIII.

General Catalogue of Stars for the year 1813.

1756 & 1813. An. Var. 1818.	Number.	Names of Stars.	Æ. 1823,	Predicted N. P. D. 1823.	Observed N. P. D. 1823. Bradley's Refraction.	Stars observed South.	No. of Observations. 1756.	1812. 1813.	1822. 1823.	Interpolated Catalogue N. P. D. 1818. (1813 + 1823)/2.	No. of Observations.
			h. m. s.	° ′ ″	° ′ ″					° ′ ″	
— 20,09	1	γ Pegasi	0 4 8,09	75 48 0,11	75 48 2,4	2,3	14	25	13	76 49 41,7	38
— 19,85	2	α Cassiopeiæ	0 30 31,29	34 26 4,23	34 26 5,7	1,5	5	77	19	34 27 44,3	136
	3	Polaris*	0 57 46,4		1 38 7,5			200	300	1 39 44,5	500
— 17,40	4	α Arietis	1 57 13,09	67 22 42,60	67 22 44,4	1,8	10	77	91	67 24 10,6	168
— 14,59	5	α Ceti	2 53 2,29	46 36 34,86	86 36 36,8	2,0	7	18	31	86 37 48,7	49
— 13,41	6	α Persei	3 11 44,48	40 46 38,34	40 46 39,0	0,7	10	66	48	40 47 45,7	114
— 7,92	7	Aldebaran	4 25 46,58	73 51 16,17	73 51 17,7	1,5	60	69	74	73 51 56,4	143
— 4,54	8	Capella	5 3 37,83	44 11 35,11	44 11 36,9	1,8	59	108	95	44 11 58,8	203
— 4,74	9	Rigel	5 6 2,21	98 24 46,44	98 24 48,4	2,0	37	30	11	98 25 11,2	41
— 3,80	10	β Tauri	5 15 6,76	61 33 5,74	61 33 6,7	1,0	14	70	66	61 33 25,0	136
— 1,36	11	α Orionis	5 45 35,66	82 38 2,11	82 38 4,2	2,1	69	66	62	82 38 9,9	128
+ 4,41	12	Sirius	6 37 20,85	106 28 45,35	106 28 48,7	3,4	84	30	82	106 28 25,1	112
+ 7,12	13	Castor	7 23 17,62	57 43 58,08	57 43 59,1	1,0	19	47	78	57 43 23,0	125
+ 8,63	14	Procyon	7 30 2,19	84 19 40,75	84 19 43,2	2,4	64	40	64	84 18 58,9	104
+ 8,02	15	Pollux	7 34 28,52	61 33 16,76	61 33 17,1	0,3	38	53	75	61 32 36,8	128
+ 15,19	16	α Hydræ	9 18 53,50	97 53 43,20	97 53 44,5	1,3	5	10	30	97 52 27,9	40
+ 17,23	17	Regulus	9 58 56,36	77 10 15,00	77 10 15,4	0,4	25	68	79	77 8 49,2	147
+ 19,26	18	α Ursæ Maj.	10 52 43,41	27 17 44,16	27 17 43,6	— 0,6	7	76	80	27 16 7,6	150
+ 20,04	19	β Leonis	11 40 1,66	74 26 17,73	74 26 18,1	0,4	11	22	32	74 24 37,7	54
+ 19,98	20	γ Ursæ Maj.	11 44 28,63	35 19 15,18	35 19 14,8	— 0,4	5	60	45	35 17 34,9	105
+ 18,94	21	Spica Virg.	13 15 52,91	100 14 0,73	100 14 0,7	0,0	19	20	46	100 12 26,0	66
+ 18,15	22	η Ursæ Maj.	13 40 33,54	39 47 59,60	39 47 59,5	— 0,1	Z. Sect.	100	95	39 46 28,9	195
+ 18,97	23	Arcturus	14 7 35,61	69 53 28,83	69 53 29,2	0,4	106	120	106	69 51 54,1	226
+ 15,30	24	1 α Libræ	14 40 54,93	105 15 11,91	105 15 12,5	0,6	4	12	14	105 13 56,8	26
+ 15,32	25	2 α Libræ	14 41 6,36	105 17 55,67	105 17 56,3		11	15	20	103 16 39,5	35
+ 14,74	26	β Ursæ Min.	14 51 19,53	15 7 16,38	15 7 15,6	— 0,8	1	110	109	15 6 2,3	219
+ 12,45	27	α Cor. Bor.	15 27 11,95	62 41 0,07	62 41 0,6	0,5	7	90	42	62 39 58,1	132
+ 11,72	28	α Serpentis	15 35 33,53	83 0 36,52	83 0 36,6	0,1	5	77	45	82 59 38,0	122
+ 8,59	29	Antares	16 18 34,23	106 1 42,50	116 1 44,1	1,6	21	36	10	116 1 0,1	46
+ 4,57	30	α Herculis	17 6 35,00	75 23 59,70	75 24 0,1	0,4	7	55	30	75 23 37,0	85
+ 3,08	31	α Ophiuchi	17 26 43,49	77 18 9,74	77 18 10,6	0,9	3	83	32	77 17 54,7	115
+ 0,67	32	γ Draconis	17 52 30,14	38 29 10,31	38 29 10,5	0,2	Z. Sect.	140	120	38 29 7,1	260
— 3,02	33	α Lyræ	18 30 56,98	51 22 30,37	51 22 31,2	0,8	89	170	147	51 22 45,9	317
— 8,34	34	γ Aquilæ	19 37 50,82	79 48 35,58							
— 9,06	35	α Aquilæ	19 42 8,94	81 35 28,31	81 35 29,5	1,2	104	140	112	81 36 14,2	252
— 8,56	36	β Aquilæ	19 46 37,27	84 1 37,94							
— 10,66	37	1 α Capri.	20 7 49,91	103 2 48,83	103 2 49,6	1,0	6	35	22	103 3 42,5	57
— 10,68	38	2 α Capri.	20 8 13,69	103 5 5,45	103 5 6,6		10	28	22	103 5 59,4	50
— 12,63	39	α Cygni	20 35 24,19	45 20 50,80	45 20 52,4	1,6	55	120	120	45 21 54,5	240
— 15,07	40	α Cephei	21 14 21,05	28 9 42,20	28 9 42,8	0,6	5	70	50	28 10 57,7	127
— 15,68	41	β Cephei	21 26 20,44	20 12 53,78	20 12 54,0	0,2	5	70	62	20 14 12,5	132
— 17,27	42	α Aquarii	21 56 41,55	91 10 28,85	91 10 31,4	2,5	9	20	55	91 11 56,4	75
	43	Fomalhaut	22 47 50,97								
— 19,32	44	α Pegasi	22 55 57,20	75 44 38,52	75 44 41,8	3,3	6	30	50	75 46 16,7	80
— 19,95	45	α Andromedæ.	23 59 15,61	61 53 10,75	61 53 12,5	1,8	11	40	40	61 54 51,4	80

* The mean of about 1300 observations of the pole star during the last ten years, is 1° 39′ 44″,5 for the N.P.D. for Jan. 1, 1818, and the mean of all the annual variations 19″,42 or 19″,43.

TABLE IX.

Observations of α Lyræ.

Two Microscopes.

Summer.

1822.	Direct. 46° 22′ ″	1822.	Reflection. 200° 40′ ″
July 3	32,82	July 1	7,94
4	34,64	6	8,64
10	34,88	14	8,51
17	34,92	19	6,59
20	34,38	31	8,25
21	35,28	Aug. 2	7,73
24	34,94	5	8,63
25	34,09	11	8,05
28	35,15	12	8,55
30	34,39	14	9,11
Aug. 4	33,36	16	8,29
8	34,80	18	9,96
10	35,82	20	9,81
13	34,79	21	8,07
15	34,40	23	8,26
17	33,70	25	8,04
19	35,68	26	7,18
22	35,88		
27	35,07		

Mean of 19 = 34,63 Mean of 17 = 8,45

$\frac{R-D}{2} = 16'',91$ of altitude.

Autumn.

1822.	Direct. 46° 22′ ″	N. P. D. 1822.	Reflection. 200° 40′ ″
Aug. 29	34,41		
Sept. 3	34,53	Aug. 31	7,37
4	34,32	Sep. 1	7,19
6	35,13	7	7,59
8	34,35	10	7,12
11	32,75	13	7,55
14	33,87	19	9,02
16	34,39	20	7,44
18	34,76	21	10,24
28	35,15	29	8,73
30	35,37	Oct. 3	9,00
Oct. 5	36,59	4	9,52
6	34,79	8	8,30
7	34,86	11	7,03
12	34,49	18	8,84
21	34,23	22	7,70
23	36,57	25	8,43
26	34,50	27	9,00
28	35,31		

Mean of 19 = 34,76 Mean of 17 = 8,24

$\frac{R-D}{2} = 16'',74$ of altitude.

Winter.

1822.	Direct. 46° 22′ ″	1822.	Reflection. 200° 40′ ″
Nov. 3	36,05	Oct. 31	9,15
4	35,64	Nov. 7	8,58
11	34,63	21	9,74
13	35,68	27	8,70
15	34,52	Dec. 2	7,89
18	36,07	3	8,43
20	36,28	7	8,88
23	35,81	26	9,02
Dec. 5	33,79	28	10,26
8	34,77	29	9,07
10	35,09	1823.	
11	35,82	Jan. 8	7,63
21	35,50	11	8,83
22	33,90	13	6,94
26	33,84	Feb. 7	7,22
1823.		8	8,84
Jan. 18	35,83	12	8,57
Feb. 3	35,15	18	6,75
4	35,06	19	8,71
13	34,46	25	8,85
23	35,28	Mar. 1	7,95

Mean of 20 = 35,16 Mean of 20 = 8,49

$\frac{R-D}{2} = 16'',67$ of altitude.

TABLE X.

Observations of α Lyræ.

Six Microscopes.

Summer.

1822.	Direct. 46° 22′ ″	1822.	Reflection. 200° 40′ ″
July 3	33,42	July 1	8,54
4	34,84	6	8,94
10	34,28	14	8,31
17	34,32	19	7,29
20	34,58	31	7,35
21	34,68	Aug. 2	8,13
24	33,94	5	8,53
25	33,99	11	8,85
28	34,45	12	8,85
30	33,39	14	9,61
Aug. 4	33,26	16	8,39
8	34,45	18	8,86
10	35,82	20	9,81
13	34,79	21	7,76
15	34,40	23	8,06
17	33,48	25	7,64
19	35,88	26	8,08
22	34,98		
27	34,47		

Mean of 19 = 34,39 Mean of 17 = 8,41

$\frac{R-D}{2}$ = 17″,01 of altitude.

Autumn.

1822.	Direct. 46° 22′ ″	1822.	Reflection. 200° 40′ ″
Aug. 29	34,71		
Sept. 3	35,13	Aug. 31	8,27
4	35,12	Sept. 1	7,99
6	35,36	7	8,29
8	34,85	10	7,37
11	32,35	13	7,95
14	34,17	19	8,52
16	33,69	20	7,14
18	34,86	21	9,34
28	33,85	29	8,33
30	34,47	Oct. 3	8,79
Oct. 5	35,08	4	9,61
6	35,68	8	8,41
7	34,75	11	7,42
12	35,09	18	8,63
21	35,12	22	8,29
23	34,30	25	8,51
26	33,68	27	8,08
28	33,89		

Mean of 19 = 34,53 Mean of 17 = 8,29

$\frac{R-D}{2}$ — 16″,88 of altitude.

Winter.

1822.	Direct. 46° 22′ ″	1822.	Reflection. 200° 40′ ″
Nov. 3	34,63	Oct. 31	8,13
4	34,42	Nov. 7	8,26
11	34,21	21	9,54
13	34,46	27	9,60
15	33,30	Dec. 2	8,69
18	34,35	3	8,73
20	34,76	7	8,68
23	34,49	26	8,67
Dec. 5	33,69	28	10,31
8	34,57	29	9,22
10	34,69	1823.	
11	35,72	Jan. 8	8,55
21	35,35	11	8,85
22	33,65	13	7,96
26	35,31	Feb. 7	7,27
1823.		8	7,70
Jan. 18	34,30	12	8,12
Feb. 3	34,32	18	7,60
4	34,64	19	8,76
13	34,35	25	8,00
23	34,55	Mar. 1	8,09

Mean of 20 = 34,49 Mean of 20 = 8,54

$\frac{R-D}{2}$ = 17″,02 of altitude.

TABLE XI.

α Lyræ compared with γ Draconis.

		No. of Obs. γ Draconis.	No. of Obs. α Lyræ.	° ′ ″
1812	Summer	30	24	12 53 56,77
1813	Summer	36	40	12 53 56,77
		Mean of 2 years		12 53 56,77
1812	Winter	16	23	12 53 57,02
1813	Winter	15	30	12 53 56,80
		Mean of 2 years		12 53 56,91
		Double Parallax of α Lyræ		0,14
1822	Winter	24	30	+ 12 53 24,7
1822	Summer	50	25	12 53 24,7
1823	Winter	40	27	12 53 24,7
		Double Parallax of α Lyræ		0,0

Explanation of the preceding Tables.

Table I. The predicted catalogue in this table is obtained from the Greenwich Catalogues of 1756 and 1813: all the computations will be found at length in the volume of the Greenwich Observations for 1820. The five groupes of stars in the last column are those referred to in page 42.

Table II. is the same catalogue arranged in the order of right ascension.

Table III. is an interpolated catalogue: it was computed some time since from a catalogue less perfect than the present, but it is sufficiently exact to show that no explanation of the difficulty can be obtained by supposing any defect in the observations of 1813. The numbers in this table under the columns Dublin and

Greenwich, are the quantities that must be applied to the Dublin and Greenwich observations to produce the interpolated catalogue.

Table IV. contains four catalogues, in which, as no systematic difference can be traced, the instrument must be considered as perfect within the limits of the small discordances in Catalogue I. and II.

Table V. contains the errors of each of the preceding catalogues. From this table it appears, that the regular difference between the results with six and with two microscopes, is now nearly insensible. This must have arisen formerly from flexure; and the new braces, though intended only to strengthen the attachment of the telescope to the circle, have, in fact, added strength and firmness to the whole frame of the instrument. (Vide Experiments on this subject in the volume of Observations for 1820.)

Table VI. shows the difference between the results of the Dublin and Greenwich circle, both at the present time, and in the year 1812. From this it is evident that a small change has taken place in one of the instruments. Formerly the two instruments differed only one second in an arc of 90°; at present, the difference amounts very exactly to double that quantity.

Table VII. contains the two catalogues of Dr. Brinkley and Mr. Bessel. Here the differences are much greater and more irregular.

Table VIII. contains a general catalogue of the stars, including several that were not very accurately observed in 1813; but which, nevertheless, confirm in a remarkable manner the general law of southern deviation.

Tables IX, X and XI. contain observations of α Lyræ, by which it appears, that whatever may be the parallax of this star, it is not within the powers of our instrument to detect it. With Dr. Brinkley's Refraction, the result would have been a very small fraction of a second less in favour of parallax.