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Stars.	No. of Obs.	Polar Distance, 1829.	Bessel.	Diff.
α Serpentis	34	83° 1′ 48″,61	51″,14	2″,53
β Aquilæ	39	84 0 51,47	52,62	1,15
α Canis minoris	45	84 20 35,91	38,48	2,57
α Ceti	18	86 35 11,16	12,04	0,88
β Virginis	17	87 16 19,71	19,81	0,10
α Aquarii	14	91 8 48,31	50,64	2,33
α Hydræ	32	97 55 18,40	19,25	0,85
β Orionis	33	98 24 21,88	22,44	0,56
α Virginis	58	100 15 56,71	58,87	2,16
α^1 Capricorni	8	103 1 47,86	50,19	2,33
α^2 Capricorni	20	103 4 4,99	7,84	2,85
α^1 Libræ	8	105 16 50,93	51,78	0,85
α^2 ——	24	105 19 31,97	33,29	1,32
α Canis majoris	44	106 29 18,25	17,65	−0,60
α Scorpii	24	116 2 38,90	40,65	1,75
α Piscis austr.	12	120 31 37,59	39,10	1,51

As the differences between our observations, in the year 1828, and the results of Bessel's observations, did not prove very satisfactory, Mr. Mayer has calculated, at my request, all the observations which we have made during the three years, 1827, 1828, and 1829, in which the meridian circle has been in its place in the observatory. The result of this calculation is contained in the following table.

Stars.	No. of Obs.	Polar Distance, 1830-0.	Bessel.	Pond.
γ Pegasi	62	75° 45′ 43″,28	43″,51	41″,6
α Cassiopeæ	108	34 23 47,87	47,33	46,9
α Arietis	83	67 20 44,44	44,30	42,6
α Ceti	51	86 34 56,58	57,58	55,2
α Persei	91	40 45 8,14	5,91	5,1

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Stars.	No. of Obs.	Polar Distance, 1829.	Bessel.	Pond.
α Tauri	67	73° 50′ 23″,86	24″,52	22″,8
α Aurigæ	105	44 11 6,64	6,41	5,1
β Orionis	79	98 24 16,98	17,82	15,4
β Tauri	87	61 32 41,88	42,75	40,2
α Orionis	88	81 37 56,58	56,88	54,9
α Canis majoris	86	106 29 22,55	22,17	19,7
α^2 Geminorum	61	57 44 50,74	51,11	48,9
α Canis minoris	87	84 20 44,91	47,26	44,2
β Geminorum	86	61 34 15,53	15,58	13,1
α Hydræ	54	97 55 33,54	34,55	31,1
α Leonis	54	77 12 18,32	19,64	16,4
α Ursæ majoris	72	27 19 58,85	60,01	58,5
β Leonis	50	74 28 40,11	40,81	38,9
β Virginis	31	87 16 39,47	40,10	....
γ Ursæ majoris	80	35 21 36,74	37,33	35,1
α Virginis	126	100 16 16,03	17,88	13,1
η Ursæ majoris	116	39 50 6,94	8,19	7,1
α Bootis	124	69 55 42,84	45,55	42,4
α^1 Libræ	18	105 17 6,99	7,16	....
α^2 Libræ	68	105 19 47,48	48,63	44,1
β Ursæ minoris	117	15 8 59,45	59,40	58,6
α Coron. bor.	86	62 42 29,21	30,24	28,4
α Serpentis	93	83 2 0,29	2,90	— 1,0
α Scorpii	79	116 2 47,90	49,25	43,3
α Herculis	77	75 24 33,62	35,50	32,5
α Ophiuchi	80	77 18 34,37	35,39	32,4
γ Draconis	69	38 29 16,63	17,49	16,5
α Lyræ	51	51 22 11,94	12,46	10,5
γ Aquilæ	87	79 47 41,51	42,97	40,4
α ———	92	81 34 28,45	29,10	26,7

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Stars.	No. of Obs.	Polar Distance, 1829.	Bessel.	Pond.
β Aquilæ	63	84° 0′ 42″,05	44″,10	40″,2
α^1 Capricorni	22	103 1 38,18	39,57	....
α^2 ———	38	103 3 54,62	57,19	51,9
α Cygni	71	45 19 24,60	25,79	24,8
α Cephei	78	28 7 57,52	58,56	57,9
β Cephei	73	20 11 4,72	5,03	3,9
α Aquarii	25	91 8 31,33	33,42	30,4
α Piscis austr.	20	120 31 18,38	20,25	14,5
α Pegasi	36	75 42 28,32	28,31	26,7
α Andromedæ	74	61 50 54,60	54,35	54,4

The positions of POND have been taken from the *Nautical Almanac* for 1830, p. 171. It will be seen from the preceding table, that, in general, the observations of Vienna fall between those made at Greenwich and those at Konigsberg: still, the differences between the three observers are greater than might be wished. These differences are remarkably great for α *Aquarii*, α *Canis minoris*, α^2 *Capricorni*, α *Pegasi*, α *Persei*, and α *Virginis*.

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XVII. *Fourth Series of Observations with a 20-feet Reflector; containing the mean places and other particulars of 1236 double Stars, as determined at Slough, in the years 1828 and 1829, with that Instrument, (the greater part of them not previously described.)* By J. F. W. Herschel, Esq.

Read, April 7, 1830.

THE catalogue which I have now the honour of presenting to the Astronomical Society contains the results of my observations of double stars, made with the 20-feet reflector, at Slough, in the interval between the 17th of March, 1828, and the end of the year 1829; together with the places and descriptions of seven of those objects observed before the first of the above dates, but which had escaped insertion in my former communications. The total number of double and triple stars of which observations are here registered is 1236; and of these, a collation with Mr. Struve's catalogue has detected 271 objects comprised in that immortal work, among which are many of those double stars to which he has there attached the epithet *vicinæ*, as well as a sufficient number of his *pervicinæ*, to demonstrate, were it needed, the adequacy of the telescope to researches where distinctness as well as light is important; but of his *vicinissimæ*, one only occurs resolved, the magnifying powers usually employed in sweeping; viz. 160 and 240, being quite inadequate to the resolution of such objects, and the performance of the telescope under a power of 320, though occasionally good, not being usually such as to encourage me to push magnifying to a violent pitch; add to which, I have rarely been able to spare time for the close examination of stars, by reason of the main object to which my attention has been all along directed—the nebulæ.

The arrangement of the present catalogue is, in general, similar to that of my previous ones; but having, on the 5th of July, 1828, begun to use a position-micrometer, and thus to obtain, instead of estimations, measures, and, for the most part, very satisfactory ones, of the angles of position of the stars, individual observations thenceforward assumed a value they had not

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before; and, for that reason, I have so far departed from my former plan as to give *all* my observations at length, whether of known or unknown double stars; and so scrupulous have I been on this point, that even in those few cases when, on viewing one of Mr. Struve's double stars, I have not been able to resolve it, the observation has uniformly been entered and registered, and is here given with the rest, that nothing may be wanting to enable the reader to form a true judgment of the capabilities of the instrument, and the reliance which may be placed on its results. In this respect, the catalogue, as it now stands, speaks a language perfectly intelligible, the agreement or disagreement of the places, measures, and estimations of the same stars, on different nights, (often when entirely forgotten, as indeed must be the case in such a multitude of objects, seen only for an instant,) being brought at once into view by their juxtaposition in order of right ascension.

The value of measures which can be depended on of objects so numerous and interesting, and so altogether out of the reach of ordinary instruments, as the double stars of Mr. Struve's catalogue, has, of late, induced me to include them in my "working lists," and take them regularly when they do not interfere with my chief objects. In so doing, it is impossible not to be struck with the constant and occasionally extravagant over-valuation of the magnitudes in that catalogue. Perhaps, of late, the great degree of tarnish the mirror I have hitherto always used has contracted may be thought to make this more apparent, its light being now perhaps one-third less than it was at the commencement of my sweeps;* but this can hardly be looked upon as a true account of the matter, since the eye will of course

* (*Note added during the printing.*)—Previous to repolishing it, I was desirous to supply its place with a new one, in case of accident. This has now been done; and the result having more than answered my expectations, the old mirror was forthwith repolished, and not only restored to the highest perfection of surface, but at the same time most materially improved in figure. The two specula (which I shall hereafter designate by the letters B and C) are in some sort *twins*, having, in fact, been cast at the same time, from the same pattern, and out of the same melting-pot; but C, from a defect in the moulding, which it has cost an *enormous* expense of time and labour to get rid of, was put aside as intractable. They are now, however, undistinguishable from each other except by a slight sand-hole in C. Their focal lengths are the same, (within a tenth of an inch), their polish and figure equally perfect, and both received their last finish from the same tool on the same day, July 10, 1830, a few hours previous to the writing of this note.

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gradually alter its judgment, and follow the degradation of the speculum; and having recently gone again over some of my earlier sweeps, I find that, in point of fact, I do continue (with occasional exceptions) to assign the same magnitudes to the same stars as heretofore.

A great many very curious and interesting objects occur in the following catalogue, which are, however, sufficiently pointed out to the cursory reader in the column of "Remarks." I will only here observe, on the subject of the binary stars, γ *Virginis*, 61 *Cygni*, and η *Cassiopeæ*, (of which observations occur), that the first (γ) has fairly shifted its position from north to south of the parallel since the publication of Mr. SOUTH's last measures, in 1825. The next (61) was in the very act of doing so at the date of the measures here recorded; and η will take the same decisive step, in the same direction, in four or five years at farthest. To this I will further add, that σ *Coronæ* has also, since 1825, done the very same thing, and is now much advanced into the southern half of its orbit. This combination, taking place in the Decade 1825—1835, marks it as a chronological epoch of some singularity, as the like will not again occur for a great many thousands of years.

In the following catalogue the first column contains the general number of each *new* double star, continued onwards from 1000 (the last of my former ones) to 1936; the second, the mean right ascension; and the third, the mean north polar distance for 1830. The fourth contains the reading off of the position-micrometer in degrees, *and decimals, when read off as a measure.* The reading commences from the *meridian*, at the *north point*, and continues round in the direction *nfspn*, (*north, following, south, preceding, north,*) from 0 to 360°; so that 1° corresponds to 89° *nf*, 91° to 1° *sf*, 181° to 89° *sp*, and 271° to 1° *np*. The convenience of this mode of reckoning, and its avoidance of continual and most annoying mistakes in the mode hitherto followed, is a great recommendation of it. If generally adopted, as I hope it will, I trust that others will conform to the *origin* and *direction* here used, not because it is meant to say it is the *best*, (though it was not chosen without a reason for the preference) but *simply for conformity*. If not, the confusion will soon be intolerable, and the remedy a thousand times worse than the disease.

In all my sweeps previous to July 5, 1828, estimations of positions only were made by the eye, and occasionally are so now, when there is no time

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for measurement; nay, even an estimation made long after, from a diagram made at the time, is better than absolute want of information. Such estimations, though expressed in the same language as the measures, are always distinguished from them by being only given *to whole degrees*, omitting decimals; and, to obviate possibility of mistake, it is always noticed in words, when such is the case, in the column of Remarks.

The column headed "Sweep" contains the number of the sweep in my journal, in which the observation was made. Should this be published at some future time, or laid up in archive, it will afford an authentic reference on any doubtful point.

The last column is headed "References," and contains the number in the Dorpat Catalogue, or in Mr. South's Synoptic Catalogue, or in my own former catalogues, of any identified object. In making this reference, the numerical extent of the catalogue referred to is the only ground of choice. There is greater chance of finding the object in a list of 3000 than in one of 800 objects, and it is never intended thereby to assign the merit of discovery where it may not duly belong.

Abbreviations used in the following pages.

Σ. Struve. The great Dorpat Catalogue.

S. South. Mr. South's Synoptic Table of measured Double Stars, and his Measures. *Phil. Trans.* 1826.

H. Sir W. Herschel. Catalogues of Double Stars in Classes.

HN. Ditto. Catalogue of 145 New Double Stars.

h. My own former catalogues and the present, cited by the general number.

A.C. Catalogue of the Astronomical Society of 2881 Stars.

S*h*. The Catalogue and Measures of Double Stars of Mr. South and myself, published in *Phil. Trans.* 1824.

L. The large star; S the small one, &c. &c. as in the former catalogues.

Where two or more observations of one star occur, they are bracketed together; and the degrees, minutes, &c. common to the right ascensions and polar distances, as resulting from the single observations, omitted in all after the first.

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No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″				
1001	0 1 20,8	46 13 0	84·5	13	9·10 10·11		189	
1002	1 42,1	75 32 21	30·0	15	10 13		175	
1003	2 13,8	33 1 38	34·8	9	9 12		212	
1004	2 34,0::	38 50 54::	336·5	20	9 10	Places ill determined in this sweep.	208	
1005	4 2,7	39 19 39	100·0	7	11·12=11·12		207	
1006	4 57,6	27 33 41	270·0	3½	12 14	Very delicate.	219	
1007	5 10,1	63 57 37	222·2	18	7 11	L. white; S. blue.	172	
——	5 46,8	28 6 32	176·4	18	8·9 9	S. 382. $85^{0}\,50'\,sf = 176{\cdot}2$; 18″,187.	216	Σ. 10
1008	6 10,1	31 10 18	125·5	15	8 11		213	
1009	7 1,2	42 20 49	206·0	13	10 = 10		207	
1010	7 19,1	30 50 4	117·0	15	9·10 10		214	
1011	7 22,8	33 34 8	101·1	7	10 14		212	
——	7 42,9	61 39 1	29·4	20	8 9·10		177	Σ. 17
1012	9 37,2	31 32 26	204·0:	10	10 10 +	A neat pair. Pos. approximate.	214	
1013	9 44,2	31 33 16	330·0:	8	10·11 11		214	
1014	9 48,2	48 27 35	51·4	10	10·11 11		183	
1015	9 53,5	65 11 17	344 0	4	9·10 10·11	Fine.	172	
1016	11 0,6	35 32 13	182·2	6	10 11		212	
1017	11 10,2	48 24 50	275·2	6	11 12		180	
1018	11 34,6	23 16 30	83·9	1½	10 11		223	
1019	11 46,2	30 53 13	93·2	3	10 11		213	
——	12 20,0	23 56 38	112·9	14	8 11	Pos. a mean of 114·4, 112·0, 112·3.	221	Σ. 26
1020	12 41,6	63 58 56	182·6	4	8·9 12·13	Neat star.	172	
1021	12 57,7	48 43 53	246·7	4	10 11	Neat.	183	
1022	14 10,2	39 12 4	15·5	3½	10 11·12	Elegant.	207	
1023	14 41,6	29 44 37	332·1	7	11 11		216	
1024	15 25,8	28 32 17	211·8	3	10 11		219	
1025	16 1,3	98 51 53	143·2	18	9·10 10		186	
1026	16 45,7	24 9 34	193·0	8	11 12		221	
——	18 0,7	40 58 49	293·4	20	8 10	Another double star, *nf.*	207	Σ. 30
——	20 16,4	57 3 6	349·8	12	8 11		168	*h.* 624
1027	21 40,6	68 47 41	169·0	7	9·10 10		166	
1028	21 56,3	25 57 16	148·9	12	11 = 11		221	
——	21 58,5	74 54 22	108·4	12	6 11		173	Σ. 32
1029	0 22 13,2	46 1 0	269·0	10	9 11		190	

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No. *h.*	Æ. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″				
1030	0 22 49,4	57 13 56	176·4	25	4·5 9	A and B } Triple. A very mi- A and C } nute star, 14 *m*; 5^{0} *np*; quite close; very strongly suspected.	168	
			359·4	20	4·5 14			
1031	23 25,2	49 21 27	112·5	3	11 12		183	
1032	23 46,6	61 24 20	249·2	13	9 11		178	
1033	23 52,1	27 39 17	220·7	5	11 11	In a cluster of the 8th class.	219	
1034	24 56,9	64 41 51	270·0	1½	10 11	Neat. Exactly in the parallel.	172	
1035	25 12,4	30 20 26	129·5	3	11 12	Neat.	214	
1036	25 28,3	48 3 20	267·5	3	11 = 11		190	
——	25 57,1 : :	32 15 33	142·8	16	9 = 9		213	Σ. 38
1037	26 17,5	25 5 2	198·7	13	10·11 11·12		221	
1038	26 31,0	27 12 57	97·0	1½	11 11 +	In contact with 160; just separated with 240.	216	
1039	26 51,2	97 4 48	291·8	15	9 12		221	
——	27 13,9	30 25 46	168·1	4½	9 10 10	Fine.	214	Σ. 43
1040	28 44,7	25 9 2	356·4	2	11·12 11·12	Delicate.	221	
1041	29 44,3	41 36 14	20·5	15	5·6 12		207	
1042	29 50,6	30 54 16	57·5	9	10 11		214	
1043	29 55,3	29 52 27	172·0	7	11 11	In a pretty rich cluster of 8th class.	219	
1044	31 2,7	47 13 0	324·5	20	9 9·10		190	
——	31 21,0	66 52 46	204·6	12	7 9	A and B } Triple. The three form B and C } an arch.	190	Σ. 47
			243·2	18	9 11			
1045	32 13,0	27 20 12	155·5	3	11 11		216	
1046	33 33,9	29 8 37	63·8	15	9·10 11	One of a fine large cluster.	219	
1047	33 47,5	26 44 40	69·4	5	11 12		221	
1048	35 12,5	98 34 6	275·0	8	11 12		186	
1049	35 15,3	40 10 19	298·0	12	10 11·12		207	
1050	35 24,2	45 53 2	187·0	8	10 11·12		190	
1051	35 32,6	66 13 16	275·0	1½	10 14	A curious close double star.	166	
1052	36 22,4	25 39 35	290·0	9	10·11 10·11		221	
——	38 51,7 : :	33 4 53	86·4	12	4 8	*η Cassiopeæ*; mean of 84·3, and 87·4 (*better*); double weight attributed to the latter therefore. *Sh.* 8. The change of position since Mr. South's last observation affords a perfect confirmation of this star's motion. The former angles were 1821·9, pos. = 82^{0}·9; 1825·8, 83^{0}·1. The quadrant will change from *nf* to *sf* probably in the year 1835.	113	Σ. 60
1053	39 38,8	29 45 17	170·0	12	10·11 11		219	
1054	0 39 42,6	30 10 17	176·0	5	9 13	Wind bad.	216	

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No. *h.*	Æ. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
——	h m s 0 49 46,1 46,8	° ′ ″ 63 13 6 12 51	° 297·0 301·0	″ 3½ 4	7·8 = 7·8 7·8 8	Fine. 65 *Piscium.* | *Sh.* 9. Pos. Fine. The same. | 25° 48′ *np*, or *sf* = 295·8; dist. 5″,960.	172 177	Σ. 61
——	42 6,2	22 3 30	215·4::	4	9·10= 9·10	Pos. a mere guess; just caught as leaving the field. *Sh.* 10. Pos. 55° 12′ *sp* = 214°,8 3″,151.	223	Σ. 65
1055	42 14,6	26 7 54	336·8	8	10 11		221	
——	45 4,5	51 45 10				Double. No particulars.	188	Σ. 72
1056	46 33,7	29 3 47	133·1	9	10 12		214	
1057	47 20,1	52 25 44	111·0	30	4 16	*μ Andromedæ.* Δ R.A. = 3ˢ,0.	188	
1058	48 12,7	40 41 49	279·8	7	10·11=10·11		207	
——	48 58,4	63 59 47	299·4	6	10 =10		172	Σ. 77
1059	49 4,6	25 15 20	185·8	10	10 10		221	
1060	49 12,7	45 59 55	297·0	8	10 11	Points *s* of a star 7·8 mag.	190	
1061	49 23,4	23 37 55	99·4	12	10 11		223	
1062	50 2,3	41 40 29	113·0	7	10 12		207	
1063	50 50,9 55,6	28 26 52 22	279·4 285·3	3 3	10·11 11·12 10·11 11	The first of a lozenge. The first of a rhomb.	214 219	
1064	53 22,2	49 34 4	4·8	16	6 15	Delicate.	183	
——	53 36,3	40 37 19	311·1	11	9 11		207	Σ. 83
1065	55 50,6	62 48 30	161·4	18	9 11		178	
1066	55 54,2	28 14 47	302·2	6	9 14	Large star ruddy; small more so.	214	
1067	55 57,2	64 40 27	238·3	15	10 =10		172	
1068	56 7,1	75 58 19	265·6	30	5·6 18	72 *Piscium.*	173	
1069	56 30,3	20 54 20	330·1	12	10·11 10·11		223	
1070	57 54,1	28 43 47	85·0:	3	11 12	In a small cluster of 7th class.	219	
1071	0 58 22,7	40 30 19	124·4	12	9·10 11·12		207	
1072	1 0 40,9	98 43 16	0·9	20	9 10		187	
——	1 49,2	25 53 39				Piazzi O. 312. Not seen double.	221	Σ. 96
1073	3 37,2	60 49 50	259·5	10	8 13	Neat.	178	
1074	3 51,6 52,6	27 43 37 44 17	347·0 341·3	8 12	10 11 10·11 11		216 219	
1075	5 41,3	22 44 0	103·5	8	10·11 11		223	
——	5 49,9 51,2	98 50 15 0	332·0 331·4	·50 45	5 7 6·7 7·8	37 *Ceti* | *Sh.* 17. Pos. 62 27 *np* = 37 *Ceti* | 332·4; dist. 50″,780.	187 186	*Sh.* 17
1076	7 9,1	77 9 37	165·9 258·0	4 25	9 17 9 14	A and B; difficult. | Triple. A and C |	173	
——	7 19,4	52 26 37	321·8	11	8 10·11	Fog coming on.	188	Σ. 104
——	1 7 33,5	24 47 51	182·4	3	9·10 11	The preceding of two in field together	221	Σ. 105,1

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No. *h.*	Æ. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″				
1077	1 7 47,7	46 16 14	293·1	25	8 10	Haze thick.	190	
——	7 51,0	24 45 11	11·1	4	11 11·12	The following of two in field together.	221	Σ. 105,2
——	8 49,5	27 0 57	6·0::	6::	10 10·11	Only a glimpse caught.	221	Σ. 109
——	14 5,1	22 45 40	100·0	30		ψ *Cassiop.* N.B. The large star was not divided with power 320. *Sh.* 18. Pos. 101·3; dist. 33″,347	223	Σ. 117
1078	15 2,0	63 18 35	95·1	11	9 12	A and B } Triple; the three ex-	172	
			95·1	25	9 10	A and C } actly in a line.		
	3,8	19 0	99·7	10:	10 11	A and B } B is half-way between A and	175	
			99·7	20:		A and C } C. Clouded thick over.		
1079	15 30,3	98 53 24	300·5	60	6 12	44 Ceti.	186	
——	16 21,0	26 24 34	277·5	15	9 9·10	Pos. a mean of 276·5, 278·4.	221	Σ. 121
1080	18 1,8	19 58 40	311·0	5	11 14	Points to a star 9th mag.	227	
1081	20 14,6	49 21 30	315·2	6	10 = 10	Points to a third, 10th mag.	183	
——	20 32,1	29 49 47	303·9	14	9 11	Mean of 303·3, 304·4.	219	Σ. 128
1082	21 19,9	27 41 37	240·2	6	10 11	Wind violent.	216	
——	22 1,9	30 11 42	139·4	15	6·7 10	The chief star in a fine cluster.	219	Σ. 131
	4,5::	18	139·6	13	8 11	The chief of a cl. of 7th class. Pos. mean of 137·8, 140·1, 141·0.	213	
——	22 18,9	20 58 25	185·5	8	9·10 10	Mean of 184·2, 181·9, 183·3.	223	Σ. 130
1083	24 15,9	29 35 37	36·2		11, 14, 10, 14	Four stars in an exact straight line, a fifth 13th mag. Pos. 280 ±	216	
1084	25 8,0	23 38 50	357·0	16	9 11		223	
1085	27 2,9	27 10 17	119·1	3½	9·10 = 9·10	Fine. Good measure.	219	
1086	28 56,7	21 45 0	297·3	5	11 12	A star 8th mag. follows.	223	
1087	29 21,4	51 51 4	76·5	7	10 11		188	
——	31 51,6	65 6 29	32·5	6	7 12		172	Σ. 145
1088	31 58,5::	32 13 53	164·5	15	7 11	Pos. mean of 163·0, 166·1.	213	
1089	32 36,4	19 9 45	89·0	15	9 10·11		227	
1090	32 46,4	19 8 0	157·5	6	11 = 11		227	
——	34,1 —	27 4 0	123·0:	1½		Barely divided with 240, and 9 inches aperture, (Struve's place)	219	Σ. 148
——	34 52,7	97 55 53	195·5	15	9 10	S. 400. Pos. 195·0; dist. 36″,645. A very strange error of estimation in my distance. Observed also by me in 2d cat., where the dist. is estimated at 30″; but the magnitudes are there called 7·8=7·8.	186	Σ. 150
1091	36 56,5	29 1 2	150·1	25	8·9 = 8·9		216	
1092	37 9,7	21 20 50	254·8	4	13 14		223	
1093	40 24,1::	32 12 53	22·0	5	10 = 10	Neat.	213	
——	40 28,3	24 7 31				Not seen double. The only star 9·10th mag. near the place.	221	Σ. 168
——	40 45,2	20 47 30	130·3	6	10 12	Elegant.	227	Σ. 169
——	40 56,0	76 29 57	199·7	15	9 10·11		173	Σ. 173

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No. *h.*	Æ. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″				
1094	1 43 8,2	50 6 40	356·5	20	6·7 14	55 *Andromedæ*; a fine nebulous star.	183	
1095	44 27,0	20 29 55	336·5	9	11 12		227	
——	44 28,2	29 32 57	123·0	4	9·10 9·10+	Very fine; good measure.	216	Σ. 182
	33,6	33 27	119·5	3	9 = 9	Pos. mean of 120·2, 122·8, 118·1, 117·1	219	
——	45 28,7	62 1 56	165·6	4	9 11	S. 403. Pos. 165·9; dist. 5″,673.	177	Σ. 183
1096	45 51,5	75 13 7	179·4	8	10 15		173	
1097	46 7,9	53 5 32	——	—	——	In cluster viii. 32. No particulars.	188	
1098	47 9,3	30 39 43	334·5	12	10 11	In the *f* part of a cluster of 15 or 20 stars.	213	
——	47 17,3	27 56 7	236·6	40	9 10	L. very red. S. fine green.	219	Σ. 188
1099	47 20,2	20 21 10	191·2	10	10 12		227	
1100	47 21,6	26 33 4	310·4	30	5·6 11·12		221	
1101	51 6,3	26 41 31	98·4	7	10 11		221	
——	52 8,7	23 8 40	20·5	30	9 9+		223	Σ. 199
1102	52 16,2	28 6 17	54·5	7	11 11+	Points back to a star C.	219	
1103	54 8,8	26 39 7	252·3	8	10 12	A and B	221	
			150·0:	10:	10 13	A and C. Estimated by diagram.		
1104	56 13,6	22 0 10	97·4	5	11 = 11		223	
1105	56 39,2::	31 50 53	77·3	12	9·10 11		213	
1106	56 58,9	27 6 42	70·5	6	10 11		216	
1107	57 26,0	17 52 40	90·5	12	10 11		227	
——	58,7 —	28 30	——		——	Not seen double. A star of 7·8th mag. examined. This, therefore, is perhaps not Struve's.	219	Σ. 216
1108	1 59 2,5	26 19 13	211·1	4	10·11 11	Neat.	221	
1109	2 0 7,4	51 37 31	181·0:	18	10 11	Position estimated from diagram. A nebula, II. 605, precedes it. Dist. 90″.	188	
1110	0 32,3	22 15 50	212·8	4	12 12		213	
——	1 38,0	77 6 42	248·9	4	9 10		173	Σ. 224
1111	1 44,2	26 32 59	346·7	5	10·11 11		221	
1112	4 32,2	23 20 10	225·5	12	10 13		223	
——	4,8 —	29 28	——	—	——	Not seen double.	219	Σ. 234
1113	5 52,5	24 19 38	178·0	4	10 14		221	
——	6 57,6	53 18 45	1·5	7	9·10 10		188	Σ. 238
1114	7 8,1::	33 37 3	324·3	12	7 10	The chief star in the magnificent cluster in *Perseus*.	213	
1115	9 7,7	62 8 5	206·8	50	6 18	This disagrees too much in distance with *Sh.* 31 to be the same star: nor can it be 10 *Trianguli*.	178	
——	2 11 25,4	23 56 15	33·5	3½	9·10 13		223	Σ. 252

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No. *h.*	*R.* 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
——	h m s 2 12,9 —	° ′ ″ 29 15 —	°	″		Not seen double. Power 240, 6 inches apert. Night not good.	219	Σ. 257
1116	13 32,9	18 59 15	123·7	7	9·10 12	Pos. mean of 123·2, 124·3.	227	
1117	14 4,8	26 24 49	293·0	5	10 12		221	
——	15 1,7	23 22 10	282·5 100::	2 12	5 8 5 10	A and B Power 320, and 6 inch. A and C Very good. The three nearly in a line. *Cassiopeæ*. S. 411. Mr. South has not measured the close star: his pos. of the distant one is 16·52 *sf* = 106·9; but this must be affected by the distortion of the large one. Dist. = 7″,909.	223	Σ. 262
——	16 52,8	30 6 47	221·8	15	10 10½		219	Σ. 263
——	17 2,8	30 6 53	98·5	12	9 11		219	Σ. 264
——	18 13,7	60 53 5	347·4	1	7·8 9·10	Piazzi II. 93.	178	Σ. 269
1118	20 8,5	24 4 34	120·0	3	11 11·12		221	
1119	21 38,9	20 14 20	321·4 22·0	10 11	10·11 13 10·11 14	A and B A and C A fourth about 320°.	227	
——	24 11,9	21 26 40	——	—	———	Not seen double with 240.	223	Σ. 278
1120	24 51,9	51 5 3	100·0 320:	15 25:	7 12 ———	A and B Pos. and dist. of C. estimated from diagram. A and C	188	
——	27 34,1	25 6 5	293·8	10	9 9	Pos. mean of 294·3, 293·8, 4·2, 3·0.	221	Σ. 282
1121	28 53,9	21 59 40	242·3	9	11 12		222	
1122	30 46,9	26 33 46	216·1	12	8·9 10·11		221	
1123	31 8,7	47 57 50	252·0	15	9 9	In Messier's 34th cluster. Badly seen in haze.	190	
1124	31 12,9	48 1 59	152·0	6	8 12	In southern part of Messier's 34th cluster.	182	
1125	31 24,8	22 25 25	223·4	20	9·10 11		223	
1126	31 38,7	47 55 50	——	—	———	Double. No particulars. In Messier's 34th cluster.	190	
1127	32 55,9	20 56 20	69·5	16	10·11 11·12		227	
——	36 17,5	26 6 2	174·1	5	8 12	Pos. mean of 173·8, 174·5.	221	Σ. 302
1128	41 27,5	20 48 45	307·3::	5	10 15		227	
——	42 44,9	21 29 40	86·1	4	9 12	A third star follows. ΔR.A. = 15ˢ; pos. = 102·4	223	Σ. 317
	43 5,6	21 30 5	85·9	4	8·9 11	Pos. mean of 86·2, 86·1, 85·3. Probably the wire mistaken.	222	
—	43 1,1	52 21 52	240·0	15	6 11	20 *Persei*. H. III. 60. S. 240. Pos. 236·2; dist. 13″,886.	188	Σ. 318
1129	49 42,5	20 27 40	170·0	50	9 9		227	
1130	51 27,9	22 59 20	220	7	10·11 11·2	Angle estimated from diagram.	222	
1131	51 54,9	22 56 5	106·0	18	9 10		222	
——	53 51,0	62 9 21	327·5	8	9 12		177	Σ. 339
——	2 54 58,4	62 45 30	301·7	1½	9·10 10	Cloudy. Bad measure.	178	Σ. 342

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No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″				
1132	2 59 27,1	23 37 44	20·0	8	9·10 10	Neat. Pos. a mean of 18·9, 21·2.	222	
1133	3 4 33,5	20 53 25	199·7	20	6 12		227	
——	6 6,4	50 8 49	27·8	2	9 10	Fine.	182	Σ. 369
——	6 12,1	22 6 50	343·6	2½	10·11 10·11	Mean of 340·8, 345·0. The latter better observed with 240, and therefore bearing double weight.	222	Σ. 368
1134	7 56,8	62 15 16	51·8	4	11 13	Hazy. Cirri forming.	178	
——	8 46,1	23 9 35	298·0	10	9 10		222	Σ. 374
1135	16 22,1	23 0 5	352·7	30	7·8 9	Pos. mean of 352·6, 352·8.	222	
1136	19 33,9	20 23 25	220·3	8	10·11=10·11	Neat. Pos. mean of 219·5, 221·2.	227	
1137	23 59,9	19 10 55	11·7	10	11 13		227	
——	27 45,6	20 42 35	256·9	4	8 8	Pos. mean of 256·0, 258·0, 256·6, 257·2.	222	Σ. 419
——	28 27,4	18 55 50	235·5	12	8 12	Pos. mean of 233·4, 236·4, 236·7.	227	Σ. 421
1138	28 35,9	22 11 0	332·2	10	10 12		222	
——	30 53,3	19 59 10	141·5	20	10 11·12	Another near.	227	Σ. 428
1139	34 39,7	20 1 0	175·6	40	8·9 10		227	
——	39 45,7::	20 59 25	167·4	12	9·10 10	Pos. mean of 168·0, 168·0, 166·2. The R.A. perhaps erroneous 20 or 30″.	227	Σ. 455
	40 24,1	21 0 0	166·8	15	9·10 10	Pos. mean of 167·0, 166·7.	222	
1140	44 29,0	20 33 55	115·7	15	9·10 11	Pos. mean of 115·0, 116·4.	227	
——	48 46,4	18 26 30	14·3	4	10 11	Fine. Pos. mean of 13·8. 14·9.	227	Σ. 472
1141	3 55 26,9	21 19 30	167·0	12	10 10	Greatly resembling Struve's 455.	222	
——	4 1 40,1	22 52 30	263·4	7	9 10·11	Pos. mean of 262·8, 264·0.	222	Σ. 504
——	3 22,9	20 2 45	291·5	5	10 = 10	Fine. Pos. mean of 290·7, 292·3.	227	Σ. 506
1142	7 54,0	21 12 0	77·8	18	9 10		227	
1143	10 52,8	19 39 0	71·2	8	10 12		227	
1144	15 20,1	21 59 50	145·3	8	10 12		222	
1145	17 19,4	20 54 0	125·1	2½	11 = 11	Neat. ? if pos. = 115·1. Manuscript indistinct.	227	
1146	19 18,0	18 53 50	15·8	15	8·9 12	Pos. estimated from diagram = 55°; but the measured angle 15·8 is distinctly registered.	227	
1147	20 34,1	21 19 10	248·3	15	9 11·12		222	
1148	23 11,1	21 52 0	117·7	6	10 = 10	Pos. mean of 119·5, 115·7, 117·8.	222	
1149	26 57,5	20 49 0	194·8	16	10 11		227	
1150	27 26,0	20 49 5	230	4	14 = 14	Follows the last in same field.	227	
——	33 12,1	23 46 24	116·7	12	8·9 11	Pos. mean of 116·6, 116·8.	222	Σ. 584
1151	33 32,9	19 25 50	7·2	10	10 13	A and B	227	
			328·4	13	10 14	A and C Triple.		
——	40 59,7	20 58:20	133·0	20	9·10 11	Pos. mean of 133·3, 132·7, 133·0.	227	Σ. 602
	4 41 9,9	20 58 30	133·2	25	9 10	Minute indistinct in original.	222	

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No. *h.*	R. 1830.	N.P.D. 1830.	Positions.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″				
——	4 42 51,5	20 50 55	300·0	25	9·10 9·10		227	Σ. 606
							222	
1152	50 7,4	21 25 50	42·8	10	10 = 10		227	
1153	50 23,4	20 55 20	48·2	12	10 = 10	Pos. mean of 47·3, 49·1.	222	Σ. 637
——	55 11,6	22 22 55	19·2	20	8·9 11	Pos. mean of 19·5, 18·9.	227	Σ. 638
——	4 56 26,4	20 53:10	219·8	5	9 10	Fine. Pos. mean of 219·2, 220·4. A star 10th mag. is *sf.*	227	
1154	5 0 39,5	18 58:30	91·0	18	9 15	(Index reading confused in MS.)	227	
1155	4 48,5	19 33 0	45·7	20	9·10 10	Pos. mean of 46·5, 45·1.	222	Σ. 663
——	5 40,6	23 58 50	73·5	5	9 11·12	Pos. mean of 73·4, 72·0, 75·2.	227	
1156	9 44,5	19 51 30	222·6	3	12 13	The N. of a trapezium. To the north is a fine coarse double star.	227	Σ. 704
——	15 52,9	20 28 45	10·0	20	9 11	Pos. mean of 9·3, 8·5, 13·4, 8·9.		
1157	5 27 ——	95 27 —	310::	—	——	The star marked *y* in my chart of the great nebula of *Orion*. The line of junction points rather below (north of) the star marked *w* in the same chart.	173	
							130	
1158	6 37 32::	100 44 0	140	8	12 12	Pos. estimated at 50 *sf.*	123	
1159	7 47 33::	80 0 0	320	4	16 17	Pos. estimated at 50 *np.*	139	
1160	8 11 36,3	42 41 37	155	20	9 12	Pos. estimated at 65 *sf.*	139	
1161	21 42,7	43 30 17	30	8	10 13	Pos. estimated at 60 *nf.*	139	Σ. 1242
——	24 3,8	42 19 9	165	$1\frac{3}{4}$	10·11 11·12	Pos. estimated at very near 75 *sf.*	170	
1162	42 24,0	13 55 9	232·8	20	8 13·14	? if P.D. be not 12° 55′ 9″	139	
1163	43 30,8	42 25 12	175	15	9·10 10	Pos. estimated at 85 *sf.*	139	
1164	8 56 41,1	44 9 12	175	9	9·10 = 9·10	Pos. estimated at 85 *nf* or *sp.* A star 12th mag., distant 20″ exactly precedes their bisecting point.	139	
							139	
1165	9 5 4,9	44 21 57	127	20	9 11·12	Pos. estimated at 37 *sf.*	139	Σ. 1358
——	19 53,2	44 34 17	150	20	8 10	Large, yellow; small, blue. Pos. estimated at 60 *sf.*	126	
1166	20 20::	55 36 —	135	50	7 11	7 *Leonis min.* Pos. estimated at 45 *sf.*	113	
1167	20 28::	91 1 —	3	87	6 7·8	Pos. estimated at 87 *nf.*	170	
1168	21 17	10 25 3	47·9	17	8 13		143	
1169	31 17,3	85 46 3	155	15	10 12·13	Pos. estimated at 65 *sf.*	143	Σ. 1377
——	34 37,4	86 35 45	155	4	9 12	Pos. estimated at 65 *sf.*	226	
1170	36 4,2	30 10 55	320·0	8			139	
1171	37 30,3	42 27 4	200	12	10 11	Pos. estimated at 70 *sp.*	139	
1172	39 53,3::	45 7::	270	10	9 11	Position nearly preceding; an elegant star.	111	
1173	49 25::	103 58::	20	4	12 12	Pos. estimated at 70 *nf* = *sp.*	144	
1174	54 32,5	87 7 38	135	8	10 12	Pos. estimated at 45 *sf.*	143	
1175	9 57 36,4	85 11 57	105	10	11 12	Pos. estimated at 15 *sf.*		

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No. *h.*	Æ. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
1176	10 h 5 m 12,4 s	31° 33′ 15″	320°·2	10″	10 = 10		226	
1177	16 55,9	85 56 0	60	12	10 11	Pos. estimated at 30 *nf.*	143	
1178	18 31,7	32 56 45	100:	—	———	Pos. estimated from diagram.	226	
1179	19 7,1	89 7 32	130	10	10 · 12	Pos. estimated at 40 *sf.*	144	
——	19 20,2	32 46 20	254·2	12	9·10 11		226	Σ. 1436
——	29 33,2	87 52 42	50	15	9 10	Pos. estimated at 40 *nf.*	144	Σ. 1456
——	32 53,2	89 23 22	310	5	8 11	Elegant; a third star 10th mag. 50° *sp*, 20″ dist., as estimated from diagram.	144	Σ. 1464
1180	44 36,6	85 14 0	35	12	11 12	Pos. estimated at 55° *nf.*	141	
——	49 20,6	30 11 30	39·3	40	9 10	L. red; S. blue. *Sh.* 118. Pos. = 38·2; dist. 35″·010.	226	Σ. 1495
1181	52 12,8	107 24 40	270	75	8 9	The large star scarlet, almost blood colour, a most intense and curious colour. Follows *α Hydræ* 42″,5, and is 1′ south of it.	149	
1182	52 21,3	89 2 32	130	22	8 13·14	Pos. estimated at 40° *sf.*	144	
——	54 15,8	85 26 55	——	1	10 10	Exceedingly close; nearly in the parallel. Power 240, 6 inches.	141	Σ. 1504.
			280	1	———	Viewed with 240, and 10 inches aperture. Cleanly divided. Night wonderfully fine. Pos. estimated at 10 *np.* Struve's 1504, marked as "*pericinæ.*"	143	
1183	55 18	13 8 37	165·0	16	8 13		170	
1184	56 15,3::	43 6 20::	30	5	10 15	A and B. Pos. estimated at 60 *nf.*	140	
			110	15	10 12	A and C. Pos. estimated at 20 *sf.*		
1185	10 58 4,3	60 34 19	30	—	———	Points northwards between a faint nebula and a star.	68	
——	11 11 5,3	95 59 16	315	8	8 8 +	Fine. Pos. estimated at 45° *np.*	147	Σ. 1530
1186	11 31	12 38 47	285·3	9	12 15		170	
1187	13 1	12 40 7	199·0	10	11 = 11	Points exactly to a star 7th mag. 2½′ dist.	170	
1188	13 53	12 43 32	208·8	15	10 11		170	
——	16 —	106 45 —	105	3	4 13	*γ Hydræ.* A beautiful double star Points exactly to a star 11th mag. at a considerable distance. Pos. estimated at 15 *sf.*	149	*h.* 840
1189	17 15,0	85 6 35	120	15	10 11	Pos. estimated at 30 *sf.*	141	
——	18 18,7	86 3 18:	145	20	7 8	33 *Leonis.* H. iv. 13. Pos. estimated at 55 *sf.* *Sh.* 124. Pos. 151·7; dist. 29″,542.	143	Σ. 1540
1190	22 9,4	95 47 22	330	12	8 10	Fine; sky beautiful. Pos. estimated at 60 *np.*	147	Σ. 3072
——	27 10,7	32 55 15	177·2	8	9 9 +		225	Σ. 1553
1191	27 54,2	85 27 13	272	8	11 12	Sky beautiful. Pos. estimated at 2° *np.*	143	

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No. *h.*	Æ. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
1192	h m s 11 29 1,1	105° 59′ 52″	357°	14″	10 11	Neat. Pos. estimated at 87 *np.*	149	
——	29 43,4	91 29 57	280	5	7 10	Beautiful. Pos. estimated at 10 *np.*	146	Σ. 1560
——	29 46,5	43 56 57	265	8	9 10	Fine. Pos. estimated at 5° *sp.*	139	Σ. 1561
1193	31 57,0	84 9 14	100	13	9 11	Pos. estimated at 10 *sf.*	142	
1194	33 39,3	89 1 7	175	12	10 10 +	Sky perfectly clear. Pos. estimated at 85 *sf.*	145	
1195	36 0,4	76 33 35	327·0	5	11 = 11		191	
1196	36 50,3	85 9 31	155	20	8·9 10	Pos. estimated at 65 *sf.*	142	
	50,8	20	155	20	9 10	Pos. estimated at 65 *sf.*	141	
1197	38 29,7	86 37 27	135	4	11 = 11	Pos. estimated at 45 *np* or *sf.*	143	
1198	38 53,0	43 22 22	97	8	10 12	Pos. estimated at 7° *sf.*	139	
1199	39 48,8	88 17 25	55	18	10 10	Pos. estimated at 35 *nf.*	145	
1200	41 10	10 8 16	90·0	9	10 = 10		170	
1201	42 13,3	76 49 35	189·0	12	6·7 13	S. red.	191	
——	42 16,4	44 58 0	5	10	9 11	Pos. estimated at 85 *nf.*	151	Σ. 1574
1202	42 27,3	84 56 45	240	3	11 12	Pos. estimated at 30 *sp.*	141	
——	44 40,8	85 23 14	170	2	10 11	A neat double star. Pos. estimated at 80 *sf.*	142	Σ. 1578
	41,3	11	170	2½	10 11	Pos. estimated at 80 *sf.* A star 10th mag. 5° *np*, distant 3′.	141	
1203	44 59,7	85 31 23	315	3	10 11	Pos. estimated at 45 *np.*	143	
1204	49 31,1	85 29 32	125	15	9·10 9·10	Pos. estimated at 35 *sf* or *np.* A star 6th mag. *s.*	142	
1205	53 58,8	84 39 26	40	10	10 11	Pos. estimated at 50 *nf.*	142	
1206	54 1,3	84 42 1	40	10	11 12	50 *nf.* In field with the last, and parallel to it.	142	
——	55 33,8	81 39 1	320	22	9 9·10	Pos. estimated at 50 *np.*	152	Σ. 1595
1207	55 41,4	45 58 3	225	23	8 11	Pos. estimated at 45 *sp.* Points to the nebula I. 195 near it.	150	
1208	56 28,5	98 10 50	280	5	12 12	Pos. estimated at 10 *np.*	136	
1209	57 54,6	106 4 45	260	9	10·11 11	Neat star. Pos. estimated at 10 *sp.*	149	
1210	58 10,3	83 13 46	100	7	9 11·12	Elegant. Pos. estimated at 10 *sf.*	152	
	11 59 10,0	57	100	6	9 11·12	The same. One or other 1m mistaken in R.A.	153	
1211	12 0 9,3	92 19 52	160	7	10 13	Pos. estimated at 70 *sf.*	146	
1212	0 50,6	106 37 35	100	18	9·10 11	Pos. estimated at 10 *sf.*	149	
1213	1 38,3	95 30 46	102	25	9 = 9	Pos. estimated at 12 *np* or *sf.*	147	
——	6 17,8	90 23 7	55	30	8 12	L. yellow; S. blue. Pos. estimated at 35 *nf.*	146	*h.* 204
1214	7 1,3	88 12 12	195	12	10 14	A and C. Pos. estim. 75 *sp.* } Triple.	145	
			330	6	10 15	A and B. Pos. estim. 60 *np.* }		
1215	8 5,9	47 13 20	35	25	9·10 = 9·10	Pos. estimated at 55 *nf.*	151	
——	12 9 24,3	93 0 36	205	25	7·8 7·8	Fine Pos. estimated at 65 *nf* or *sp.*	147	Σ. 1627
	27,3	13	200	30	6·7 7	Beautiful. Pos. estimated at 70 *sp.* *Sh.* 140. Pos. 197·0; dist. 21″,017.	146	

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No. *h.*	Æ. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
1216	h m s 12 10 2,2	77° 45′ 54″	245°0	5″	8·9 9	A star 10th mag., 20″ north of A.	192	
——	13 52,8	83 44 26	330	15	8 11	17 *Virginis*. Pos. estimated at 60 *np*. *Sh*. 142. Pos. = 339·6; dist. 20″,932.	152	
——	18 44,4	81 40 36	255	18	9 10	Pos. estimated at 15 *sp*.	154	Σ. 1644
——	19 —	44 16 —	350	10	9 9·10	Very fine. Pos. estimated by hasty glimpse at 80 *np* or *sf*. *Sh*. 144. Pos. 162·9 or 342·9.	140	Σ. 1645
——	21 —	105 34 —	222	27	3 9·10	ϑ *Corvi*. S. purplish. Pos. estimated at 43 *sp*.	149	*Sh*.145
	21 5,0	105 32 43	210		3·4 8·9	ϑ *Corvi*. Pos. estimated at 60 *sp*. *Sh*. 145. Pos. 213·7; dist. 24″,005.	157	
1217	24 19,4	91 21 7	310	25	8 15	Pos. estimated at 40 *np*.	146	
1218	26 51,3	105 53 37	266	12	7·8 15	L. white; S. red. Very neat. Pos. estimated at 4° *sp*.	149	
1219	29 49,7::	44 19 20::	85	8	10 = 10	Pos. estimated at 5° *sp* or *nf*.	140	
——	29 55,8	94 23 16	90	6	8 = 8	Nearly equal. Fine. Pos. estimated at 0° *p* or *f*. S. 640. Pos. 95·8; 10″,197. Can this difference arise from mistaken estimations?	147	Σ. 1665 S. 640
1220	30 27,3	90 37 13	50	4	10·11 11·12	Pos. estimated at 40° *nf*.	146	
——	33 2,9	90 31 10	95 90	2 90	15·16	A and B) *γ Virginis*. Well de- A and C) fined. Power 240, and 6 inches. A very small star, 15·16th mag., follows about 1½′ nearly in parallel.	146	Σ. 1670
1221	36 —	15 33 —	260			A fine coarse double star. L. red, S. blue. Has a nebula following.	170	
——	40 55,9	85 15 5	20	6	8·9 = 8·9	Pos. estimated at 70 *nf* or *sp*.	141	Σ. 1681
1222	44 29,8	42 18 2	—	—	9·10	P. xii. 209. Strongly suspected, close double.	139	
——	48 3,5	50 45 4:	227	25	4 5	12 *Canum*. No contrast of colours observed; probably the eye out of order. Pos. estimated at 43° *sp*. *Sh*. 158. Pos. 227·0, 19″,764.	155	Σ. 1692
——	50 36,3	81 10 52	275	15	8 11	Pos. estimated at 50 *np*.	152	Σ. 1703
——	50 55,3	92 53 22	50	20	6 11	44 *Virginis*. S. blue. Pos. est. 40 *nf*.	146	Σ. 1704
1223	51 24,9	46 19 35	190	15	9 11·12	Pos. estimated at 80° *sp*.	151	
1224	51 44,4	95 9 6	50	5	11 12	Pos. estim. Close to nebula II. 778.	147	
——	53 33,8	81 48 16	300	10	9 10	Pos. estimated at 30 *np*.	152	Σ. 1708
1225	54 4,3	91 3 57	110	11	11 12	Pos. estimated at 20 *sf*.	146	
1226	55 54,6	48 11 48:	215	8	10 = 10	Pos. estimated at 55 *sp* or *nf*.	155	
——	12 58 39,8	88 30 2	7	10	8·9 9	Pos. estimated at 83 *nf*. S. 645. Pos. 5·2; dist. 8″,098.	145	Σ. 1719
——	13 1 10,6	94 38 1	340	5	4 10	ϑ *Virginis*. Pos. estimated at 70 *np*. A third a few degrees *np*. *Sh*. 160. Pos. 347·1; dist. 8″,301.	147	Σ. 1724
1227	1 51,2	85 27 13	125	10	11 13	Pos. estimated at 35 *sf*.	143	
1228	13 4 12,8	91 57 7	200	9	10 12	Pos. estimated at 70 *sp*.	146	

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No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″				
1229	13 8 28,9	93 9 56	160	15	10 13	Pos. estimated at 70 *sf.*	147	
1230	8 46,4	47 3 45	290	12	11 = 11	Immediately following Messier's 63rd neb. Pos. estim. at 20 *np.*	151	
——	15 0,5	86 23 35	83	25	7·8 8	Pos. estimated at 7 *nf.* *Sh.* 163. Pos. 76·3; 28″,465.	141	Σ. 1740
	2,7	22 56	75	25	7 7·8	Pos. estimated at 15 *nf.* The *f* star taken.	142	
1231	17 42,4	48 38 37	5	9	9 13	Pos. estimated at 85 *nf.* Two more exactly in one line *sp.* The most distant (90″) is *very* red.	156	
1232	19 0,8	82 12 6	310	10	9 9·10	Pos. estimated at 40 *np.*	152	
	1,3	27	305	8	9·10 11	Pos. estimated at 35 *np.*	154	
——	21 32,8	95 36 16	25	25	6 13	72 *Virginis.* Oscillates violently. Pos. estimated at 65 *nf.*	147	Σ. 1750
1233	26 20,3::	105 58 18	90	9	10 13	R.A. very doubtful.	157	
1234	26 49,6	50 21 19:	40	30	7 11	R.A. well observed. Pos. est. 50 *nf.*	155	
	26 51,2:	50 20 12	52	25	8 12	P.D. well observed. Pos. est. 38 *nf.*	156	
1235	28 7,3	90 46 17	245	6	11·12 12·13	Pos. estimated at 25° *sp.*	146	
——	29 5,8	86 44 30	35	15	8 10	55 *nf.* L. pale yellow; S. very fine sky-blue. Beautifully contrasted colours.	141	Σ. 1764
	6,7	21	—	—	8 11	Red and blue.	142	
1236	30 32,4	93 44 19	95	6	10·11 13·14	Pos. estimated at 5 *sf.*	147	
1237	30 35,0	90 42 37::	10	4	11 13	Pos. 80 *nf.* A star 8th mag. precedes 90″.	146	
1238	31 46,4	81 59 17	300	10	10 10·11	Pos. 30 *np.* Three more 10th mag. in field.	154	
1239	33 55,4	94 25 16	320	15	9 10	Pos. 50 *np.*	147	
——	34 40,2	85 35 48	230	4	6 10	Pos. 40 *sp.* 84 *Virginis.* Very beautiful. *Sh.* 374. Pos. = 229·9; 3″,918.	143	Σ. 1777
1240	36 2,8	81 37 10	285	6	11 12·13	Pos. estimated at 15 *np.*	154	
1241	39 8,4	92 19 37	145	15	9 12	Pos. estimated at 55 *sf.*	146	
——	39 40,6	50 36 2	240:		5·6 8	Very coarse. Pos. estim. 30 *sp.* *Sh.* 654. Pos. = 337·8; 70″,844.	156	S. 654
1242	40 54,8	83 44 43	125	7	11 12	Very neat; bears perfect illum. Pos. estimated at 35 *sf.*	154	
1243	42 31,3	95 13 —	150::	—	———	An elegant double star. Hurried. Pos. 60 ± *sf.*	147	
1244	46 16,0	46 58 40	150	6	7·8 17·18	Fine. Dead calm. Sky 10. Pos. 60 *sf.*	151	
1245	57 34,7	106 20 28	260?	12	12 13	10 *sp* by diagram; *np* by description. Double stars rare here.	157	
——	57 58,9	83 13 52	75	18	9 10	Pos. estimated at 15 *nf.*	154	Σ. 1801
	59,6	32	65	18	9·10 10	Pos. estimated at 25 *nf.*	153	
——	59 17,6	50 46 23:	50	15	9 11	Pos. estimated at 40 *nf.*	155	Σ. 1803
	18,9:	45 52	50	12	9 10	L. yellow; S. blue.	156	*h.* 537
1246	13 59 34,8	88 58 37	100	20	9 12	Pos. estimated at 10° *sf.*	145	
——	14 2 31,3	92 31 22	35	5	8 9	Pos. estimated at 55 *nf.* S. 661. Pos. = 27·2; dist. 7″,937.	146	Σ. 1807

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No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″				
1247	14 3 47,0	48 4 12	120?	4	10 11	30 *sf.* ? estimated pos.	156	
1248	7 28,9	81 52 8	340	2	16 16·17	The most minute double star I have hitherto seen. Pos. estim.	154	
1249	7 40,8::	105 38 26	155	5	9 12	The large star a fine red, between rose and garnet: it is rather a florid than a deep blood red. Estimated pos. 65 *nf*, per description; but the diagram makes it *sf*, which must be preferred.	157	
1250	8 27,4	88 8 44	12	15	9·10 10	Pos. 78 *nf* by estimation.	144	
1251	10 30 ±	85 15 ±	70	15	9 12	Pos. estimated at 20 *nf*.	142	
1252	11 54,3	80 55 56	267	6	9 15	Estimated pos. 3° *sp*.	152	
1253	12 51,9	89 22 35	300	7	11 12	Pos. 30° *np* by estimation.	144	
——	15 1,8	80 46 41	195	9	6·7 8	Pos. 75 *sp*.	152	Σ. 1835
1254	17 59,4	87 6 7	65	5	10 10+	Neat. Pos. 25 *nf* by estimation.	144	
——	19 27,9	91 27 42	125	4	5 14	ϕ *Virginis*. Best seen with 160, and 12 inches aperture; but was detected in sweeping with the whole open. 35 *sf* by estim.	146	Σ. 1846
1255	23 20,0	47 48 58	290	25	8 9	20 *np* estimated pos.	150	
1256	27 6,5	89 28 47	240	5	10 10+	A neat star. 30 *sp* by estimation.	144	
1257	32 29,5:	85 44 11	225	12	10 11	Estimated at 45 *sp*.	142	
——	36 26,3	81 34 4	95	8	9 9·10	Elegant. Dist. estimated from the diagram. 5° *sf* estim. pos. *Sh.* 183, 94·5; 7″,335.	154	Σ. 1873
——	40 27,3	83 19 7	275	—	9	In contact. Found in sweeping. "*Seen first as a star with a disc. With* 240, *and* 6 *inches aperture and illumination*, (*the surest way to separate a doubtful star*,) *it is positively not a single star, and is either a close double star in contact, or a planetary nebula with an oval disc.*" On finally collating these observations with Struve's catalogue, it appears to be his No. 1883, marked "*pervicinæ*." Pos. estimated at 5 *np*.	154	Σ. 1883
1258	42 23,4	45 51 48	60	15	9 13	30 *nf* by estimation.	150	
1259	46 59,8	82 31 12	85	30	7·8 10	L. orange; S. blue. Pos. estimated at 5 *nf*.	153	
1260	49 19,0	48 2 17	190	6	10 10·11	80 *sp* by estimation.	156	
1261	49 21,6	31 44 39	15·0	8	10 = 10	A neat star.	226	
1262	50 17,5	47 13 13	280	3	10 11	Very beautiful. A third 45° *np*. Pos. estimated at 10 *np*.	150	
1263	50 49,0	82 30 22	102	15	10 10+	12 *sf* by estimation.	153	
——	50 57,5	49 8 55	50	8	9·10 10	Estimated at 40 *nf*.	155	Σ. 1895
	— 59,6:	—— 57	55	10	9 10	Estimated at 35 *nf*.	156	
1264	14 51 54,8:	49 2 44	315	14	10 11	45 *np* by estimation.	157	

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No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″				
1265	14 52 39,1	82 57 37	273	3	13·14 14	3 *np* by estimation.	153	
1266	52 47,2	85 3 58	30	12	9·10 10	60 *nf* by estimation.	143	
1267	54 50,1	81 39 37	5	14	10 11	Oscillates much. 85 *nf* by estim.	153	
	50,4	— 38 45	25	12	9 10	65 *nf* by estimation.	154	
——	55 47,7	83 50 28	345	12	7 7·8	Pos. 75 *np* by estim. *Sh.* 192; 346·5; 10″,749.	143	Σ. 1904
1268	14 58 12,5	83 34 2	80	20	9 12	Clouded.		
——	15 3 28,8	50 22 42	320	5	10 12	50 *np* est. 5·663; 333·8; 10″,740.	156	Σ. 1916
1269	5 31,2	87 38 2	255	18	8·9 12	15 *sp* by estimation.	144	
1270	5 40,8	82 29 34	155	12	9 10	Neat. 65 *sf* by estimation.	154	
1271	15 17,6	107 59 48	110	7	10 = 10	20° *np* or *sf*.	157	
1272	21 45,4	94 16 46	130	2½	11 11 +	Neat. Pos. estimated at 40 *sf*.	147	
1273	23 7,3:	107 20 13	330	10	9·10 10·11	60 *np* estim.	157	
1274	24 45,4	47 31 45	310	3	10 11	Neat. 40 *np* estim.	151	
1275	24 50,9	95 3 52	55	10	10 12	35 *nf* estim.	147	
1276	28 16,4	90 7 2	260	5	10 11	Neat. 10 *sp* estim.	146	
1277	35 54,5	83 2 17	2	50	2 14·15	*α Serpentis.* Oscillates much, so that the true angle cannot be got; but I am convinced it is rather *nf* than *np*.	153	
1278	37 41,5:	105 38 33	140	25	8·9 10·11	50 *sf* by estimation.	157	
1279	43 6,4	95 22 11	175	15	10 13	85 *sf* estim.	147	
1280	46 52,3	50 16 29:	350	18	9 12	80 *np* estim.	155	
1281	47 27,8	105 31 59	215	18	6·7 20	Caught in a glimpse. The small star requires the most cautious illumination, and turning the eye aside. Pos. estim. at 55 *sp*.	157	
1282	49 27,8	91 5 37	132	10	10 12	42 *sf* estim.	146	
1283	50 20,0	88 56 12	130	15	10 11	40 *sf* estim. A star 7th mag. *nf*.	144	
1284	51 57,9	89 59 47	190	16	10 14	80 *sp* estim.	146	
1285	54 51,5	50 20 16:	180	12	6·7 18	Delicate. Pos. estim. as due south.	155	
	52,7:	—— 27	183	9	7 18	Better seen. Pos. 87 *sp* estim.	156	
——	15 58 45,3	92 11 19	60	9	10 10 +	30 *nf* estim.	146	Σ. 2008
1286	16 0 51,8	82 12 27	155	14	10 12	A and B. 65 *sf* estim.	153	
			215	17	10 15	A and C. 55 *sp* estim.		
1287	2 43,1	49 39 29:	90	5	9 11	Possibly Struve's 2014, with 10′ mistake in the declination on one part or other.	155	
1288	2 59,7:	106 18 13	130	15	10 11	40 *sf* estim.	157	
1289	4 40,3	50 4 52	65	6	10·11 = 10·11	Neat. Pos. estim. at 25 *nf* or *sp*.	156	
1290	16 6 32,8	90 19 40:	105	10	10 11	15 *sf*. Pos. estimated.	146	

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No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
——	h m s 16 10 —	° ′ ″ 91 50 —	° 0	″ 15	8·9 8·9	Exactly in meridian.	146	Σ. 2033
1291	10 38,7	47 52 12	130	14	9 11	Pos. 40 *sf* by estimation.	156	
1292	28 1,2	114 52 30	240	20	9 9·10	Pos. 30 *sp* by estimation.	148	
1293	34 18,8	91 33 7	105	2½	10 10·11	Neat; among several other stars. Pos. estimated at 15 *sf*.	146	
1294	37 55,0	114 13 15	135	18	7 17	L. red. Pos. estimated at 45 *sf*.	148	
1295	41 30,0	116 20 59	150	7	11 12	60 *sf* by estimation.	148	
1296	41 37,5	116 20 59	220	10	———	50 *sp*. Estim. from diagram. In field at once.	148	
1297	16 49 42,0	115 31 35	50	5	10 10·11	Neat. Pos. 40 *nf* by estimation.	148	
——	17 4 53,5	116 19 0	235	3	6 7	36 *Ophiuchi*. Fine. 35 *sp* estim. *Sh*. Pos. 227·3; 5″,200. Not in Struve.	148	*Sh*. 243
——	7 40,0	114 5 35	355	5	6 8	39 *Ophiuchi*. Fine. 85 *np* estim. *Sh*. Pos. 355·8; 12″,512. The low situation of the star unfavourable to exactness.	148	*Sh*. 245
——	8 1,5	64 56 56	175·5	15	4 9·10	δ *Herculis*. The small star well seen with 4 inches aperture. *Sh*. 172·2; 28″,869.	160	*Sh*. 246
——	10 54,8	60 53 54	96·0	4	8·9 14	Neat.	158	Σ. 2147
1298	14 1,8	65 33 31	229·9	4	10 11		160	
1299	19 9,4	62 58 16	20·7 60·5	32 30	7 13 7 14	A and B A and C } Triple.	160	
1300	27 27,8	64 33 41	300·0 190·0	8 2	10 11 12 = 12	A and B + C B and C } Observed first as a double star. On closer examination, the small one found to be close double.	160	
1301	31 47,3	60 38 4	90·0	3	11 = 11		158	
1302	33 29,8	65 4 21	320·3	1¾	11 = 11	Fine.	160	
——	34 3,2	60 39 59	92·5	8	8·9 11	Both red.	158	Σ. 2192
1303	36 31,1	75 30 43	150·5	40	5·6 11		195	
——	39 49,3	62 10 35	236·1	25	3·4 10	μ *Herculis*. H. IV. 41. S. 693. Pos. = 240·8; 29″,297.	158	Σ. 2220
1304	40 51,5	64 20 6	275·6	6	10 11		160	
1305	43 26,7	64 51 26	284·9	9	10 11		160	
1306	45 25,2	75 57 1	0·0	40	9·10 10		195	
1307	45 46,8	62 45 29	327·0	25	8 11		158	
1308	50 40,8	80 35 15	113·6	12	10 = 10		196	
——	50 41,1	75 21 55	86·0	15	8 11	L. red.	195	Σ. 2253
1309	52 54,0	64 26 51	2·4	2	10 11		160	
1310	53 1,9	64 24 21	25·3	6	10 10·11		160	
1311	56 45,2	76 31 7	92·5	4	11 12		195	
1312	17 56 56,7	76 26 31	57·5	12	10 11		195	

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No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
——	h m s 17 57 46,4	° ′ ″ 77 57 35	260°0	″ 6	8 9	Fine. H. III. 56. *Sh.* 260; Pos. 257·6; 6″,748.	196	Σ. 2276
1313	17 59 44,2	61 18 15	321·9	8	10 12		159	
1314	18 0 46,4	57 37 52	152·5	15	9·10 10		197	
1315	3 21,7	60 20 53	133·7	3	10·11 12		159	
1316	7 1,1	76 36 27	265·3	8	10 11		195	
1317	10 10,7	62 40 18	131·6	12	10 11		159	
1318	12 24,6	61 55 33	141·9	3	11 11	Good measure.	159	
	— 24,7	—— 44	144·5	3	11 = 11	Good measure.	158	
1319	13 22,9	57 52 24	192·8	13	9 11		197	
——	14 17,3	78 38 25	171·5	8	9·10 10	Neat.	196	Σ. 2311
1320	15 26,4	59 4 7	149·2	15	9·10 = 9·10		197	
1321	15 42,7	50 44 55	95·8	8	10 11		201	
1322	15 56,3	62 18 14	246·1	15	9 11		158	
	— 56,6	—— 13	250·3	12	10 11		159	
1323	17 8,6	77 12 12	284·1	10	10 11		195	
1324	19 53,8	61 24 49	10·8	3	11 12		158	
1325	20 21,1	60 16 3	279·0	1¾	11 12	Neat.	159	
——	22 37,7	60 12 13	318·5	18	9 12		159	Σ. 2327
1326	22 51,4	57 47 32	20·6	8	10 10·11		197	
——	22 56,7	60 12 18	263·6	2½	10 = 10	Fine.	159	Σ. 2328
——	24 43,7	57 50 48	334·4	6	9 10	Very fine. } S. 703. 66° 9′ *np*	198	Σ. 2333
	46,4	— 52 0	332·8	5	9 10	Very neat star. } = 336·1. Dist. = 6″,433. One observation has it *sp*, the other *np*. The latter is the true one.	197	
——	25 9,1	51 26 38	302·0	10	9·10 10		200	Σ. 2338
1327	25 23,2	76 56 2	178·0	12	9 10		195	
1328	25 32,2	48 13 25	109·0	12	9·10 10·11		201	
1329	26 11,3	78 44 35	328·0	8	9·10 17	Very delicate.	196	
1330	29 12,4	59 32 17	262·1	5	11·12 = 11·12		197	
1331	30 52,4	75 4 2	210·0	30	6·7 11	Two more small stars *nf*.	195	
	31 1,6	51 22 8	——	—	———	*α Lyræ*. The small star not seen before and at sunset. Atmosphere unfavourable.	188	
——	31 —	—— 45	132·3	—	1 10	*α Lyræ*. ΔR.A. = 6ˢ,0. Well seen, and measured in broad twilight, just after sunset, and with a moon.	180	*Sh.* 272
	31 8,6	— 21 56	135·1	45	1 12	Excellent. Full illumination. Pos. mean of 135·0 and 135·3. *Sh.* 272. Pos. = 132·7; 42″,108.	196	
1332	18 31 44,2	65 29 15	224·0	18	8 11	Small star ruddy.	167	

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No. *h.*	Æ. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″				
1333	18 31 49,3	63 3 3	229·0	2	10 11	Power 320.	159	
——	32 5,2	59 22 31	283·4	9	10 13		198	Σ. 2359
1334	32 55,3	77 55 27	85·5	10	10 14		196	
——	33 9,3	65 26 30	183·9	4	9 10·11	Both ruddy. Neat.	167	Σ. 2364
1335	33 13,9	54 49 56	5·3	10	10·11 11		168	
1336	33 54,2	59 52 19	89·0 300	8 15:	10 12 ——	A and B } Pos. and dist. of C. es- A and C } timated from diagram.	158	
1337	34 29,4	58 34 48	174·9	6	9 12	S. ruddy. Requires good illum.	197	
——	34 42,8	59 51 49	192·8	11	9 10	A neat star.	158	Σ. 2367
1338	35 37,1	78 0 37	190·0	5	10·11 11	A star 8·9th mag. follows.	195	
1339	35 38,5	44 3 46	333·5	20	8·9 10	L. orange; S. yellow.	205	
1340	36 8,2	57 38 38	90·0	7	10·11 13		198	
1341	36 57,8	50 31 55	105	10	——	Pos. and dist. estim. from diagram.	201	
1342	38 45,6	46 40 44	182·8	10	9 14		202	
——	39 —	50 30 —	204·3	$2\frac{1}{2}$	——	ε *Lyræ*. *Sh.* 276. Pos. 205·9.	180	Σ. 2382
	——	——	202·2	—	——	ε *Lyræ*. A bad measure, being taken under most difficult circumstances. Angle between ε and 5 = 175·0.	201	
——	39 —	50 32 —	215·8	—	14 = 14	ΔR.A. = 3ˢ,5 :: (Inter. ε et 5 *Lyræ*)	200	*Sh.* 277
	——	——	217·0	—	15 = 15	ΔR.A. = 2ˢ,5. (To be preferred.)	201	
——	39 —	50 34 —	156·4	2	——	5 *Lyræ*. Position of the distant star *x*; ε and *x* = 137·0; 5 and *x* = 37·1 *Sh.* 278. Position = 159·9.	180	Σ. 2383
1343	39 7,7	62 50 33	121·5	3	11 12	Power 320.	159	
1344	39 24,7	74 55 32	203·8	10	9·10 10		195	
——	39 39,3	55 38 56	159·9	5	8 10	Fine. S. 705. Pos. 158·2; 4″,492.	168	Σ. 2390
1345	39 45,7	58 53 58	171·1	8	13 = 13		198	
1346	39 47,2	44 20 17	215·8	12	9 10		205	
——	40 17,7	44 3 41	304·1	8	8 10		205	Σ. 2395
1347	40 32,2	61 45 29	276·1	15	9·10 10		158	
1348	42 26,2	44 5 34	195·0	5	11 12		205	
1349	42 30,7	56 52 3	74·0	8::	9: 12:	Dist. and mag. estim. from diagram.	198	
1350	42 41,7	77 52 12	176·0	3	11 11	Very neat.	195	
1351	42 52,5	46 18 44	357·8 314·5	16 4	9·10 10 10 12	A and B } Triple. B and C }	202	
1352	18 43 27,1	60 23 8	234·6	6	8 9	Well measured. Bears a singularly bright illumination.	159	

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No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″				
			151·3	30	3 9	A and B		
	18 43 46,2	56 49 25	319·4	40	3 9	A and C } β *Lyræ.*		
			30::	50	3 9	A and D estim. from diag. }		
——							198	*Sh.* 281
			153·3	30	——	A and B }		
	— 47,8	—— 21	323·3	45	——	A and C } β *Lyræ.* *Sh.* 281.		
			16·8	60	——	A and D } Pos. 150·0.		
1353	46 22,3	78 54 3	212·2	5	9 10	Very neat.	196	
1354	47 0,6	53 50 38	187·0	8	10 10	Neat.	200	
1355	47 16,7	62 54 29	14·8	9	10 11	Clouded.	158	
1356	51 23,9	44 42 50	345·4	30	9 9·10	Mean of 344·6, 346·2.	206	
1357	52 8,5	44 22 36	210·8	16	8 12		205	
——	52 17,8	51 59 41	266·4	4	10 = 10	A star 8th mag., 2′ north. Struve's distant star of course seen, but not noticed in the obs.	200	Σ. 2427
1358	52 25,0	46 48 29	266·0	12	9·10 10	Another, 9th mag. precedes 75″.	202	
——	53 11,3	49 33 0	234·8	20	7 10		201	Σ. 2431
1359	53 25,8	78 37 25	180:	8	9·10 16	In middle of a cluster, class viii.	198	
1360	54 44,3	53 35 28	232·5	3	14 = 14	Very delicate. Good measure.	200	
1361	54 47,7	60 58 3	166·6	8	9 12	The chief star in a cluster.	159	
——	56 18,1	75 27 47	311·0	8	9 9·10		195	Σ. 2443
	— 18,4	—— 26	315::	6	10 = 10	Pos. estimated from diagram.	194	
1362	56 38,0	43 18 41	270·0	25	6 14	Hurried. Dist. evidently incorrect.	205	
	— 38,1	—— 4	269·0	50	5·6 15	P. XVIII. 299. Δ R.A. = 3ˢ,5.	206	
1363	57 52,9	107 2 34	323·5	3	13 = 13		162	
1364	58 5,5	45 47 14	204·5	1	10·11 11	A most elegant double star; chief of a small cluster. Pos. mean of 204·0, 205·1.	202	
1365	58 20,3	63 7 25	327·5	15	9·10 11	L. ruby red; S. green by contrast.	167	
——	59 24,7	50 7 55	100·0	15	8·9 10		201	Σ. 2453
——	59 53,6	51 43 18	193·7	15	9·10 = 9·10		200	Σ. 2456
1366	18 59 58,4	58 31 17	57·8	10	9·10 12		197	
——	19 0 57,7	57 45 34	327·6	2½	7 12	Very delicate. Small star hardly perceptible with 12 inches; mirror much tarnished.	198	Σ. 2461
	1 3,5	44 26 51	6·4	8	9.10 10	Is Σ. 2463; but the small star not noticed by Struve.	205	Σ. 2463
——			286·4	13	9·10 14			
	— 4,9	—— 20	5·7	7	9·10 10	A and B.	206	
			279·9	18	9·10 14	A and C difficult. Pos. mean of 281·2, 279·0, 279·5.		
1367	1 5,3	107 42 7	62·0	12	9·10 10·11	A and B } Triple.	162	
			315·0	15	9·10 17	A and C }		
1368	1 44,8	77 55 50	20::	5	10 15	A and B } Triple.	196	
			220::	10::	10 15	A and C }		

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No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″				
1369	19 1 52,6	53 20 38	124·7	4	11 11·12	Mean of 123·0, 126·4.	200	
——	2 5,4	59 28 8	86·0	6	10 = 10	Full illumination.	199	Σ. 2467
1370	2 20,7	49 25 20	278·5	15	8 13		201	
1371	2 54,2	75 48 22	95·2	10	9·10 10·11		195	
1372	2 57,7	65 35 35	174·4	10	10 13·14		167	
1373	3 28,3	108 23 37	227·5	9	10 11		165	
——	4 43,9	34 56 23	43·5	10	8 11	(Unless pos. = 32·3.)	212	Σ. 2479
1374	5 2,3	45 42 39	110·3 350 : :	8 15	9 15 9 17	A and B. A and C. Pos. estim. by diagram.	202	
1375	5 44,7	62 2 43	91·0	12	10 11		159	
——	5 50,4	59 56 32	321·5	—	————	No other particulars.	197	Σ. 2483
1376	6 47,7	74 55 17	120·4	6	8 12		195	
1377	7 28,7	42 55 21	357·0	30	7 16	Very difficult to measure.	205	
——	7 56,6	51 8 8	88·0	30	5 8	Hazy. *η Lyræ.*	200	Σ. 2487
	– 57,7	—— 15	88·0	30	5 9	*η Lyræ.* Δ R.A. = 4ˢ,6, 5ˢ,0. *Sh.* 291. Pos. 84·0.	201	
——	8 3,2 : :	106 18 35 : :	11·6	8	8 9	S. 715. Pos. = 15·5. Also, *h.* 596.	162	S. 715
1378	8 5,3	110 45 25	65·0	5	12 13		165	
1379	8 5,9	58 39 56	310·3	5	10·11 12	Power 240.	199	
1380	8 6,4	42 31 30	225·9	4	9·10 11	Difficult from difference of mag.	206	
1381	8 28,7 : :	106 18 25 : :	12·0	4	10 = 10		162	
1382	12 3,0	42 17 41	308·5	6	10 11·12		205	
	— 4,6	— 18 34	309·5	5	10 11		206	
1383	12 41,4	58 44 50	110·2	6	10·11 = 10·11		199	
1384	13 0,5	34 10 18	146·0	4	11 = 11	Neat.	212	
1385	14 13,5	46 16 4	205·3	3	11 16	Difficult.	202	
1386	14 16,7	42 16 56	327·8	6	10·11 10·11		205	
	— 17,1	— 17 10	326·8	7	11 11		206	
1387	14 28,1	45 55 50	137·4 279·1	20 5	8·9 10 10 13	A and B } The close star not noticed by Struve. B and C }	203	Σ. 2507
1388	14 54,2	60 6 50	214·5	14	9·10 12	The field full of small stars.	198	
——	15 10,4	80 48 15	185·5	7	8·9 = 8·9	Very neat.	196	Σ. 2510
1389	15 19,4	59 28 26	102·0	5	14 = 14		199	
1390	15 34,9	59 25 1	102·5	10	10·11 11		199	
1391	16 45,2	49 19 50	81·4	12	9·10 11		201	
1392	17 4,7	43 52 31	233·1	3	12 = 12	A very neat but delicate star.	205	
——	17 37,4	34 29 58	239·6	4	9·10 11	Pos. a mean of 240·0, 239·1.	212	Σ. 2516

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No. *h.*	Æ. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″				
1393	19 17 37,6	42 56 50	121·0	5	11 12		206	
1394	18 54,8	55 8 43	41·0	10	10 11		168	
1395	19 5,8	53 12 28	65·1	1½	10 = 10	Very fine, neat star.	200	
1396	19 32,2	59 51 48	89·0	5	12 12		198	
1397	19 33,7	56 41 56	152·2	3	12 12		199	
1398	19 33,7	56 39 16	161·0	6	10·11 12		199	
——	19 37,6	33 18 13	85·0::	15	9 11		212	Σ. 2526
1399	19 38,7	56 40 36	204·8	14	10 11	Unless R.A. = 19 28·7.	199	
1400	20 19,2	44 28 21	203·4	5	11 = 11	Insulated, but among many.	205	
1401	21 14,1	42 57 10	189·4	9	11 11·12		206	
——	21 51,9	81 3 25	232·0	6	10 11	Another double star follows.	196	*h.* 888 *h.* 889
1402	21 56,2	44 52 43	90·0	8	10 11		201	
1403	21 57,3	111 33 13	332·3	5	10·11 13		165	
1404	23 44,6	44 2 46	129·3	4	10 11	Neat. Pos. a mean of 129·4, 129.6.	206	
	— 45,0	— 3 35	130·0	4	10 11	Mean of two good meas. 129·4, 130·6.	205	
1405	23 45,2	49 29 10	50·0	10	10 11		201	
1406	23 52,7	57 1 58	314·6	6	11 = 11	A and B } C is distant.	198	
			312·2	—	11 13	A and C }		
1407	24 1,6	60 53 3	276·3	5	10 11		159	
1408	24 1,9	41 15 49	252·8	5	10 11		207	
1409	24 52,4	59 15 1	358·0	9	9·10 10		199	
——	25 14,3	53 38 43	66·1	3½	10 11	Neat. Points nearly to a star 10th mag. S. 719. Pos. = 56·5; dist. 6″,295. A strong suspicion of change in this star.	200	Σ. 2538 S. 719
1410	25 20,2	49 30 45	219·5	2	14 15	Power 240. Delicate; but good measure.	201	
1411	25 46,8	36 17 8	90·0	15	9·10 10·11		212	
1412	25 55,8	111 12 2	332·2	6	10 11	Neat.	165	
1413	27 19,9	57 32 31	214·4	6	10 10·11		199	
1414	27 20,0	54 10 57	22·8	12	10 11	Neat.	168	
1415	27 39,4	57 30 32	16·5	4	11 13	A and B } Form nearly an equi-	199	
			76·5	4	11 14	A and C } lateral triangle.		
1416	28 4,7	58 30 18	253·5	5	10 11		198	
1417	28 8,1	106 12 49	——	2	12 = 12		162	
1418	28 37,8	40 20 34	8·1	25	9·10 10		207	
1419	28 46,9	42 15 0	37·6	3	11 12		206	
	— 49,2	—— 46	32·8	4	10·11 11		205	
1420	19 28 52,2	33 45 6	337·9	10	10 11		212	

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No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
——	h m s 19 29 57,7	° ′ ″ 65 21 50	° 97·6	″ 8	·9 10	Struve says, "In acervo." The cluster is, however, considerably distant from the star, and is described in my journal as very large, loose, and straggling. — Class viii.	167	Σ. 2548
1421	30 6,9	54 46 9	229·0	12	10 11		168	
1422	30 17,7	35 19 33	283·8	14	10 11		212	
1423	30 25,3	61 3 3	136·3	12	7 15	Good measure.	159	
1424	30 49,2	57 28 33	206·2	4	11 11		198	
——	30 59,1	106 40 16	13·6 (A and B)	25	6 8	A and B, A and C: Triple. 2302 A.C. This is no doubt my No. 559; but now first observed as triple. In the former obs. contrasted colours are noticed.	162	*h.* 599
			273·0 (A and C)	15	6 18			
1425	31 11,7	57 28 28	239·5	5	10 11		198	
1426	31 59,3	49 12 35	100·0	4	12 13	Power 240.	201	
1427	32 21,0	44 4 41	283·4	5	11 11	In southern part of a fine cluster of perhaps a hundred stars.	205	
	———	——— 0	286·7	3	11 11 +	In a cluster.	206	
1428	33 13,4	41 6 29	270·0 (A and B)	40	7·8 12	A and B, A and C: Struve's 2559, described by him as cl. iv. and vi. (5), (11), and (10); but he has overlooked the small star, which makes C double of the second class.	207	Σ. 2559
			277·3 (A and C)	15	7·8 13			
			275 : : (C and D)	6	13 15			
——	33 53,7	63 14 56	319·3	14	8 11		167	Σ. 2561
1429	34 19,4	34 9 3	242·8	4	11 11 +		212	
1430	34 54,7	57 10 10	157·2	12	10 11		198	
1431	34 55,8	48 54 55	340·6	12	10 10		201	
1432	36 7,6	74 55 57	314·8	10	8·9 10·11		195	
——	36 54,3	79 37 25	273·0	5	8 11	Fine. H. I. 91. S. 723. Pos. 276·5.	196	Σ. 2570
1433	37 3,2	57 58 58	302·5	12	10 11		198	
1434	37 25,3 :	60 8 23	291·0	3	11 12		159	
1435	39 0,9	77 52 36	293·0	8	11 11·12	In the milky way.	194	
——	39 4,4	56 47 16	141·9	2½	8·9 = 8·9	Fine. Pos. mean of 140·0, 143·0, 142·8, taken with an aperture of 6 inches. *Sh.* 300. Pos. 326·2 = 146·2. Perhaps changed in pos.	199	Σ. 2576
	— 4,8	— 46 21	145·0	3	9·10 = 9·10	Fine.	168	
1436	39 17,2	75 15 32	303·5	6	9·10 10·11		195	
1437	39 47,2	48 56 31	247·2	7	9 14	Power 320.	201	
——	19 39 57,7	56 40 10	77·5	20	6 8	χ *Cygni*. Fine doub. star. Good meas.	198	Σ. 2580
	— 59,3	— 39 21	78·4	20	5·6 8·9	χ *Cygni*. H.IV.11.*Sh.* 305. Pos. 73·3. N.B. An erratum in Mr. S.'s Index Cat. A very remarkable difference.	168	

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No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
1438	h m s 19 40 32,8	° ′ ″ 34 37 45	86·5	12″	9 · 12		212	
1439	41 10,2	34 33 48	195·0	30	8 11	L. yellow; S. bluish.	212	
1440	43 23,2	75 53 37	51·0	12	10·11 11		195	
	— 26,4	— 54 36	54·5	12	11 11·12		194	
1441	43 27,2	59 58 28	42·2	5	10 15	A and B } Pos. and dist. of C esti-	198	
			190 : :	10::	10 11	A and C } mated from diagram.		
1442	43 27,2	75 55 17	275·5	5	10 10·11	In field with the last but one.	195	
	— 30,4	— 56 6	278·0	6	10 11		194	
——	44 10,4	80 4 20	301·2	12	8 11		196	Σ. 2590
1443	44 23,2	65 4 10	195·0	15	10 10 +		167	
1444	44 27,8	48 59 25	288·0	3	13 14		201	
1445	44 58,4	59 17 51	182·1	12	7 10		199	
1446	45 1,5	109 41 16	53·4	12	9·10 11		165	
1447	45 16,8	56 21 21	337·0	12	9 13	A and B } Triple.	168	
			90·0	12	9 15	A and C }		
1448	45 53,3	52 24 14	170·0	6	10 = 10		200	
——	45 58,3	35 46 18	145·1	12	9 11	A bad measure gave pos. 152·5.	212	Σ. 2598
1449	46 39,2	57 23 18	286·5	4	10 13		198	
1450	46 47,1	60 9 18	251·6	3	11 11		159	
1451	47 38,4	58 16 11	229·0	10	10 12		199	
1452	48 24,7	49 22 5	228·8	5	11 12		201	
1453	48 34,2	65 47 55	227·1	23	9 = 9	The preceding star reddish.	167	
1454	48 48,8	107 49 10	236·5	10	9 13·14		165	
1455	49 54,3	55 21 21	170·0 :	20 :	4·5 18	A and B } Triple.	168	
			332·0	30	4·5 18	A and C }		
1456	51 18,8 :	46 10 20	51·8	10	9 11	Excellent measure.	203	
1457	51 33,6	52 32 18	221·7	8	10 = 10		200	
1458	51 59,9	79 16 25	311·8	20	9 = 9	Good measure.	196	
1459	52 5,4	75 43 6	108·5	3	12 13	In the milky way.	194	
1460	52 7,1	43 40 10	90·0	2½	11 11 +		206	
	— 8,5	—— 11	90·0	3½	11 11·12		205	
1461	52 40,4	58 7 46	130 : :	4	10 12	Angle estimated from diagram.	199	
——	52 46,7	43 6 46	204·2	5	9·10 = 9·10	Both ruddy. Very satisfactory measure. See the next star but one. S. Pos. 26·6 = 206·6.	205	Σ. 2611 S. 731
1462	52 59,3	64 30 23	22·6	27	8 10		167	
——	19 53 45,4	43 5 37	26·4	4	10 = 10	Sky perfectly clear. This is most probably the same with the last but one, with a mistake in the minute of R.A.	210	S. 731 ?

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No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″				
1463	19 54 17,6	44 39 5	316·1	8	11 12		206	
1464	54 28,3	39 47 44	31·3	13	8 17	Small star requires power 240 to be seen. The moon illuminates the wires.	207	
1465	54 40,4	106 38 19	113·2	3	11 12		162	
——	54 54,6	75 53 12	264·0	4	6·7 10	In milky way.	195	Σ. 2616
1466	54 58,2	79 12 25	339·0	5	13 = 13	The middle star of a cluster 8th class.	196	
1467	55 5,3	49 32 43	127·0	7	10 10 +		201	
1468	55 29,2	50 10 18	275·4	8	9 12		183	
1469	55 57,4	75 53 6	217·0	14	10 = 10	In the milky way.	194	
	56 0,5	42 13 45	67·1	3	9·10 = 9·10	Fine.	210	
——	56 —	42 13 —	67·0	4	9·10 = 9·10	Very neat.	205	Σ. 2619
	56 —	42 13 —	68·2	4	9 = 9	A and B } Struve's 2619; the	206	
			280·0::	12::		A, B, and C } small star C not noticed by him. Pos. and dist. of C. estimated from diagram. Perhaps too remote.		
1470	57 30,3	52 8 43	332·5	25	8·9 10	L. ruddy yell.; S. contrasted green.	200	
1471	57 56,4	58 15 46	1·5	30	6 11		199	
1472	58 12,8:	46 28 50	44·5	10	9·10= 9·10	In the cluster vii. 59.	203	
1473	58 25,3	63 12 26	143·3	7	10·11=10·11		167	
1474	58 32,1	60 18 18	350·4	8	10 11	Power 240.	159	
1475	58 32,7	49 11 45	271·0	5	11 13		201	
1476	58 33,4	77 36 18	79·0	8	10 11·12		194	
1477	58 33,4	77 50 —	265·0	12	8 12		194	
1478	58 39,1	46 28 40	220·0::	4	11 = 11	Angle estimated from a doubtful diagram.	203	
1479	58 42,0	64 53 51	1·5	30	9 12	Cloudy.	172	
1480	59 15,3	35 12 38	98·0	12	9·10 13	A star 8th mag. *nf.*	211	
——	19 59 30,9	54 42 17	299·9	9	8 9	In a cluster of 5 bright and many small stars. *Sh.* 314. Pos. = 300·9.	168	Σ. 2630
1481	20 0 20,4	41 5 39	8·4	12	11 = 11	A and B } Triple.	207	
			268·0:	20	11 = 11	A and C }		
——	0 41,4	57 54 11	99·5	5	9 11·12	Either this or the next but one is Struve's 2633. This appears most like his description; but a doubt may arise.	199	Σ. 2633
1482	0 50,3	77 21 47	120·0	5	9·10 12		195	
1483	1 17,7	57 54 28	106·3	8	8 10	Quadruple. Two very small stars precede.	198	
1484	1 41,2	105 59 2	335·9	6	10 13		162	
1485	20 2 59,4	57 5 21	276·2	3	9·10 10	Pos. mean of 276·0 and 276·4. Good measure.	199	

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No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
1486	h m s 20 2 59,7 : :	79° 19′ 25″	232°·0	7″	11 = 11	In the milky way.	196	
1487	3 4,0	49 45 45	290·2	6	10 13		201	
1488	4 23,3	44 42 20	278·0	4	10·11 = 10·11		203	
1489	4 51,9	54 39 36	236·3	13	9·10 10	In a cluster of stars 10...13 mag.	168	
1490	4 58,4	54 39 4	359·8	2	11 13	Is directly pointed to by the last.	168	
1491	5 12,7	48 59 45	301·6	2½	10 = 10	A very neat double star.	183	
——	5 28,4	40 40 29	117·2	5	9 10	Neat.	207	Σ. 2648
1492	5 58,1	61 17 33	58·8	15			159	
1493	6 2,2	104 52 58	339·8	7	10 13		162	
1494	6 10,3	78 28 15	3·0	3	10 11		196	
1495	8 17,0	43 46 17	332·8	20	4·5 17	31 *Cygni*. Difficult from faintness of the small star. This is also H. VI. 10, and S. 742; but the small near star here described has escaped the notice of both my Father and Mr. South.	205	
——	8 27,8	48 24 45	33·2	9	7 11	Pos. a mean of 34·2 and 32·3.	201	Σ. 2657
——	8 36	103 4 —	134·8	6	2·3 15·16	α^2 *Capricorni*. The small star is brighter than 18th mag., as set down in my former catalogue. The position differs greatly from my former estimation; but this is satisfactorily accounted for by the proper motion of the large star. See Piazzi.	162	*h.* 608
1496	9 30 : :	65 41 —	45	12	8 10	R.A. inaccurate. Pos. estim. 45 *nf.*	167	
1497	9 57,9 :	46 50 55	308·5 251·4	2½ 14	9 11 9 10	A and B } Is Struve's 2659, IV.; A and C } but he has overlooked the close star which constitutes it double of 1st class. Power 240. Full aperture.	203	Σ. 2659
1498	10 45,8	79 18 39	209·0	10	10 11	Unless pos. = 29·0.	196	
1499	11 2,2	64 53 18	358·4	15	8 13		172	
1500	11 4,9	56 59 21	110·8	5	10 12	Two more 13th mag., dist. about 15″	168	
1501	11 37,8	61 59 13	359·5 2·3	5 —	10 11	A and B } Double-double. C and D }	159	
——	11 38,2	77 31 7	323·0	35	8 8·9	S. 744. Pos. 322·9.	195	Σ. 2664
——	11 58,6	44 53 20	43·1	8	10 = 10	S. 746. Pos. 226·5 = 46·5.	206	Σ. 2667
——	— 23·0 : :	— 52 51	44·0	12	9·10 = 9·10	The R.A. may be very erroneous.	210	Σ. 2667
1502	12 35,9	78 5 45	327·3	5	10 12		196	
1503	13 2,8	48 5 0	82·0	10	10 11		201	
——	14 46,2	77 11 28	336·0	2	10 11	An exquisite double star.	174	Σ. 2673
——	20 14 49,7	77 11 40	0,0	12	9·10 11·12	Close to the foregoing.	174	Σ. 2674

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No. *h.*	Æ. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″				
1504	20 15 20,3	64 14 53	239·7	12	7 13	A and B	172	
			250::	25::	7 12	A and C estimated from diagram.		
1505	15 27,8	46 55 56	110·8	15	9 11		203	
	— 29,5	— 56 39	109·8	10	8 12		202	
1506	16 36,8	54 50 23	199·5	6	8·9 14	A and B.	168	
			191·1	20	8·9 12	A and C.		
1507	16 43,2	75 54 12	67·0	5	10 10·11		195	
1508	16 44,2	75 49 7	70::	5::	———	Estim. from diagram. L. strongly suspected to be D.	195	
1509	16 44,4	80 17 5	182·0	20	9 9·10		196	
1510	16 57,7	42 45 23	151·9	3	10 = 10	A very neat star.	210	
	— 58,9	— 46 10	154·0	4	10·11=10·11		206	
1511	17 2,7	42 45 53	244·3::	10	11 12	Pos. marked as doubtful (??) for some reason. Perhaps micrometer touched.	210	
	— 3,4	— 46 40	237·5	10	11 12		206	
1512	17 20,7	61 31 3	166·5	4	10·11=10·11	A coarse double star 8th m. precedes.	159	
1513	18 12,5	44 1 46	322·0	8	9 11		205	
1514	19 4,8:	45 4 50	212·8	9	9 12		203	
1515	20 15,4	57 4 56	24·4	10	10 11		199	
1516	20 54,5	35 51 28	147·5	20	7 10		212	
1517	21 17,2	60 9 11	105·0	8	10 10·		177	
	— 19,2	—— 53.	103·2	5	10 = 10		159	
1518	21 20,7	44 54 41	86·5	10	10 10·11.	Δ R.A. = 1ˢ,0.	205	
1519	21 59,1	63 3 15	234·3	8	10·11 13		172	
——	22 17,2	33 54 38	117·5	25	8·9 9·10	*Cephei* 37. S. 753. Pos. 119·6.	211	Σ. 2687
1520	22 26,7	64 23 45	332·5	13	11 12		167	
1521	22 31,4	59 45 51	188·0	12	9·10 11·12		199	
——	23 3,4	79 18 51	256·5	18	7·8 8	A and B } The small star not noticed by Struve. Sh. 325. Pos. 255·6. Also, *h.* 269, and H. III. 16; but none of the former observations take notice of the small star.	196	Σ. 2690
			121·5	20	7·8 15	A and C }		
1522	23 4,0	31 33 56	93·4	13	10 14		214	
1523	23 21,8	49 33 50	357·4	15	9·10 10	Capital measure.	201	
——	23 22,3	52 26 18	210·7	15	8 = 8	Fine.	200	Σ. 2691
1524	23 38,4	39 55 49	129·9	4	10 11·12	Elegant.	207	
1525	23 43,1	50 12 5	230·7	7	10 10 +	A very pretty double star.	183	
1526	24 3,9	55 12 31	154·4	8	10 = 10	Neat.	168	
1527	20 24 5,2	76 36 32	294·5	3	10 = 10	Very neat.	195	

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No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
1528	20 h 24 m 11,2 s	78° 13′ 45″	237°0	8″	11 12		174	
1529	24 19,6	96 47 29	114·0	25	7·8 11	L. red.	185	
1530	25 34,8	48 51 0	243·1	12	10 10·11	A third star 12th mag. near.	201	
1531	25 35,8	51 14 18	313·7	4	10 11		200	
1532	25 42,9	58 53 44	306·6	10	11 12		199	
1533	25 59,6	44 53 46	188·6	6	11 11·12		205	
1534	26 5,4	41 20 49	—	—	———	ω^3 *Cygni*. Quadruple, if not quintuple. All distant, 6th class.	207	
1535	26 33,7	57 11 53	108:: (A and B) 240·3 (A and C)	7 12	9 13 9 11		198	
1536	26 38,3	63 36 23	112·9	6	12 13	Neat.	167	
1537	26 46,4	105 51 32	194·8	1¾	10 = 10	Close. Power 320.	162	
1538	27 2,3	56 56 41	128·4	3	10·11 12	Neat.	168	
1539	27 7,7	49 15 51	201·4 (A and B) 70:: (A and C)	8 15	10 11 ———	A fourth more dist. *sf*.	183	
1540	27 10,9 — 11,2	34 23 18 — — 48	345·2 347·2:	15 15	8·9 12 9 12	A third star, 13th mag. dist. 25″.	212 211	
1541	28 0,6	43 31 41	268·0	4	10 12		210	
1542	28 15,4	57 36 6	227·4	10	9·10 11		199	
1543	28 22,2	57 12 58	206·2	15	9 = 9		198	
1544	28 31,3	62 41 6	237·0	3	11 = 11		177	
1545	29 30,5	34 17 18	175::	20	10 = 10	Pos. estimated from diagram.	212	
——	29 34,3 — 35,6	75 59 0 — — 17	346·5 (A and B) 107·7 (A and C) 339·4	20 18 45	5 12 5 14 4 11	β *Delphini*. Triple. β *Delphini*. (A strange difference.)	174 195	Σ. 2704
1546	29 52,0	34 12 18	255·4	20	9·10 10		212	
1547	29 55,2	60 45 8	16·4	12	10 11		159	
1548	30 7,3	52 10 43	252·8	6	11 11·12		200	
1549	30 36,8	42 49 58	52·3	4	11 14		210	
1550	30 46,5	68 11 16	220·5	4	10 11		166	
1551	30 49,2	34 11 8	250::	20	9·10 10	Pos. estimated by diagram.	212	
1552	30 53,7	34 14 18	260::	20	9·10 10	Pos. estimated by diagram.	212	
——	30 53,9	57 13 46	263·3	2½	8·9 9·10	Pos. mean of 263·2 and 263·5.	199	Σ. 2705
1553	31 37,3	50 21 40	99·0	4	10·11 11		201	
1554	31 44,3	74 41 27	278·0	35	5 6·13		195	
1555	20 31 47,9:	45 31 32	357·2	10	9·10 10		203	

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No. *h.*	Æ. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
1556	20 h 31 m 59,7 s	34° 39′ 3″	250°0	4″	10 11	Two more 12th mag. follow at 25″ or 20″.	211	
1557	32 13,3	63 20 40	207·2	6	11 11		167	
1558	33 14,4	42 5 34	200·9	5	10 12		207	
——	34 26,9	77 52 20	270 : :	10::	10 : : 10+ : :	All estim. from diagram S. 760.	196	Σ. 2718
1559	34 29,2	28 9 52	121·2	16	9 14	Quintuple.	218	
1560	35 9,3	54 42 21	246·6	5	11 13	A and B	168	
			70 : :	10	11 14	A and C		
1561	35 12,2	61 57 58	275·0	4	10 11	Fine.	159	
	— 13,4	— 58 31	271·0	5	10 11		177	
1562	35 14,3	35 21 18	165·6	18	9·10 10		212	
1563	35 36,4	44 18 54	105·8	—	1 12	*α Cygni.* Δ R.A. = 7ˢ,5. 1° mistaken.	210	
	— —	45 19 40	103·5	—	2 12·13	*α Cygni.* Δ R.A. = 7 ,0.	203	
	— —	——	——	—	1 12	*α Cygni.* No measure or estim.	189	
1564	35 36,7	74 32 27	35·2	8	10 10·11		195	
1565	35 48,6	67 36 51	72·8	20	9 10		166	
1566	35 49,8	78 6 15	70	5	10 13	Is close to the nebula iii. 219, which precedes to south. Pos. est. 20 *nf.*	196	
1567	35 53,5	105 37 56	345·3	25	8·9 11		162	
1568	36 16,9 :	54 41 21 :	48·1	5	10 13		168	
1569	36 40,6	31 38 11	309·8	3	10·11 11	Careful measure.	214	
1570	36 55,5	33 36 18	81·2	10	11 = 11		211	
1571	37 16,7	49 5 5	58·2	2½	10·11 = 10·11	Neat.	201	
1572	38 9,8	51 15 58	278·3	12	10 11		200	
——	38 16,6	74 42 37	356·2	4	9 = 9	Or 8·9 = 8·9. H. II. 66. Also S. 764. Pos. = 355·0.	195	Σ. 2725
1573	38 19,2	49 56 48	266·4	2½	14 15	A double double star. A curious couple.	183	
1574	38 21,2	49 55 48	277·8	3	13 14		183	
——	38 36,2	59 54 28	56·5	5	5·6 10	52 *k Cygni.* S. 762. Pos. = 57·3.	159	Σ. 2726
	— —	——	70 : :	7	5 13	*k Cygni.* Suspicion of variability in the small star. Pos. estim.	178	
	— 38,9	59 53 56	——	—	——	*k Cygni.*	199	
1575	40 36,3	51 47 2	49·8	10	10 11		200	
1576	40 47,5	66 20 51	52·2	3	11 12		166	
1577	41 47,8	77 43 10	255·5	12	8·9 10		196	
1578	41 48,1	77 16 57	308·0	8	10 11		195	
1579	42 35,6	63 26 14	300·7	3	10·11 = 10·11	Elegant.	172	
1580	42 53,0	34 44 38	249·1	4	9·10 12		212	
1581	43 7,4	44 30 40	173·3	14	5·6 11		203	
1582	20 43 18,4	52 5 48	328·0	25	9·10 12	L. red.	188	

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No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″				
1583	20 43 20,5	28 0 12	75·5	12	10 12		218	
1584	43 59,9	42 33 5	220·6	3½	10 12		210	
1585	44 45,2	75 11 7	190·0	6	9 11		195	
1586	45 29,8	54 54 16	267·3	10	7·8 12·13		168	
1587	45 37,6	35 46 33	288·5	4	11 12	Thick fog.	211	
1588	46 19,1	27 40 47	33·5	18	9·10 12		218	
1589	46 25,1	62 34 43	——	—	10 10 +	A neat double star.	159	
1590	46 48,0	107 10 10	244·3	4½	10 11	Fine.	165	
1591	47 15,9	44 24 22	124·0	4	11 12	A star 7th mag. dist. 7′ *nf.*	210	
1592	47 29,1	78 5 15	22·0	60	5 13	χ *Delphini.* A third precedes.	196	
1593	48 37,2	77 39 10	226·1	3	10 11	Neat. It can scarcely be Struve's 2736, whose magnitudes are (7) and (8), yet the places agree very nearly.	174	
1594	48 42,3	43 4 41	48·7	6	10 11		209	
1595	49 0,4	32 54 58	327·0	8	11 11 +		212	
1596	49 6,1	51 37 26	285·6	10	9·10 11		200	
1597	49 45,8	43 16 55	132·5	10	10 11	Between the cluster VIII. 76, and a star 7th mag.	210	
1598	50 11,5	68 27 3 ::	141·1	5	10 10·11		166	
1599	50 20,2	62 37 13	219·7	7	9·10 11		159	
1600	51 10,8	52 6 2	157·7	14	10 10·11		200	
1601	53 0,6	53 35 40	147·0	4	10 10·11	Neat.	188	
——	53 6,5	29 5 52	332·8	5	9·10 11·12	Mean of 331·2, 333·4, (321·6 rejected).	218	Σ. 2740
——	53 9,9	40 12 4	30·2	—	——	230 (Bode) *Cygni.* H. I. 97. S. 770. Pos. 32·9. Most beautifully defined with 240. Pos. a mean of 28·9, 32·8, 29·0.	207	Σ. 2741
1602	53 51,2	29 18 21	94·8	8	9 10·11		214	
1603	53 59,4	80 23 30	119·0	12	10 11		196	
——	54 2,3	43 8 11	351·6	16	6 11	A and B } The small star not noticed in Struve's catalogue.	209	Σ. 2743
			143·8	20	6 13	A and C }		
1604	54 26,6 ::	41 28 24 ::	129·0	18	10 10		208	
1605	55 10 ::	36 10 50 ::	200 ::	—	——	No further particulars.	212	
1606	55 20 ::	36 6 50 ::	——	—	——	A double star close to the neb. I. 192.	212	
	55 26,7	36 7 43	185·1	12	9·10 10	In contact with a large neb. I. 192.	211	
——	55 43,6	52 59 40	79·5	4	9·10 = 9·10	Fine.	188	Σ. 2747
——	55 48,6	51 9 43	296·6	15	8 10	L. orange, S. indigo. Also, *h.* 613.	200	Σ. 2748
1607	20 56 28,4	29 10 37	102·2	8	9 11·12		218	

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No. *h.*	*R.* 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
1608	20 56 42,9	78° 14′ 55″	256°·2	5″	7 11	A star 14th mag. in the same line prolonged, and another 15th mag. nearly in the opposite direction.	196	
1609	56 45,2	61 59 13	219·6	5	10 = 10	Very elegant. Pos. mean of 219·7, 219·5, taken with 320, which shews it beautifully.	159	
——	57 24:	34 2:	343·4	1½	8 = 8	Exquisite with 9 inches aperture, and power 160.	212	Σ. 2751
1610	57 29,4	54 32 16	256·1	6	11 14		168	
——	59 9,3	75 16 50	1·4	20	8 11	Cloudy.	174	*h.* 275
——	59 16,4	52 4 49	90·0	16	6 6 +	A very splendid object. (Is 61 *Cygni*.)	188	Σ. 2758
	— 16,8	— 5 8	89·5	14	7·8 = 7·8	Both fine yellow. (61 *Cygni*.) *Sh.* 329. The motion of this star regularly maintained.	200	
——	59 24,9	58 13 44	316·0	15	9 10		199	Σ. 2759
1611	59 40,1	62 24 38	304·8	8	11 11 +		178	
——	20 59 59,1	66 12 41	114·2	4	9·10 10	Fine.	166	Σ. 2761
1612	21 0 5,5	106 59 19	143·8	4	10 11		162	
1613	0 41,3	49 8 46	1·0	10	9·10 11·12	In cluster viii. 57.	180	
1614	0 50,3	56 18 33	264·7	6	11 12·13		168	
——	1 25,1	60 29 1	303·6	3	6 10	II. 97. S. 775. Mr. South's angle is 45° 12′ *np*. differing 12° from mine, in whose reading there is, therefore, probably a mistake of 10°.	177	Σ. 2762
1615	1 26,1	45 26 3	92·5	6	11 12		204	
——	1 42,8	28 31 37	303·5	12	8 8·9	Pos. mean of 304·9, 302·5, 303·0.	218	Σ. 2764
	– 43,7	— 32 1	302·1	12	9 9·10	Too distant for class ii., which Struve places it in. S. 777. Pos. 302·5.	217	
——	2 35,7	31 41 16	250·0	4	10 10 +		214	Σ. 2766
1616	2 44,7	59 40 38	279·3	4	10 11	A third *nf* and others near.	198	
——	2 58,6	96 30 27	195·0	5	8 14	Delicate. II. (7) and (9) according to Σ.	185	Σ. 2768
1617	3 13,9	111 52 9	85::	——	———	A small double star, closely following a star 6th mag., whose place is that set down.	165	
1618	3 50,4	46 41 20	172·0	15	9·10 14	Not noticed by Struve as double, though seen by him.	203	
——	3 59,4	46 41 0	113·5	2½	10 10 +	Struve's 2773. I. (8) (9), *Duarum sequens*. The preceding is the double star above.	203	Σ. 2773
1619	4 21,9	76 9 37	170·0	5	9 11	Sextuple. C = D = 14ᵐ, E = 15ᵐ, F = 16ᵐ. E is *np*, dist. 10″ or 12″, F is *sf*, dist. 15″ or 20″. C and D form a close double star *sp*.	195	
1620	21 4 22,4	77 9 35	175·8	4	A 10 B 11	Double double. Can this	174	
			330::	5::	C 13 D 14	be the same with the foregoing, with a wrong degree, and not so distinctly seen?		

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No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
1621	21 h 4 m 23,2 s	35° 38′ 58″	150°0	11″	9 14		212	
1622	5 10,9	35 30 3	293·8	8	10 11		211	
1623	5 43,3	53 22 28	332·3	10	10 = 10		200	
1624	6 4,1::	42 2 24::	190·2	11	9 12	Places ill determined in this sweep.	208	
1625	6 55,2	42 21 41	91·0	7	11 11 +		209	
1626	7 8,1	66 15 46	167·4	9	10 11	Neat.	169	
——	7 32,0	30 42 56	45::	1	——	Elongated with 240. ? if divided.	214	Σ.2780
1627	7 46,9	58 1 56	182·2	2½	13 14		199	
1628	8 9,4	58 6 51	254·5	10	9·10 11		199	
——	9 17,4	32 24 36	37·0::	2	10 10·11	Hurried.	214	Σ.2783
1629	9 25,4	44 4 31	78·8	10	10 11		209	
	− 26,9	—— 43	77·4	12	9·10 10		210	
1630	9 42,2	33 39 18	124·3	15	9·10 11		211	
	− 44,7	—— 58	125·2	15	9·10 10		212	
1631	9 44,8	39 27 49	5·0::	30::	7	A coarse double star.	207	
1632	10 44,2	62 16 54	45·4	4	10·11=10·11		177	
	— 44,2	— 17 38	46·2	5	11 = 11		178	
——	10 55,4	55 48 33	221·0	10	5 13	A and B } υ *Cygni.*	168	*h.* 932
			180·8	14	5 13	A and C }		
1633	11 25,9	42 41 6	240·0	8	10 11	Unless Pos. = 60·0.	209	
1634	11 50,6	47 57 43	133·4	25	9 9·10		204	
1635	12 33,2	42 55 37	13·0	13	10·11 13		210	
1636	13 59,3	62 48 42	6·7	3	10·11=10·11		177	
——	14 52,1	97 18 9	85·9	35	8·9 9	Δ R.A. = 2ˢ,5. S. 788. Pos. = 83·5.	185	S. 788
1637	15 21,4	58 45 56	105·7	8	9 12		199	
1638	15 42,6	62 46 43	332·1	6	9·10 12	Neat. This is *possibly* Struve's No. 2792, with 1° mistake in P.D. on the part of one observer or the other.	178	
1639	15 43,2	46 35 39	104·5	5	11 12		204	
1640	16 12,6	46 34 33	54·0	6	10·11 11·12		204	
1641	16 20,0	66 27 1	327·5	30	6 14	A.C. 2541.	166	
——	16 59,3	30 2 54	118·0	1½	10 10 +	It agrees in place and in closeness with Struve's 2795, but hardly with his description, "inter plures exiguas maxima," as there are two stars 8th mag. and one 7th mag. just preceding, and this follows unnoticed.	214	Σ.2795
1642	17 2,2	35 40 18	177·5	13	10 11		212	
1643	21 17 48,1	41 16 34	24·0	15	10 12	Places ill determined in this sweep.	208	

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No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
——	21 h 18 m 31,6 s	77° 2′ 30″	216°·7	2″	9·10 11	Fine. Struve's magnitudes are (6·7) (8). S. 789. Pos. 213·5.	174	Σ. 2797
1644	18 33,1	42 42 26	122·2	20	9 11	The chief star of a poor cluster.	209	
1645	19 3,4	40 29 29	38·2	7	10 11·12		207	
——	19 19,9	57 28 26	20::	12	10 11	Pos. estimated by diagram, is my 935, no doubt; but in one or other obs. the degree of P.D. is mistaken.	199	*h.* 935
——	20 2,2	25 48 20	146·9	7	10 11	Pos. mean of 144·8, 149·0.	221	Σ. 2798
1646	20 49,8	47 29 10	124·3	12	9 13	Pos. mean of 124·2, 125·0, 123·8.	203	
1647	21 14,5	68 33 6	179·4 30 134·8 31		6 12 6 14	A and B A and C	166	
1648	22 33,7	32 56 28	26·4	4	12 12	Clouding over, and fog.	211	
1649	22 33,8	33 47 23	205·7	6	10·11 10·11		212	
——	22 35,5	96 19 9	322·8	20	3 15	β *Aquarii*. Delicate. Angle by two measures exactly agreeing. Called, by mistake, β *Aquilæ* in my former observations.	185	*h.* 936
——	22 43,1::	40 52 14::	260·0	8	10 10·11	Moon troublesome.	208	Σ. 2800
	— 50,8	— 51 59	262·4	10	9·10 10	? This great difference of the right ascensions in the two observations.		
1650	22 44,7	30 59 31	187·0	13	6 12	L. orange red.	214	
1651	22 45,5	42 34 50	328·0	9	10 11		210	
1652	23 2,8	56 40 21	46·6	8	10·11 11		168	
1653	24 8,9	53 52 29	202·5	12	10·11 12		188	
1654	24 14,4	29 8 21	26·6	6	9·10 10		217	
1655	24 16,5	75 54 5	22·4	12	9·10 11		174	
1656	24 37,5	25 19 35	147·8 11 13·5 15		10 12 10 11	A and B A and C Triple.	221	
1657	26 —	42 19 —	10::	10::	———	In a cluster. (Estimations.)	209	
——	26 25,3	20 11 0	253·1	15	4 6	β *Cephei*. L. white, S. blue. Pos. mean of 254·2, 251·9, 253·3. *Sh.* 330. Pos. 250·4.	223	Σ. 2806
1658	27 33,7	34 37 23	147·0	8	10 12		211	
	— 41,5	— 38 3	150·4	8	9·10 11	The same star, but one or the other 5^s *mistaken* in the time.	212	
1659	27 50,4	32 5 26	312·2	9	9·10 10	Pos. mean of 313·0, 311·5.	214	
1660	28 5,2	44 46 33	217·8	3	12 13	One of a cluster of 8th class.	210	
1661	28 19,8	64 23 14	89·0	7	10 = 10	Neat.	167	
1662	28 34,5	98 29 39	126·0	10	10 12	In field with, and *np* ξ *Aquarii*.	185	
1663	21 28 37,0	98 31 9	68·3 7 90:: 15		10 13 ———	A and B In field with, and *np* A and C ξ *Aquarii*.	185	

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No. *h.*	Æ. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.		Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″					
1664	21 28 41,9	57 25 44	271·0	4	10	10		199	
1665	29 6,8	24 37 49	72·6	18	9·10	11	Pos. mean of 72·8, 72·4.	221	
1666	29 9,3	47 12 50	233·2	6	11	11 +		203	
1667	29 30,5	77 33 30	198·3	12	10	11		174	
——	29 36,2	31 38 46	292·8	15	9·10	9·10		214	Σ. 2810
1668	29 40,1	67 5 28	34·2	7	10	12	Neat.	166	
1669	30 13,8	40 16 9	239·8	12	8	13	L. white, S. red.	207	
1670	30 48,6	60 47 15	88·0	6	10·11	=10·11		178	
——	30 49,0	33 16 28	272·6	7	10	10·11		211	Σ. 2813
1671	31 14,6	39 55 4	328·4	9	9·10	10	Neat.	208	
——	31 48,8	54 22 21	165·4	6	9	10	Struve's magnitudes are 6 and 11. I am sure mine are right. Sky glorious. S. 794. Pos. 162·1.	168	Σ. 2814
——	32 24,2	33 12 13	85·0	8	9	11		212	Σ. 2815
1672	32 27,2	33 17 48	261·0	12	10	11	Perhaps Pos. = 81·0.	211	
1673	32 33,4	46 25 0	265·2	3	10·11	10·11		203	
1674	32 55,9	41 6 19	330·2	9	10	13		207	
1675	32 56,9	51 15 6	263·0	15	9	15		188	
1676	33 16,4	43 34 11	135·7	20	8·9	10·11		209	
1677	33 16,9	31 45 28	128·8	13	9·10	10		214	
1678	33 28,2	47 29 50	254·3	45	5	9·10	P. XXI. 246.	190	
1679	33 32,1	46 24 43	85·8	3	10	11	Elegant.	204	
1680	33 33,2	26 43 2	263·8 224·5	10 12	10 10	12 13	A and B A and C } Triple.	221	
——	33 38,9	33 16 33	337·3 118·1	10 18	7 7	9 10	A and B A and C } S. 795. Pos. 339·3, 121·5.	212	Σ. 2816
1681	33 47,6	42 22 0	114·3	5	10	11		210	
1682	34 53,7	77 8 5	73·8	10	11	12		174	
——	35 5,0	33 11 15	58·2	14	9·10	11	S. 797. Pos. 56·4.	211	Σ. 2819
1683	35 5,5	68 53 46	174·3 307·9	5 15	10 10	11 11	A and B A and C	166	
1684	35 36,5:	40 18 34:	319·8	8	9·10	12		208	
——	36 31,1	62 1 0	114·2	5	5·6	6·7	*μ Cygni.* Sh. 332. Pos. 113·1.	177	Σ. 2822
	— 32,3	—— 13	107·8	5	6	7	*μ Cygni.* One or other angle must have been read off incorrectly.	178	
1685	36 45,7	46 29 43	227·0	13	11	11 +		204	
——	36 56,8	65 8 15	305·5	9	4·5	10·11	*κ Pegasi.* L. white; S. dusky red.	167	Σ. 2824
	— 57,3	— 7 27	307·4	10	4	11	*κ Pegasi.* Pos. mean of 308·7, 306·1.	172	
1686	21 37 3,9	59 6 56	226·0	7	10	11		199	

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No. *h.*	Æ. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″				
1687	21 37 58,3	44 35 50	238·5	2	10·11 11	The middle star of three.	203	
1688	38 27,9	59 31 16	5·6	12	10 10·11		199	
1689	39 25,1	45 40 58	46·1	3	10 13		204	
1690	39 31,8	27 11 1	206·5	6	9·10 10·11		217	
1691	39 37,5	97 1 54	275·5	10	9 13		185	
1692	40 6,1	43 34 41	260·8	12	10 11		209	
1693	40 18,1	76 7 15	310·3	6	11 11·12		174	
1694	40 48,2	32 59 28	15·7	15	9·10 10		212	
	— 48,4	—— 18	13·8	20	9·10 10		211	
1695	41 10,0	59 32 26	113·8	7	9 11		199	
1696	41 58,7	24 58 57	140·2	10	10 13	The chief star in cluster vii. 66.	221	
1697	42 47,3	55 55 6:	263·0	8	8 12		168	
——	43 0,6	40 15 34:	212·2	14	9 9 +	(Places ill determined this sweep.)	208	Σ. 2832
	— 1,2	— 17 39	212·3	12	9 = 9		207	
1698	43 1,1	43 30 56	336·0	6	10 12		209	
1699	43 1,8	55 56 6	70·0	10	10 11	Points back to No. 1697.	168	
1700	44 5,7	46 28 43	195·8	3	11 13		204	
——	44 42,7	21 28 57	78·0::	1::	11 = 11::	Cloud and haze. Almost sure I saw it double.	224	Σ. 2835
1701	45 1,5	43 41 54	187·3	10	10·11 11		210	
——	45 21,6	23 59 57	150·6	13	7·8 11		220	Σ. 2836
1702	46 0,0	29 10 26	222·2	7	9·10 10	Fine.	217	
——	46 9,6	34 59 48	192·3	15	6·7 7	Superb object. *Sh.* 334. Pos. = 193·8.	212	Σ. 2840
	— 11,9	—— 38	193·6	20	7·8 8		211	
——	46 36,2	26 46 13	103·6	4	9 13		221	Σ. 2842
1703	47 9,2	50 55 0	90·0	5	10 12		183	
——	47 27,1	25 2 27	135·9	2½	9 9·10		220	Σ. 2843
——	47 35,9	27 41 52	171·6	2	9·10 10	Pos. mean of 171·5, 171·7.	218	Σ. 2845
——	48 8,2	45 0 53	265·0	2	10 12	A and B. Pos. mean of 264·0, 266·0	204	Σ. 2846
			155::	20	10 11	A and C.		
	— 8,7	44 59 51	266·4	2½	8·9 11·12	A and B	209	
			156·8	25	8·9 10	A and C		
1704	48 11,7	62 53 50	318·6	1½	13 14		178	
1705	48 54,9	43 44 52	80·4	3½	11·12 14	Difficult.	210	
1706	48 55,2	61 48 11	293·2	4	10·11 12		177	
1707	48 58,4	58 51 44	320·0	3	10 11	Beginning to grow hazy.	199	
1708	21 49 7,0	67 12 19	240·3	3	10 12		166	

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No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″				
1709	21 52 17,6	34 13 18	312·9	6	9·10 13		211	
1710	53 6,0::	40 11 34::	282·2	12	9 11	(Places ill determined this sweep.)	208	
	— 9,7	— 13 25	281·6	12	10 11		207	
1711	53 16,1	23 41 12	250·1	12	9·10 11		224	
1712	53 24,4	42 5 59	171·5	6	10·11=10·11		210	
	— 26,8	— 6 6	169·1	5	10·11=10·11	Elegant.	209	
1713	53 48,6	26 14 22	126·0	18	9·10 11		220	
——	53 54,4	58 6 8	98·4	3½	9·10 10	*h.* 951. Pos. 20 *sf*=110; dist. 8...10″. Surely this star has changed.	199	*h.* 951
1714	54 34,8	44 28 20	252·2	14	9·10 9·10		203	
1715	54 54,6	45 32 33	251·8	9	11 12		204	
1716	55 10,3	39 35 19	90·0	3	12 12	A and B	207	
			315·5	3	12 13	A and C		
——	55 37,2	22 50 15	184·4::	4	9 12		223	Σ. 2853
	——	—— 44	185·6	3	10 14	Power 320. Sky thick and bad.	224	
1717	55 42,1	51 15 18	200·0	7	9·10 13		188	
1718	55 46,4	35 42 48	41·2	4	10 10	A and B	211	
			280::	4	10 11	A and C estimated from diagram.		
1719	55 54,5	35 43 23	224·0	4½	11 11	A third star 12th mag., dist. from B 4″. Also, a fourth.	212	
1720	56 32,1	96 15 9	147·6	6	11 11 +	Points back to a star 14th mag.	185	
——	57 52,6	29 57 32	259·9	3	10 11·12	Pos. a mean of 261·3, 258·4, 260·0.	218	Σ. 2860
1721	58 4,1	60 54 50	281·1	6	9 12		178	
1722	58 9,4	58 53 51	43·0	12	9·10 10		199	
1723	58 14,8	45 45 8	185·0	15	9 10	A and B	204	
			256·3	15	9 15	A and C		
1724	58 22,0:	39 24 44:	223·0	13	9·10 10	(Places ill determined this sweep.)	208	
1725	58 29,7	44 20 17:	40:	20	11 11 +	In the cluster vii. 53.	210	
1726	58 43,0	75 44 11	24·8	12	11 11 +		175	
——	58 51,1	26 11 57	290·0	9	5 7	ξ *Cephei.* (H. II. 16.) Pos. a mean of 289·4 and 290·6.	220	Σ. 2863
	— 55,9	—— 21	290·1	10	5 7	ξ *Cephei.* Pos. a mean of 288·4, 290·8, 290·7, 291·2, 289·7. *Sh.* 337. Pos. = 293·2.	221	
1727	58 59,5	75 39 47	222·3	20	10 = 10		175	
1728	59 46,4	77 27 45	309·4	4	10 15	A and B	174	
			201·5	12	10 12	A and C		
1729	59 55,0	32 31 27	97·2	14	9·10 11		215	
1730	21 59 57,0	50 11 45	51·4	8	11 12	This *may possibly* be Σ. 2866; but the difference in R.A. (1m 12s) is too great: neither do the magnitudes agree, even making all allowances.	180	

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No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″				
1731	22 0 28,4	48 57 7	208·8	8	10 12		183	
1732	0 55,0 : :	40 25 24 : :	250·1	10	10 11		208	
1733	1 45,1	35 52 13	261·7	16	9·10 12		211	
1734	2 5,8	50 9 25	54·3	4½	10 12		180	
1735	2 17,2	44 58 50	112·0 160 : .	15 12 : :	7·8 9·10 9·10 15	A and B B and C. Pos. and dist. estimated from diagram.	190	
1736	2 25,9	28 42 2	269·7	5	10 11	Pos. a mean of 269·5, 270·0. A degree mistaken in P.D. would identify this with Σ. 2870, but the MS. is clearly written.	218	Σ. 2870
1737	2 27,4	43 15 16	348·8	5	10 = 10	Very neat. Pos. a mean of 349·0, 349·3, 348·0.	209	
1738	2 32,4	44 21 54	179·3	4	10 11·12		210	
——	2 49,0	31 32 42	137·4	18	8·9 = 8·9	*Sh.* 338. Pos. = 315·2 = 135·2.	215	Σ. 2872
1739	3 0,2	26 44 23	68·7	15	10 11·12		221	
1740	3 0,6	98 18 54	118·0	3	11·12 12	Quadruple. Two other small companions *nf* and *sp*.	185	
1741	4 31,0 : :	39 59 54 : :	328·5	20	6 11	Two more precede. Nearest = 12ᵐ; farthest 10ᵐ	208	
	— 34,2	40 1 49	330·0	18	7 12	Cloudy.	207	
1742	4 32,3	23 6 45	336·3	18	8 10	Multiple. 6 or 8 small ones near, forming a small cluster.	223	
——	4 37,6	53 11 23	73·8	9	9·10 11	Perhaps pos. = 70·8. MS. effaced.	188	Σ. 2876
1743	5 5,6	67 0 6	303·3	9	11 11		166	
1744	5 20,6	66 58 36	356·8	12	10 11		166	
1745	5 25,6	76 44 17	0·0	12	10 = 10		175	
——	5·9 —	31 4 52 : :	200 : :	8 : :	10 = 10	A glimpse only caught. R.A. from Σ.	215	Σ. 2880
1746	6 35,7	51 6 40	178·0	18	5·6 13	2650 A.C. A third dist. 40″ nearly in line.	180	
	— 36,6	— 7 5	180·0 185·5	20 60	6 12 6 13	A and B A and C } 2650 A.C.	133	
——	6 47,8 — 48,6	61 15 36 —— 50	107·8 108·9	1 1¼	10 11 10 10·11	Beautiful. Verified with 240. A beautiful double star. Power 240. S. 807. Pos. 111·2.	177 178	Σ. 2881
——	7 1,2	27 6 22	156·2	2½	10 12·13	Hazy and moonlight.	218	Σ. 2884
——	7 20,1	98 31 39	103·4	18	9 11		185	Σ. 2885
——	7 59·1 : :	41 28 54 : :	108·4	20	8·9 11		208	Σ. 2886
1747	8 25,5	22 21 20	94·5 215·6	6 20	10 12 10 11	A and B A and C	223	
——	22 8 29,2	40 57 49	11·1	10	9·10 = 9·10	A fine double star, in a large rich cluster.	207	Σ. 2890
	— —	——	10·8	10	10 = 10	Pos. a mean of 189·0, 192·1. The latter *better*, and double weight allowed.	208	

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No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
——	h m s 22 8 29,8:: — 33,4	77° 52′ 11″ —— 36	276°4 275·6	10″ 11	9 13 9·10 12	*h.* 293. The northern of 3 bright stars.	175 174	Σ. 2888
——	9 35,2 — 36,1	42 51 47 — 52 1	306·6 307·4	14 14	9 10 9 10	Fine. Pos. a mean of 306·8, 307·4, 308·0.	210 209	Σ. 2891
——	9 45,1	17 31 48	349·3	20	8 11	Fine. Pos. mean of 349·2, 348·7, 350·0.	228	Σ. 2893
1748	10 38,6	32 19 2	269·0	10	10·11=10·11		215	
——	11 29,1	53 4 57	195·0	12	8 10	P. XXII. 65.	188	Σ. 2894
1749	11 38,1	68 38 31	271·0 31·3	5 6	10 16 10 16	A and B A and C } The southern of two.	166	
1750	11 39,0	75 0 45	242·0	15	9·10 13		174	
1751	12 35,3	34 43 38	112·5	8	10 10·11		212	
1752	12 40,2 — 40,9	65 46 22 — 45 58	288·6 288·6	13 12	10 10 + 10 11		167 172	
——	12 46,4	65 53 28	3·4	2½	9 11	Elegant. L. red. Another double star very near.	172	Σ. 2895
——	13 2,1	27 38 2	243·2	20	9 9·10		218	Σ. 2896
1753	13 20,6	45 36 58	184·8 179·0	2½	11 11 + 11 11	A and B A and C } Pos. mean of 184·5, 185·2.	204	
1754	13 45,9	26 56 27	158·1	8	10 11		220	
1755	14 0,8 — 0,9	44 18 56 —— 58	10·0 9·2	30 30	5·6 12 5·6 12	2 *Lacertæ.* 2 *Lacertæ.*	209 210	
1756	14 32,7	50 11 12	283·5	15	9 12		183	
1757	14 57,1::	39 39 2::	306·3	8	10 12		208	
1758	15 47,2	62 49 20	262·9	8	11 11		178	
1759	15 53,4	51 39 6	304·8	5	11 12		188	
1760	16 17,8	63 39 44	341·2	2½	11 13		167	
1761	16 23,8	16 0 38	40::	1½	12 = 12	Oblong. Almost sure of its being double; but had not time to apply a higher power.	228	
——	16 26,3	45 31 0	92,0	5	8·9 9·10	Fine. HN. 64. *Sh.* 344. Pos. 89·9.	189	Σ. 2902
1762	16 27,6	42 26 46	355·3	16	9·10 10		210	
1763	16 47,6	66 42 6	113·5	10	10·11=10·11		166	
——	16 43,3 — 55,2 — 58,1	24 8 50 — 9 11 — 6 47	93·9 93·2 93·4	5 4½ 4	8·9 9 8 9 8 8·9	Pos. a mean of 93·7, 94·2. Pos. a mean of 92·4, 92·7, 93·8, 93·8. Fine. Pos. a mean of 93·3, 93·5. *Sh.* 343. Pos. 92·6.	223 221 220	Σ. 2903
1764	18 22,6	98 5 45	191·8	16	8 12		185	
1765	18 23,1	47 35 15	183·8	8	10·11 11		204	
——	18 48,4 22 18 52,5	75 42 35 —— 35	278·5 280·5	2 1¾	10 = 10 10 10 +	Fine.	175 174	Σ. 2905

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No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep	Reference.
1766	h m s 22 19 41,0 :: — 47,3	° ′ ″ 40 33 4 :: — 34 19	° 264·8 262·0	″ 10 8	10 11 10 11	Places ill determined this sweep.	208	
1767	19 49,0	35 16 58	211·8	9	10·11 11		212	
1768	20 24,8	43 3 1	8·3	20	9 9·10	Fine.	209	
1769	20 36,7 ::	30 40 53	50·0	6	10·11 13		213	
1770	20 45,4	55 18 41	103·3	3	11 = 11	A star 10th mag. precedes 1m of time.	168	
1771	21 19,9	33 22 58	208·6	10	11 11·12		211	
1772	21 24,3	44 43 14	103·1	3	10·11 = 10·11	Very neat.	210	
1773	21 33,5	31 58 26	——	—		Double.	214	
——	21 38,1	98 58 27	334·5	5	8 9·10	Fine.	185	Σ. 2913
——	22 52,0	32 27 12	191·3	50	4 7	ϑ *Cephei*. *Sh.* 347. Pos. 191·3.	215	*Sh.* 347
	— 54,2	—— 28	191·4	40	4·5 8	ϑ *Cephei*.	211	
	23 1,7	—— 16	191·8	60	4 6·7	ϑ *Cephei*. Some mistake in the R.A.	214	
1774	22 59,1	53 45 46	52·2 307·8 ::	10 15	11 12 ——	A and B } BAC make a right angle A and C } at A.	188	
1775	23 8,0	75 14 40	204·9	8	10·11 12·13		174	
1776	23 47,3	77 40 35	277·5	5	10·11 14		175	
1777	23 50,8	42 26 3	318·8	8	9 13		210	
1778	24 13,2	24 38 19	296·9	3	14 15	Very delicate.	221	
——	24 21,8	40 2 9	249·2	1½	10 12	Very difficult to measure, from the inequality of the stars; best seen with 240 and 6 inches.	207	Σ. 2918
	——	——	246·5	2	9·10 12	Not very good measure. Power 240. Moon full and on meridian. One of Struve's *pervicinæ*.	208	
1779	24 50,8	56 38 41	244·9	20	8 11		168	
1780	25 32,4	34 2 48	245·0 ::	10 :	10 14		212	
1781	25 39,3	65 46 20	290·2	10	10 15		167	
1782	26 18,0	30 38 11	330 : :	2	11 11 +	Two near together. A neat pair of double stars.	214	
1783	26 23,9	30 38 16	278·8	3	11 11		214	
1784	26 34,3	28 23 37	339·7	10	10 11		218	
1785	26 42,7	61 8 28	175·7	12	9·10 10	Fog coming on.	178	
1786	26 58,8	49 5 25	228·0	30	8·9 11		180	
1787	27 2,4	42 22 5	291·1	8	11 11 +		210	
1788	27 26,7	49 18 8	297·8	2½	10 11	Fine.	183	
——	22 28 8,8	20 58 25	80·0	1	9 9	One of Struve's *vicinissimæ*. After vainly attempting it with apertures of 6 and 4 inches, 320 and 9 inches resolved it. Very close; but a black division well seen between the stars.	223	Σ. 2924

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1831MmRAS...4..328M

No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″				
——	22 28 16,6	51 14 35	185·0	15	6 6+	A and B } Quadruple. Forms an	188	Σ.2922
			155·2	20	6+ 11	B and C } arch. 8 *Lacertæ*. Sh.		
			120::	25::	11 10	C and D } 348. Pos. 184·4.		
1789	28 20,0	35 49 23	111·1	7	10 12	A and B } Triple.	211	
			191·0	12	10 12	A and C }		
1790	28 24,0::	75 2 11	83·4	6	10 13	Hazy.	175	
1791	29 3,7	34 0 48	64·1	16	8 9		212	
1792	30 52,3	31 22 36	133·3	5	9 12		214	
1793	31 2,1	43 50 11	296·2	8	10·11 11		209	
1794	31 5,1	43 53 4	313·1	12	9·10 11		209	
1795	31 11,9	43 32 10	209·1	7,6	10, 11, 12	A, B, C, in a line. Query a fourth.	210	
1796	31 53,0	34 5 15	22·1	18	5·6 11		212	
1797	32 30,0::	40 45 54::	128·8	12	10 11		208	
——	32 45,1	60 53 15	84·2	5	10 10+		178	Σ.2932
	— 47,4	— 54 6	81·4	4	10 10	Sky perfectly clear.	177	
——	32 55,4	60 51 9	278·2	15	9·10 10	S. 814. Pos. 279·7.	177	S. 814
1798	33 28,7	60 50 13	277·1	15	10 10+	A and B. }	178	
			15::	20	10 13	A and C. Pos. estim. }		
1799	33 29,3	25 19 22	339·0	10	10 12	Unless the Pos. be 39·0.	221	
1800	34 40,0	67 5 6	248·4	8	10 12		166	
1801	35 5,8::	78 0 1	298·0	15	10 10+		175	
			354·5	10	10 14			
1802	36 23,4	51 25 18	274·0	2	6 10	Fine. Small star just visible with 6 inches. Agrees in P.D. with Struve's 2942, but differs 2^m in R.A. But the magnitudes (8) (9) assigned by Σ to his star decide the point. They cannot be identical.	188	
1803	36 27,2	49 3 45	131·8	12	6 12·13		180	
	— 29,1	— 4 0	134·0	12	6 13	Fine.	183	
1804	36 51,4	26 24 43	339·0	15	9 15	Delicate.	221	
——	36 59,7	18 9 43	144·4	2½	10 12	Pos. mean of 143·2, 145·6.	228	Σ.2940
1805	37 26,7	43 53 56	173·9	4	11 12	Difficult to measure. The moon full.	209	
1806	37 37,7	46 4 33	338·0	6	9·10 10		204	
1807	37 49,3	23 10 0	188·3	20	9·10 10	Pos. mean of 187·6, 188·9.	223	
1808	39 5,5:	41 50 4:	133·8	6	10 = 10		208	
	— 6,2	—— 9	132·5	9	10 = 10	Pos. mean of 132·2, 132·8.	207	
1809	39 18,0	32 48 16	——	20	7·8 9		214	
1810	22 40 9,5	32 48 36	356·2	12	8 12	The chief of the cluster viii. 77.	214	

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1831MmRAS...4..328M

No. *h.*	Æ. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
1811	h m s 22 40 25,9 :	° ′ ″ 77 45 59	157°9	2½	10 11	Neat.	175	
1812	40 27,4	43 22 6	54·5	10	10 11		209	
1813	40 53,3	49 17 25	233·8	6	10 10		180	
	— 54,6	—— 59	244·7	5	11 = 11	Neat. One or other Pos. 10° wrong read off.	183	
1814	42 0,1	42 18 27	78·0	12	9·10 10	Power 240.	210	
1815	42 2,6	45 26 58	29·6	5	11 11 +	Elegant.	204	
1816	42 24,8	44 34 1	138·9	6	9·10 10	Pos. mean of 136·5, 139·0, 140·0.	209	
1817	42 49,9	56 26 16	247·5	8	10 11		168	
1818	42 56,1 :	77 23 5	49·1	8	10 12		175	
——	43·3 —	22 22 —	73·8	4	8·9 9	Struve's place.	223	Σ. 2947
1819	43 11,6	61 39 50	73·3	15	9 11		178	
1820	43 22,1 :	38 43 24 :	258·0	12	11 13	In a group of about a dozen.	208	
1821	43 36,0 ::	30 36 13	110 : :	8	10 12	Pos. estimated by diagram.	213	
——	43 45,7	24 20 55	2·2	3	8·9 9·10		221	Σ. 2948
1822	44 2,7	49 33 42	148·1	4	9·10 11	The two *f.* stars of a triangle. The latter points a little north of the single star, which is 9·10 mag.	183	
1823	44 6,7	49 35 2	258·0	12	8 11			
1824	44 16,7	33 41 33	47·4	18	9·10, 10		211	
——	44 47,1	29 12 4	328·5	3	6 7	AC. 2734.	218	Σ. 2950
1825	45 16,5 :	77 18 1	230 : :	1	10 11	Very delicate. Could not verify it, having mislaid the high power.	175	
1826	45 28,9	15 44 8	188·9	20	8 14		228	
1827	45 49,7	38 47 —	322·4	9	10·11 = 10·11		207	
1828	46 3,8	46 9 10	350·4	20	6 11		189	
	— 5,2	—— 8	351·1	18	7 11		190	
——	46 6,1	62 52 55	137·0	15	8 11		178	Σ. 2952
	— 6,6	—— 56	139·2	13	9·10 11		177	
1829	46 19,1	21 29 0	357·6	12	10·11 11		223	
1830	47 10,3	35 14 18	83·4	8	10 10·11		212	
——	47 46,9	54 32 51	247·5	45	6·7 9·10		168	*h.* 975
1831	48 5,7	47 51 3	91·5	10	10 11		204	
——	49 54,6	28 2 37	352·4	2	9·10 9·10		218	Σ. 2961
1832	49 54,6	52 13 47	79·9	8	10 10 +		188	
1833	49 59,3	26 7 12	110·8	16	9·10 9·10		221	
1834	50 6,6	60 32 22	168·4	18	9 11	A and B	178	
			179·0	30	9 10	A and C, unless Pos. = 269·0.		
1835	22 50 23,6	67 0 26	302·1	10	10 10·11		166	

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1831MmRAS...4..328M

No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
1836	h m s 22 50 35,0::	39° 36′ 34″::	241°8	12″	9 11	Places bad throughout this sweep.	208	
	51 39,8	39 38 54	241·3	10	9·10 11	Most probably the same star, with the minute mistaken in one or the other obs.	207	
——	50 36,5	18 3 48	215·1	3	10 11	Power 240. Pos. mean of 215·6, 214·8, 215·0.	228	Σ. 2965
——	51 1,9	18 3 53	257·8	18	8·9 12		228	Σ. 2966
1837	51 24,5	60 49 1	347·4	10	10 13·14		177	
1838	52 5,2	23 48 45	90::	1	11 = 11	Oblong with 160. Resolved with 320.	223	
1839	52 34,7	49 46 34	293·5	15	9·10 12	Small star, dusky red.	183	
	— 35,3	—— 37	287·5	9	10 12		180	
1840	52 44,0	42 32 46	298·4	14	9 11		210	
——	54 59,3	46 51 5	36·5	3	6·7 10	Fine. Struve makes this of the 3d class.	189	Σ. 2973
	55 0,1	—— 13	40·7	5	7·8 11	Measured very well, with the strongest illumination the lamp will give.	204	
1841	55 12,3	44 44 36	345·8	15	9 9 +	A and B	209	
			285·8	24	9 9·10	A and C		
1842	55 32,6	62 50 10	204·1	80	2 16·17	*β Pegasi.*	178	
1843	55 35,5	33 35 48	103·0	6	11 = 11		211	
1844	56 33,2	16 25 43	70·5	13	11 12		228	
1845	56 48,4	30 3 52	8::	10	9 14	A and B	216	
			35::	14	9 13	A and C — Estimations.		
1846	57 35,1::	39 36 39::	171·8	8	11 = 11		208	
1847	58 19,0::	32 29 33	52·0	3	11 11 +		213	
1848	58 48,7	47 57 10	293·6	3	16 17		180	
——	59 28,1	29 27 42	341·5	3½	8 12	Pos. mean of 339·5, 343·5. Difficult to measure, from inequality, but bears good illumination.	218	Σ. 2977
——	59 48,9	51 7 25	224·5	3	8 10	Fine.	188	Σ. 2979
	— 49,5	— 6 27	219·7	1½	9 11	A beautiful double star. P.D. may be 30″ out, from the tube touching the gallery.	183	
1849	59 53,7	44 31 51	347·0	50	6 13	Piazzi xxii. 301.	209	
1850	22 59 57,9	34 43 38	132·2	3½	11 = 11	Neat. Or perhaps magnitudes may be 11·12 = 11·12.	211	
——	23 2 9,2	42 57 30	255·0	15	8·9 9	Pos. mean of 255·8, 255·3, 254·3, 254·6.	210	Σ. 2985
	——	——	252·0	15	11 11 +	*Sh.* 253. Pos. 253·0.	209	
1851	2 28,9	20 49 50	348·5	5	10 11	Beautiful.	223	
1852	2 30,3	15 32 3	242·9		5 16	*π Cephei.* Δ R.A. = 12ˢ,5. Pos. a mean of 241·4, 242·4.	228	
——	2 32,7	41 54 19	169·3	3	9 11·12	Pos. mean of 168·4, 169·5, 170·3.	207	Σ. 2987
	2 35,5	—— 4::	171·7	3	9 12	Pos. mean of 171·2, 170·5. (Power 240, 12 *in.*)	208	
	23 2 36,8	—— 16	175·0	2½	8·9 12		209	

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1831MmRAS...4..328M

No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″				
1853	23 2 46,7	46 3 20	265·4	15	8·9 12		190	
1854	2 55,1	61 25 35	267·0	8	11 17		178	
1855	4 0,1	45 20 38	296·7	1½	11 = 11		204	
——	5 2,3	50 54 45	280·0	12	9 11	Fine.	180	Σ. 2992
1856	5 7,5	35 11 3	326·8	4	10·11 11·12		211	
1857	5 58,3	33 33 48	102·8	17	9·10 10		212	
1858	6 4,7	61 12 5	89·0	20	10 13		178	
1859	6 6,2	61 9 10	118·2	25	7 12		178	
1860	6 22,9	28 15 37	14·9	6	9 14		218	
1861	7 30,2	35 53 21	266·2	10	10·11 11		211	
1862	7 33,1	63 26 19	231·7	10	8 11·12	No doubt the same star, with an erroneous reading in P.D.	172	
	— 33,8	— 31 48	234·5	14	9 12		167	
1863	8 3,9	41 55 38	241·0::	5	12 13	Difficult to measure.	210	
1864	8 16,3	48 17 21	205·5	18	9·10 10		180	
1865	8 28,2	23 9 25	213·9	8	11 11 +		223	
1866	10 16,6	77 31 11	160·0	15	——		175	
1867	10 33,1	46 34 53	114·8	10	10 11		204	
——	10 48,6	77 28 56	329·0	15	9·10 11	Hurried. Pos. perhaps erroneous.	175	*h.* 307
——	10 57,6	77 31 11	280::	15:	10 12	Pos. and dist. estimated from a hurried diagram.	175	*h.* 308
——	11 3,1	77 29 56	320::	15::	10 12	Estimations from a hurried diagram.	175	*h.* 309
——	11 41,4	22 49 25	173·7	2	6 10	*o Cephei.* Pos. mean of 172·4, 175·1.	223	Σ. 3001
1868	11 57,1	35 12 13	158·0	15	10 12		212	
1869	12 22,3	68 57 19	87·0	2½	9 10		166	
——	12 41,3	46 48 40	182·0	12	7·8 11	Neat.	189	Σ. 3004
	— 42,3	—— 40	180·1	10	7 11	An elegant double star.	190	
——	13 8,7	65 58 19	21·9	18	9 11		172	Σ. 3005
1870	13 27,1	17 0 26	280·4	12	8 13		228	
1871	13 37,7	39 4 19	132·8	10	10 12		207	
1872	14 0,6	48 23 23	102·5	12	12 13		204	
1873	14 21,5	34 50 48	64·4	7	9 11		212	
	— 22,5	—— 18	60·4	7	9·10 12		211	
1874	15 2,8	98 7 48	310·0	8	11 12	Great scarcity of double stars in this part of the heavens.	186	
1875	17 16,5::	39 5 44::	166·0	15	10 11		208	
1876	17 37,9	54 5 56	210·1	5	10 = 10	Fine.	168	
1877	23 17 44,2	48 23 53	58·5	—	12 13	The place is that of a beautiful planetary neb. close to the double star.	204	

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1831MmRAS...4..328M

No. *h.*	Æ. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
1878	h m s 23 19 0,2	° ′ ″ 40 30 54	90°0	6″	11 = 11	Very neat.	207	
1879	19 4,0	34 32 8	65::	15::	10 : : 13 : :	Estimations from diagram.	212	
1880	19 4,7	35 2 58	182·8	10	10 12		211	
1881	19 19,5	34 32 8	60 ::	5::	10 : : 14 : :	Estimations from diagram.	212	
1882	19 32,8	51 31 54	306·0	10	9·10 14		188	
1883	19 32,9	44 32 26	154·6	15	9 9 +		209	
1884	19 53,0	40 45 9	251·3	12	9·10 10		208	
——	20 11,3	97 34 13	317·2	18	9·10 10		186	Σ. 3016
——	21 1,9	16 48 38	34·5	$2\frac{1}{2}$	10 11	Pos. mean of 36·5, 35·0, 32·0.	228	Σ. 3017
	——	——	35·8	3	9·10 10·11		229	
1885	21 36,3	39 17 59	220 ::	—	8·9, 12, 13,	Three in a straight line. Estimated from diagram.	207	
——	21 58,1	60 6 10	204·0	15	8·9 11		178	Σ. 3018
1886	22 2,6	32 23 13	340·5	18	7 13	Precedes A.C 2807. The large star of this, with A.C. 2807, make up the double star S*h*. 355.	212	
1887	22 10,5	32 22 37	74·0	4	12 = 12	A small double star close to A.C. 2807.	211	
	— 12,0	— 23 23	72·4	4	11 11 +	The close double star measured; but the place is that of the large star A.C. 2807.	213	
1888	22 12,0	32 23 23				A.C. 2807 } Place observed.	213	
	— 13,1	—— 13	120 ::	20::	6 12	A.C. 2807 } Has a companion *sf*, and	211	
	— 13,0	—— 26				A.C. 2807 } a sm. close doub. star *np*.	214	
——	23 0,8	32 31 16	227·0	16	8·9 9		214	Σ. 3022
	23 9,9	32 25 48	230::	18	9 10	Follows A.C. 2807. Pos. by estim.	211	
1889	23 39,5	52 37 45	238·2	20	7·8 15	A and B } All exactly in one line.	188	
			58·2	25	7·8 15	A and C }		
1890	23 45,6	21 1 50	227·8	6	11 12		223	
——	23 49,8	47 6 35	307·9	4	9 10	S. 832. Pos. = 311·9.	189	Σ. 3024
1891	24 31,0::	41 37 14 : :	326·4	18	9·10 11		208	
1892	26 10,0	31 9 51	96·4	6	10 10·11		214	
	— 15,6::	— 10 8	91·5	6	10 12		213	
1893	26 48,1	43 56 11	251·7	5	9·10 10	Pos. mean of 250·6, 252·8.	209	
1894	27 48,6::	39 24 29 : :	20·5	20	9·10 = 9·10	In a group of six or eight.	208	
——	27 50,9	62 2 21	270·0	$2\frac{3}{4}$	10·11 11	Neat.	177	Σ. 3026
1895	29 1,3	34 22 3	108·3	3	11 = 11	Neat.	211	
——	29 25,0	78 3 31	230·0	12	8·9 11	A star 14th mag. is about 15″ *np*; the smaller of the two.	175	*h*. 317
1896	31 0,5	28 49 37	115·2	18	6 12		219	
1897	23 31 47,2	23 59 0	203·5	20	10 10·11		223	

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1831MmRAS...4..328M

No. *h.*	Æ. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
	h m s	° ′ ″	°	″				
1898	23 32 2,8	46 36 30	182·8	30	5 12	*κ Andromedæ.*	189	
	— 3,2	—— 25	181·4	35	5 14	*κ Andromedæ.*	190	
	— 3,6	—— 51	181·5	40	———	*κ Andromedæ.*	204	
1899	32 15,0	35 43 3	261·4	12	9 11		212	
——	32 34,1	76 12 7	339·5	15	9 12		173	Σ. 3032
1900	32 39,1	53 17 17	168·2	14	7 11		188	
1901	33 16,6	35 43 18	260·0	15	10 11		211	
1902	34 1,2	31 11 6	294·5	10	10 10		214	
1903	34 4,1::	40 59 54::	295·5	7	9·10 10	A star 10th mag. rather to the south of the line of junction.	208	
1904	34 7,9::	31 10 33	111·0	9	10 11		213	
1905	34 10,0	16 48 3	168·4	12	10·11 12	A and B	228	
			157::	10	12 12	B and C		
1906	35 11,1	28 22 7	353·5	12	10 11	Cloudy.	218	
	— 14,1	— 23 2	356·8	12	10 10·11		219	
——	37 57,0	30 28 26	207·4	1½	9·10 11	Pos. mean of 207·3, 207·5.	214	Σ. 3037
1907	38 7,1	28 17 7	272·0	3	10 10 +	Both very red, almost ruby coloured. A large white star 7·8th mag. precedes 8ˢ,5 of time.	219	
——	38 19,1	62 31 10	37·7	24	8 10	L. yellow; S. bluish. S. 834. Pos. = 36·5.	178	Σ. 3039
——	38 32,9	28 20 22	136·8	12	9·10 9·10	Clouds.	218	Σ. 3038
	— 41,1	—21 7	128::	10	10 11	A strange discrepancy of obs.	219	
1908	38 33,4	55 18 33	78·9	12	10 10 +		168	
1909	40 13,5	77 7 29	119·1	3	12 13		175	
1910	41 1,9	35 8 48	252·5	10	10 11		212	
1911	42 58,8	48 51 45	341·5	—	———		180	
	43 0,1	—— 51	346·4	22	8 11		183	
1912	43 8,7	32 40 46	219·1	7	10 12		214	
1913	43 31,4	54 13 21	390·0	15	10 10 +	A and B	168	
			340·2	13	10 + 15	B and C — Three forming an arch.		
1914	44 19,8	35 8 13	264·5	2	13 = 13	Delicate.	212	
1915	44 49,9	76 44 31	274·0	3	14 15	An insignificant object.	175	
1916	45 0,0::	41 18 48::	35·3	16	10 = 10		208	
1917	46 14,3	45 10 55	88·4	7	10 12		189	
1918	47 1,1	33 5 16	47·6	4	11 12·13		214	
1919	48 7,6::	41 26 39::	61·4	8	10 13		208	
1920	48 22,1::	41 26 44::	258·5	16	9 12		208	
1921	48 29,2	34 13 18	217·8	5	11 12	In the splendid cluster vi. 30.	211	
1922	23 49 9,8	26 41 17	148·3	6	9·10 12		221	

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1831MmRAS...4..328M

No. *h.*	R. 1830.	N.P.D. 1830.	Position.	Dist.	Magnitudes.	Remarks.	Sweep.	Reference.
——	h m s 23 49,0 —	° ′ ″ 33 35 —	°	″	——	A star examined for Struve's 3047 "*pervicinæ*." Two seen; but the larger of the two is the *preceding*; whereas Σ. calls his star "*sequens major duarum*." Neither seen double. Query if the right star examined.	211	Σ. 3047 ?
1923	51 45,8	40 13 39	275·8	6	12 = 12	In a tolerably rich cluster.	207	
1924	51 50,3	23 43 50	224·6	6	11 = 11	Pos. mean of 225·2, 224·0.	223	
1925	52 42,5	34 52 8	334·4	12	10 11		212	
——	54 5,4	24 51 30	69·3	18	7 8	L. yellow; S. blue. Pos. mean of 70·0, 69·5, 68·3. ΔR.A. = 3ˢ,0. S. 794. Pos. 70·8.	221	Σ. 3053
1926	54 26,3	33 33 33	315·3	13	8 11		211	
1927	54 26,3	45 48 45	85·0	16	9·10 10		189	
1928	54 34,2	30 2 47	199·5	14	10·11 11		216	
1929	55 10,2	62 57 57	287·5	3	9·10 10·11	Fine.	172	
1930	55 10,9	30 5 57	168·1	10	10 10 +		216	
1931	55 24,6:: — 25,3	40 57 14:: — 58 49	116·1 115·0	15 18	8 12 8 11		208 207	
1932	55 32,6 — 32,7	48 21 26 —— 35	302·2 301·4	5 4	10 = 10 10 11	Neat. A third *sp.* Elegant.	183 180	
——	55 44,9	56 40 41	358·0	18	7 10		168	Σ. 3056
——	56 12,4:: — 13,8	32 24 28:: —— 26	302·3 300·8	3 4	9 11 8·9 10·11	Pos. a mean of 303·1, 301·6. Pos. a mean of 300·2, 301·3.	213 214	Σ. 3057
1933	56 21,7	27 34 37	91·5	15	10 10 +		219	
——	56 25,7 57 1,7	60 36 50 60 38 1	49·7 50·5	12 12	8 9 9 10	The same. The wire mistaken. To correct it, 35ˢ,4 must be *subtracted* from the R.A., which brings it to 56 25·3, agreeing perfectly.	178 177	Σ. 3058
1934	57 19,7	32 30 26	45::	—	——	An elongation suspected with 240; but if double, it must be very close indeed, if the star.	214	Σ. 3062
1935	58 53,3	33 34 13	7·9	15	9 10	Pos. a mean of 9·4, 6·4.	212	
——	58 53,7	50 47 35	351·1	20	7 11	L. yellow; S. blue.	183	Σ. 3064
1936	59 29,5	28 40 22	193·8	10	10 10·11		119	
1937	59 35,2 23 59 36,4	61 50 15 —— 46	268·9 ——	— —	1 14 ——	*α Andromedæ*. ΔR.A. = 4ˢ,5. *α Andromedæ*. ΔR.A. = 4 ,5.	178 177	

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XVIII. *On a Method of ascertaining any inaccuracy in the formation of the Pivots of Transit Instruments, &c., or any subsequent derangements of their true shape.* By Lieut. Peter Lecount, R.N., *Member of the Society.*

Read April 7, 1830.

In a paper read before this Society March 13, 1829, I pointed out a minute error likely to arise in the use of transit instruments, &c., from the decomposition which would take place in the steel pivots, in consequence of the oil used becoming rancid, and forming with them and their brass Y's the galvanic circuit.

It being an established chymical fact, that this decomposition will take place under the above circumstances, a method of ascertaining whether any injury has taken place will perhaps be acceptable to the Society, particularly as the same instrument which will shew a deterioration in a transit that has been used, will also, in a new one, detect any inaccuracy in the original formation of the pivots, and may in both cases be made to measure the amount.

Giving the true cylindrical shape to pivots is one among several points to which the German artists pay very considerable attention; and I have every reason to believe that the correctness of their workmanship is in a great degree owing to the means they use to counteract the effects of friction, flexure, and temperature, while the metals are undergoing their various processes during manufacture.

It was in the workshop of M. Repsold, of Hamburg, that the idea first suggested itself to me of ascertaining the existence of any errors in the shape of the pivots of instruments. I do not know what final measures M. Repsold may pursue for fully satisfying himself that he has counteracted any irregular expansion or alteration from flexure while his pivots are being turned in the lathe; but one step which he shewed me was, that when the pivot, of about $\frac{3}{4}$ inch diameter, fixed to a brass circular block about 3 inches diameter and $\frac{1}{2}$ inch thick, was put into a socket longer than itself, it rested on the compressed air; and while the socket was held in a vertical

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position, a light touch of the finger spun it round for upwards of a minute (no oil being used). This freedom of motion would alone form a very delicate test, especially when the depth to which the pivot sunk by compressing the air in the socket was observed before the motion was given it, and after the temperature of the metals had become equalised; for, on then putting it in motion, it should rise in the socket, if perfectly air-tight, from the friction expanding the contained air.

The instrument which M. Repsold shewed me for detecting flexure was a series of inverted levers; and upon considering this and Reichenbach's lever of contact, it appeared to me, that a wheel pyrometer might be adapted for the purposes of both instruments with advantage, it being capable of greater susceptibility, and having less friction among its parts; while, as a measure of the deviations of pivots, it would possess a greater accuracy than Reichenbach's lever of contact, for the same reason that it does over the old pyrometer on the lever construction.

A pyrometer on the wheel construction (the motion being, in the first instance, communicated by a rack,) is simply a conversion of a rectilinear motion into a circular one, and may therefore be very advantageously made use of for measuring any other rectilinear motion within the range of the scale, as well as that produced by the expansion of metals; the circular motion producing any extent of accuracy which may be wished.

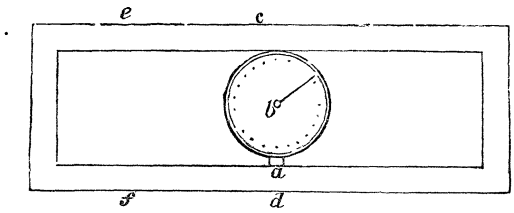
The one which I have, was constructed on my own plan, the diameter of the circular scale being $2\frac{1}{4}$ inches, and each division $= \frac{1}{6572}$ of an inch; and as the divisions are about $\frac{1}{15}$ of an inch apart, it is capable of being read off with ease to the $\frac{1}{26288}$ of an inch. I am not aware that it possesses any peculiar accuracy beyond others: at all events, an equally good one can be constructed by any workman of common abilities. It may be as well to add, that it shews very sensibly the expansion of a brass rod 12 inches long and $\frac{1}{4}$ inch diameter by the warmth of the breath.

I first adapted it to exhibit the effects of flexure. For this purpose, I placed it between the two longest sides of a wrought-iron parallelogram, each of which is $9\frac{1}{2}$ inches in length and $\frac{1}{2}$ an inch square. The bending of these sides by the thumb and finger is shewn by a motion of the index equal to $\frac{1}{6}$ the circumference of the scale, as in the annexed diagram, where *a* represents the rack, *b* the face of the pyrometer, and *c* and *d* the places where the pressure is applied.

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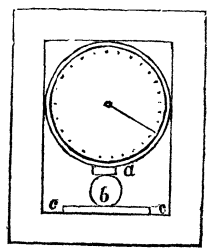
In the same manner, it shews a bending by the thumb and finger of the sides of a cast-iron parallelogram, 1 foot long, and $1\frac{1}{2}$ inches square, equal to $\frac{1}{60}$ of the circumference of the scale; and I consider it would render the same force sensible if the sides of the parallelogram were $2\frac{1}{2}$ inches square.



In a cast-iron parallelogram, if the thumb and finger are applied, as at *e* and *f*, one inch from the ends, a motion is produced in the index.

The mode of applying this instrument, in order to ascertain the flexure of any proposed body, with any given pressure, will require but little mechanical genius. As, however, each case will possess its own peculiarities, I presume it is unnecessary to enter into this part of the subject, as it would unavoidably lead to a considerable detail.

To adapt it to the examination of the pivots of astronomical instruments, or other cylindrical bodies, it must have a contrivance for back motion, which, in fact, it ought to have as a pyrometer. This is effected in my instrument by the centre pivot (which carries the index) winding up a small weight as the index revolves, which weight is therefore constantly acting on the train of wheels, and endeavouring to make them retrograde; and that a weight of a few grains may be sufficient, (which it will be, if it only has to move the wheels,) the rack is pushed outwards by a spring.



The instrument must be put in a strong frame, as shewn in the annexed figure, where *a* is the rack-piece, and *b* the new pivot to be examined.

If we now suppose the rack pushed in to about $\frac{1}{3}$ its range, so as to admit the pivot, as shewn in the figure, it is plain that, by turning the frame round the pivot, or the pivot round in the frame, any inequalities in its shape will be indicated by the scale; the amount will be shewn by the value of the divisions, and the delicacy of the test will be governed by the powers of the instrument, which, with reference to practical results, are unlimited.

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The end of the rack should be faced with hard polished steel, to prevent abrasion; and a similar piece of steel should be placed under the pivot, on the lower part of the frame, (as at *c c*), so that the rack-piece is exactly above it. If this piece of steel, and that at the end of the rack, are equally thick, the examination may be made on successive parallels of the pivot, from its shoulder to its end, each of which parallels will, of course, be equal in thickness to the facing at the end of the rack.

By a precisely similar method of proceeding, the effect of any deterioration will be discovered, after any length of time that the pivots have been in use, and the positions of a transit ascertained in which any respective errors from this cause will require correction. The peculiar circumstances of the case must alone determine the manner of applying this correction, the calculations for which may be rendered very simple.

It will, however, be more convenient to examine the pivot of a transit, while in its Y, without removing the transit instrument. In this case, the bottom of the frame before described is to be dispensed with; the two uprights are to be made with enlarged ends, to perform the office of feet; and the frame being placed on the pillar of the transit, so that the rack stands at a right angle with the axis of the pivot, a weight must be put on the top sufficient fully to insure all motion taking place on the rack alone.

When a correctly made pivot is afterwards found to have altered its shape, it will not be very easy to ascertain what part of the deterioration is due to abrasion and what part to decomposition; but as the pivots are made of hard steel, almost all abrasion must necessarily take place on the brass Y's, while, as I have before shewn, all decomposition will take place on the steel pivot.

PETER LECOUNT.

Nov. 20, 1829.

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XIX. *On an Appearance of Divisions in the exterior Ring of Saturn. By Capt. Henry Kater, Vice President and Treasurer of the Royal Society.*

Read May 14, 1830.

The observations which form the subject of the present paper were made in the years 1825 and 1826, and have remained until now unpublished, as I wished to witness again the appearances which I then remarked. The ill state of my health, however, has prevented me from availing myself of the extremely rare opportunities which this climate presents for investigations of so delicate a nature; but the phenomenon which I am about to describe having been seen by others, I feel the less hesitation in placing it upon record.

I have been much accustomed to observe *Saturn*, principally for the purpose of trying the light and distinctness of my telescopes, of which the satellites and ring of that planet are good tests. The telescopes which I usually employ are of the Newtonian form; one made, I believe, by Watson, and another by Dollond. The telescope by Watson has a mirror of $6\frac{1}{4}$ inches diameter, and 40 inches focus. Unfortunately, the mirror of this telescope is too thin, and its performance, in consequence perhaps of this, is subject to much uncertainty; but, under favourable circumstances of temperature, &c., the precise nature of which I have not been able to ascertain, I have never seen a telescope which gave a more perfect image.

The telescope by Dollond has a mirror of $6\frac{3}{4}$ inches diameter, and about 68 inches focus, and is constructed with peculiar contrivances, to prevent the figure of the mirror from being injured by its own weight. It may be considered a very good instrument.

I have been accustomed, on many occasions, but, I regret to say, not always, to note down, either at the time or immediately afterwards, the phenomena I may have remarked. The following are extracts from my memoranda.

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"*November* 25, 1825.—I may almost say I have seen *Saturn* for the first time to-night; for I never before saw this planet so well. The double ring was beautifully defined and perfectly distinct all round, and the principal belts well seen. This was with Dollond's Newtonian. 259 was perhaps the best power. 480, a single lens, was very distinct. I tried many concave lenses, and found that the image was much sharper than with convex eye-glasses, and the light apparently much greater.

"*November* 30.—The night very favourable, though not equal to the 25th. The exterior ring of *Saturn* is not so bright as the interior, and the interior is less bright close to the edge next the planet. The inner edge appears more yellow than the rest of the ring, and nearer in colour to the body of the planet.

"*December* 17.—The evening has been extremely fine; no wind, and a very slight fog, which is always favourable to distinct vision. Both reflecting telescopes were in excellent order. With Dollond's Newtonian I perceived the outer ring of *Saturn* to be darker than the inner ring, and I saw the division of the ring all round with perfect distinctness; but with Watson's Newtonian, I fancied that I saw the outer ring separated by numerous dark divisions, extremely close, one stronger than the rest dividing the ring about equally. This was seen with my most perfect single eye-glass, power about 280. I have little doubt, from a most careful examination of some hours, that that which has been considered as the outermost ring of *Saturn* consists of several rings. The inner ring decidedly has no such appearance; and it is visible only in Watson's Newtonian. I tried the effect of lessening the aperture of Watson's Newtonian a little; but it was not in the least improved by it.

"*January* 16, 1826.—Part of the evening was fine, and I examined *Saturn* carefully with Dollond's Newtonian. I thought I could perceive the outer ring to be made up of several, as before mentioned; but it was not so distinct as with the small Newtonian, on the 17th December. Tried concave eye-glasses. One which magnifies about 160 times is very beautiful, and certainly superior in light to a convex eye-glass.

"*January* 17.—Viewed *Saturn* with Dollond's Newtonian and a new plane mirror. I think this is more distinct. The outer ring appeared to be made up of several rings, but not so distinctly marked as to enable me to say positively.

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"*February* 26.—The evening appeared very fine, and I got out DOLLOND's Newtonian, hoping to see the divisions of the exterior ring; but though the atmosphere was certainly favourable, and the telescope performed well, I could not see the divisions, in consequence, I believe, of the London smoke. The grand division of the ring did not appear intensely black; and this, I believe, is necessary to the visibility of the divisions of the exterior ring.

"*January* 22, 1828.—The evening was remarkably fine; and after the moon was set, I examined *Saturn* for some hours with DOLLOND's Newtonian. The separation of the double ring could be traced until it went behind the body of the planet. The quintuple belt was also distinctly seen, and the shading, or deeper yellow, of the inside edge of the inner ring; but no trace of divisions in the outer ring could be perceived. I am, therefore, the more persuaded that they are not permanent."

The above extracts comprise the substance of all the observations on this subject contained in my journals. On December 17, 1825, I made a drawing of the appearance of the ring, which is given, Plate I, fig. 1; and on the same evening I requested a friend to examine the ring, and make a drawing of its appearance. This is given, Plate I, fig. 2. Another friend also, not much accustomed to telescopic observations, who was requested to describe the appearance of *Saturn's* ring, stated the outer ring to be divided into two parts by a black line, as in fig. 3. We have, then, the evidence of three persons as to the general fact of the appearance of divisions of the exterior ring. To me it appeared to be divided into two parts, nearly equal, by a strong black line, and each part to be subdivided into at least two others by fainter black lines. By the observation of the second person, the outer ring appeared to consist of several divisions, which were verbally described to be "similar to coarse line engraving." I chose to let the sketch made by this person remain as first drawn, rather than lead, by any question, to the observation that one of the lines was stronger than the rest. By the third person, the stronger division of the outer ring was seen, but not the minor divisions. This person was extremely short-sighted; and as the adjustment of the telescope remained as it suited my eye, this may account for the finer divisions not being seen, whilst the stronger division remained visible.

On referring to the observations of the 25th November, 1825, we find

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that, though the evening was very favourable, no mention is made of divisions in the outer ring; and we may therefore suppose that they were not then visible.

On the 30th November it is remarked, that the exterior ring was not so bright as the interior; but no suspicion is expressed of the existence of divisions.

On the 17th December, 1825, and on the 16th and 17th January, 1826, the outer ring appeared to be made up of several rings.

The evening of the 22d January, 1828, is stated to have been remarkably fine, and as favourable for distinct vision as that of the 17th December, 1825; yet no trace of divisions of the outer ring could then be perceived.

I shall now proceed to the evidence of other observers, with respect to the existence of this interesting phenomenon.

I recollected to have somewhere read, that Short had, with one of his large telescopes, observed that the ring of *Saturn* appeared to consist of several concentric rings.

After much search, I found the following note in the second volume of Brewster's edition of Ferguson's *Astronomy*. "Mr. Short assures us, that, with an excellent telescope, he observed the surface of the ring divided by several dark concentric rings, which seem to indicate a number of rings proportional to the number of dark lines which he perceived."

The observations by Mr. Short, thus referred to, I regret to say, I can no where find.

In the *Mémoires de l'Académie Royale des Sciences*, for 1787, is a Memoir, by M. de Laplace, *sur la Théorie de l'Anneau de Saturne*, in which he says, "Enfin, M. Short, avec un fort télescope, apperçut plusieurs bandes concentriques à sa circonférence. Ces observations ne permettent pas de douter que l'anneau de *Saturne* ne soit formé de plusieurs anneaux, à-peu-près dans le même plan."

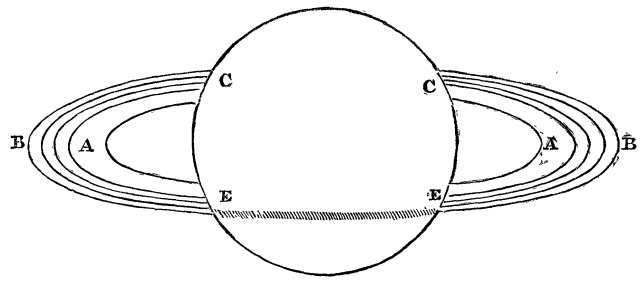
In the third volume of Lalande's *Astronomie*, Art. 3351, (third edition), we have a most important record of a conversation between Mr. Short and M. de Lalande. "Cassini observa que la largeur de l'anneau étoit divisée en deux parties égales par un trait obscur, dont la courbure étoit la même que celle de l'anneau, et que la partie extérieure avoit une lumière moins vive. (*Mém.* 1715, p. 13.) Short, avec son grand télescope de douze pieds, m'a dit y avoir observé des phénomènes encore plus singuliers.

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L'épaisseur des anses A B étoit, selon lui, divisé en deux; la partie intérieure A paroissoit avoir une lumière continue sans interruption. SHORT disoit avoir vu la partie extérieure B divisée par plusieurs lignes, qui paroissoient concentriques à la circonférence de l'anneau, et qui feroit croire qu'il y a plusieurs anneaux placés dans un même plan. . . . . Les lignes de la figure 280, plus distinctes dans la partie B, se rapprochent et se confondent vers les pointes C et E, parceque l'anneau y est trop mince, à raison de l'obliquité, qui n'a pas lieu dans le sens AB perpendiculaire au rayon visuel."

In the annexed wood-cut I have given an exact copy of the figure in LALANDE's *Astronomie*, above referred to.



I must here beg it may be remarked, that this figure shews it was the exterior ring which SHORT observed to be divided, and that the interior ring is without such divisions. These appearances agree with those observed by myself.

M. DELAMBRE, in his *Abrégé d'Astronomie*, p. 485, says, "SHORT avoit cru que l'anneau étoit quadruple, c'est-à-dire composé de quatre anneaux situés dans un même plan." This is probably given on the authority of LALANDE.

M. BIOT, in his *Traité Elémentaire d'Astronomie Physique*, vol. iii. p. 95, speaking of the ring of *Saturn*, has the following passage:—"En observant l'anneau avec d'excellentes lunettes, on reconnoit sur sa surface des lignes concentriques, noires et extrêmement deliées, qui semblent le séparer en autant de circonférences paralêles. Il y auroit donc ainsi plusieurs anneaux distinctes et séparés les uns des autres. Il faut des lunettes extrêmement parfaites pour appercevoir cette séparation. Dans les autres, l'irradiation,

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étendant un peu l'espace occupé par chacque anneau, fait disparoître les intervalles qui les séparent, et les réunit tous en un seul."

It is much to be regretted that M. Biot does not give his authority for what he has here so distinctly stated; and I am hence disposed to conclude, that the assertion is founded on the conversation before detailed between Short and M. Lalande.

Having the honour of being acquainted with Professor Quetelet, Director of the observatory at Brussels, I mentioned to him, when he was in England, the observations I had made upon the ring of *Saturn;* and he informed me that, in December 1823, at Paris, with the achromatic telescope of ten inches aperture, which was exhibited at the exposition, he saw the outer ring of *Saturn* divided into two. This, he informed me, he mentioned the following day to M. de Laplace, who observed, that " those, or even more divisions, were conformable to the system of the world."

Having thus adduced all the evidence I have been able to collect for the outer ring of *Saturn* being subdivided, I shall now add observations of an opposite tendency.

In the *Philosophical Transactions* for 1792, Sir William Herschel, in his paper upon the ring of *Saturn,* refers to Mr. Short's conversation with M. de Lalande; and, on examining his own observations, finds no evidence of the division of the outer ring, but seems inclined to attribute the phenomenon observed by Mr. Short to " the tremors in telescopes of large apertures, which multiply small lines." This, however, I conceive, will not account for the appearance which has been described; for, if the multiplication of the grand division of *Saturn's* ring by tremors were the cause, it would not have been confined to the outer ring.

I communicated to Mr. Herschel, in the beginning of 1826, the observations which I had made; and when he next went to Slough, he examined the ring of *Saturn* with the twenty-feet reflector, but could perceive no subdivisions. Mr. Herschel also wrote to M. Struve, who, in a paper read the 9th June, 1826, at the Astronomical Society, says, " As to a division of the ring into many parts, I have noticed no trace. It is remarkable that the outer ring is much less brilliant than the inner. The inner one, too, towards the planet, seems less distinctly limited, and

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to grow fainter, so that I am inclined to think that the inner edge is less regular than the others."

From the observations which have been given in the present paper, we may deduce the following conclusions:—

That the exterior ring of *Saturn* was observed by SHORT to be divided into three or four concentric rings:

That Professor QUETELET, in December 1823, at Paris, with an achromatic telescope of ten inches aperture, saw the outer ring of *Saturn* divided into two concentric rings:

That, on the 17th December, 1825, the outer ring of *Saturn* appeared to me to be made up of at least four rings, the widest interval being in the middle:

That, on the 16th and 17th January, 1826, I again remarked these divisions of the exterior ring:

That these divisions were also observed by a friend who was with me on the 17th December, 1825, but who did not remark that one division was stronger than the others:

That another friend who was with me on the same evening, and who is very short-sighted, saw the stronger division, but could not perceive the others.

I think it will be allowed that the evidence here given goes far to establish the probability of the outer ring of *Saturn* being composed of several concentric rings. On the other hand, it appears that Sir WILLIAM HERSCHEL, Mr. HERSCHEL, and Mr. STRUVE, though observing with very superior instruments, could perceive no such divisions as those which I have described.

On the 22d January, 1828, the evening being perfectly favourable, I again examined *Saturn* with great care for several hours, but no divisions of the outer ring were then perceptible.

It has been remarked by Sir WILLIAM HERSCHEL, by Mr. STRUVE, and by most persons who have observed *Saturn*, that the exterior ring is much less brilliant than the interior: may not this want of light in the outer ring arise from its having a very dense atmosphere? and may not this atmosphere, in certain states, admit of the divisions of the exterior

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ring being seen through it, though under other circumstances they remain invisible?

With respect to the form of the edge of the inner ring of *Saturn*, next to the planet, the appearance under favourable circumstances is such as to leave no doubt on my mind of its being rounded.

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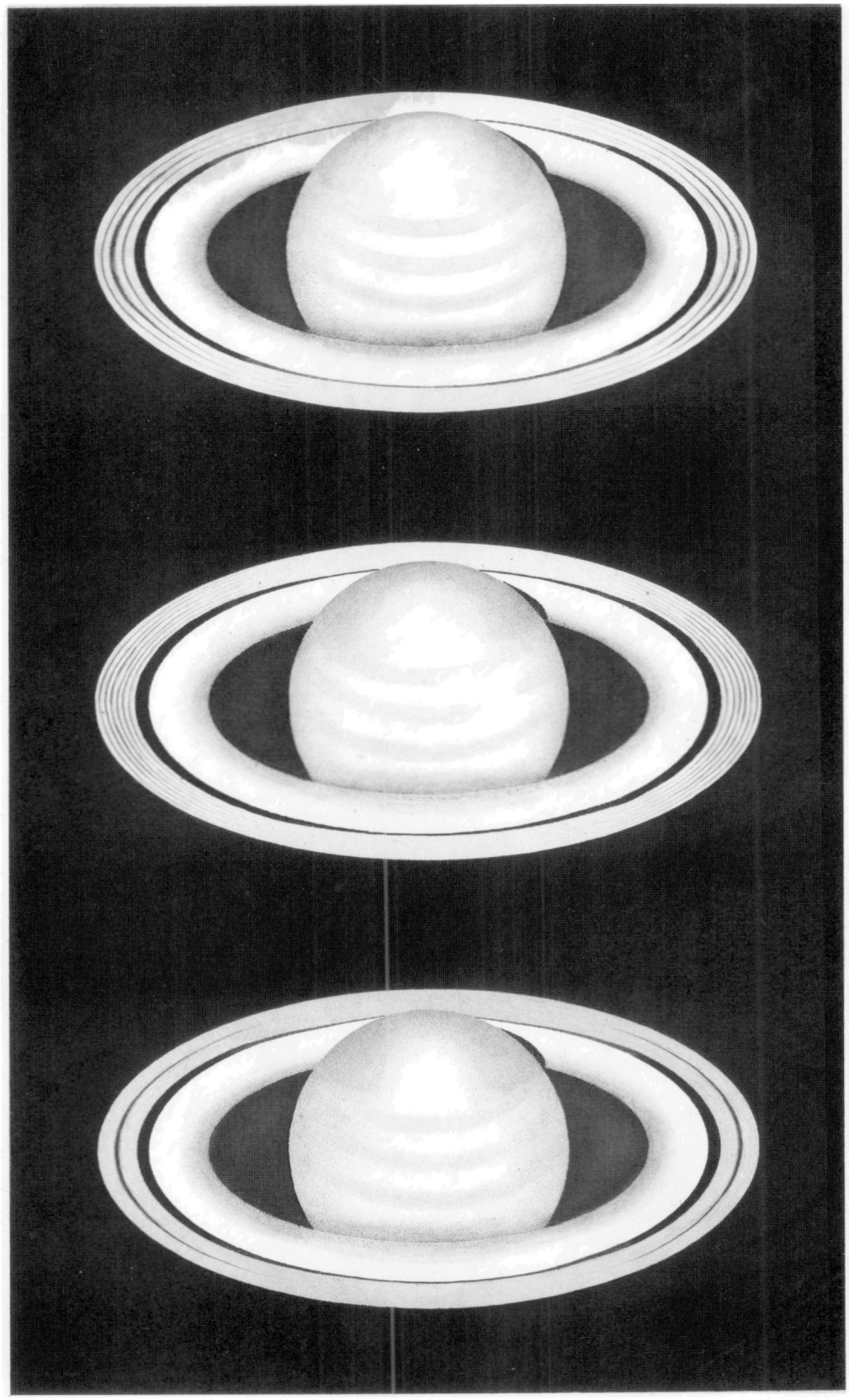


Fig. 1.

Fig. 2.

Fig. 3.

Drawn by Capt.n Kater.

Engraved for the Astronom.l Society of London by E. Turrell.

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XX. *Mayer's Catalogue of Stars, corrected and enlarged; together with a Comparison of the Places of the greater part of them, with those given by Bradley; and a reference to every observation of every Star. By Francis Baily, Esq., F.R.S., &c. &c.*

Read June 11, 1830.

It is needless for me here to enter into any panegyric on the celebrated catalogue of stars, deduced from the observations of Tobias Mayer, and which consequently bears his name. The zeal and ability of the observer, and the excellence of the instrument employed by him, at a period when good instruments were not so attainable as at the present day, have stamped on it a reputation which will last as long as the science of astronomy exists. The work itself has always been scarce in this country, and I believe is known here chiefly through the imperfect version of it in Vince's *System of Astronomy*.

The instrument, with which Mayer made his observations, was a brass quadrant of six feet radius, made by Bird: divided on the limb in three different ways. The *inner* division was, in the usual manner, into 90°; and each of these degrees was again divided into 5′; the parts of which could be read off, by means of a vernier, to 30″; and by estimation to a smaller quantity. The *middle* division was into 96 parts; each of which was subdivided by 16 dots, and the parts read off to single seconds by means of a micrometer screw. The *outer* division was (like the middle one) into 96 parts; each of which was subdivided into 16 parts by lines instead of dots; and each of these again into 16 other parts by means of a vernier: the more minute subdivisions being estimated by the eye. The value of each of these vernier divisions was thus equal to 13″,18359 (sexagesimal); the next larger divisions equal to 13″,18359 × 16 = 3′ 30″,94 (sexagesimal); and the largest divisions equal to 3′ 30″,94 × 16 = 0° 56′ 15″ (sexagesimal). This last (or the *outer*) division of the quadrant was the one generally used by Mayer in his observations: and it is the more necessary to attend to

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this fact, as it will account for some of the discordances observable in the catalogue. For we shall find, in the sequel, that Mayer has probably made a mistake, in recording his observations of zenith distances, in one instance, of 3 of the largest divisions (= 2° 48′ 45″): in six other instances, of one of the next subdivisions (= 3′ 30″,9): in another case, an error of 6 of the same subdivisions (= 21′ 5″,6): in another case, an error of 10 divisions of the vernier (= 2′ 11″,8): and, in another case, an error of 4 divisions of the vernier (= 52″,7): all of which are either corrected, or noticed for correction, in the present catalogue.

The observations of Mayer were confined principally to stars situated in the zodiac.* There are a few, however, contained in his catalogue, which are far distant from that zone of the heavens: and many others, scattered amongst his observations, which have never yet been reduced. These last I have collected together, and inserted at the end of this memoir, in a *Supplementary Catalogue.*

Mayer had no transit instrument for determining the right ascensions of the stars; but took them with the telescope of his quadrant, which was furnished with 5 vertical wires: the equatorial intervals of which (on each side of the centre wire) were respectively 30, and 60 seconds (in time). These intervals, being multiplied by the secant of declination, will give the interval of any other star; and thus enable us to correct some apparent errors in Mayer's catalogue; as I shall more particularly allude to, in the *Notes* at the end of this paper.

Mayer was only thirty-nine years of age, when he died in 1762. He was appointed the director of the observatory at Göttingen, founded by his late Majesty George the Third, in 1756; and he continued to make observations there till the time of his death: but the major part of those observations were made in the years 1756 and 1757, during part of which time the city was besieged by an invading army, and whilst it was unsafe to venture into the observatory, which was very much exposed to the fire of the enemy. In fact, nearly the *whole* of the observations, *from which the catalogue is deduced,* were made in those two years: for, it does not appear that many of the observations made in the years 1758, 1759, 1760,

* Out of the whole number of stars, which Mayer's catalogue contains, there are only 57 that are not situated within 10° of the ecliptic.

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or 1761 (amounting to about 145 in number) have ever been reduced. Probably the whole (or nearly the whole) of these two years' observations were reduced during his lifetime; as, in a memoir which he drew up relative to the proper motion of some of the fixed stars (January 12, 1760), he refers to, and makes extracts from, his manuscript catalogue. But, the catalogue, which bears his name, was not printed and published till the year 1775; when it formed part of a work edited by Professor Lichtenberg, entitled *Tobiæ Mayeri, Astronomi celeberrimi, Opera inedita*, vol. i., *Göttingæ*, 1775. At that time astronomers had no other guide than the catalogue of Flamsteed: as Bradley, the contemporary of Mayer, had not yet published the results of his observations.* Mayer's catalogue, therefore, was of inestimable value to the practical astronomer, as it enabled him, by a comparison with that of Flamsteed, to fix more accurately the positions of most of the principal stars in the heavens, and to form some opinion of their proper motion.

In the posthumous work just alluded to, there is a memoir by Mayer, on the methods adopted by him for correcting the errors of observation arising from the erroneous position of the quadrant; and which are similar to those practised at the present day. This memoir has been reprinted in the recent volume of Mayer's *Observations*, to which I shall presently allude.

When the catalogues of Piazzi and Bradley appeared, several discordances in Mayer's catalogue were discovered on comparing it with those works; and some of his stars were supposed even to be lost, since they could not be found in the places assigned to them. These discordances could only be set right by a reference to the *original observations:* and having ascertained that the manuscripts were still existing, and in the possession of Baron Zach, who had kindly offered to lend them, I addressed a letter to the late Board of Longitude stating this fact, and suggesting the propriety of their being printed at the public expense.† This suggestion was favourably received: and, the manuscripts having been forwarded to this country,

* In the *Nautical Almanac* for 1773, however, a catalogue of 389 principal stars, deduced from the observations of Bradley, was published.

† This letter was delivered, and the subject of it supported, by Davies Gilbert, Esq.; whose zeal in the cause of science is too well known to require any comment here.

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the work soon after appeared, under the title of *Astronomical Observations made at Göttingen from* 1756 *to* 1761. *By* Tobias Mayer. *London*, 1826. *Folio*. The superintendence of the press was intrusted to Signor Mossotti, at that time residing in this country; who appears to have executed his task with great ability.

From the 8th of February 1756, when the observations commenced, to the 23d of May in the same year, the manuscript, from which the above-mentioned observations were printed, contains only the *transits* of the stars over the meridian; with the corrections for the error of the clock, precession, aberration, &c., by the author himself: the *zenith distance* observations being probably lost. But, after that date, the observations are given at full length, as they were made with the instrument. Mayer seldom observed a star at more than one wire, unless it were one of considerable magnitude: and if the wire happened to be one of the side wires, it was put down in the margin, and reduced to the middle wire in the subsequent column. In the latter period of his life, however, he usually observed with all the five wires. The zenith distances were generally observed with the 96 division of the quadrant, and reduced to the sexagesimal division in the contiguous column.

By comparing the discordant stars, alluded to in the preceding page, with the printed observations, the source of the discordancy may, in most instances, be detected; and, by correcting the catalogue accordingly, it may be made to correspond with the same stars in the catalogues of Bradley and Piazzi, within the ordinary limits of the errors of observation. Some few cases, however, I must confess, still remain, which have baffled all my endeavours to reconcile them with the observations: and I must leave them, with a hope that they will yield to more skilful hands.

The arrangement of the present catalogue is similar to the original, with the exception of the additional columns. The first column contains the numbers in ordinal succession, for the sake of a convenient reference. The second column contains the names of the stars; which are taken from Bradley and Piazzi. These names are for the most part omitted in the original: and when inserted are sometimes erroneous. Piazzi's numbers are enclosed in a parenthesis, for the sake of distinction. The third column contains the magnitudes of the stars, as given by Mayer; which will be found to differ occasionally from the value given by Piazzi. I have thought

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it right to preserve the original values;* as it might tend to throw some light on this still doubtful branch of the science. In some few cases Mayer has reversed the order of the numbers, as in No. 52, which he calls 4·3 magnitude: by which I presume he means that it is nearer the 4th magnitude than the 3d. This system of notation I have retained. The fourth and fifth columns contain respectively the right ascension and declination of each star, reduced to January 1, 1756: north declination being denoted by a positive, and south declination by a negative sign.† The sixth and seventh columns denote the difference of Bradley's catalogue in right ascension and declination respectively: or the values which must be applied (with their proper algebraical signs) to the present catalogue, in order to produce the values in Bradley's catalogue. The last column contains a reference to the *pages* of the printed observations, where the observations of each star will be found recorded.‡ I have considered it unnecessary to indicate the *line* in each page; as this would have taken up too much room: and, in fact, the star may generally be found very readily, by the order of right ascension. When the number of these pages exceeds 100, I have had recourse to a contrivance, in order to prevent confusion, which (and the cause of which) I shall now proceed to explain.

When Baron Zach forwarded Mayer's manuscripts to England, he did not include the observations for the year 1756; because the manuscripts in his possession (for *that* year) were only *copies* of the *originals*, which were

* Except in the case of No. 583. See the note to that star.

† I have not thought it necessary to preserve the columns denoting the *number of observations*, from which the right ascension and declination of each star is deduced; as they may be supplied from the last column here given. I would, however, remark, that Mayer appears to have wholly excluded all the doubtful or imperfect observations, unless there was only *one* observation of the star. And I would also remark, that, after this is allowed for, I still find an occasional discordance in the *number* of observations as given in his catalogue; even without taking into account those made in the years 1758-1761: which, as I have already observed, have not yet been reduced. Thus, in the case of No. 777 (ϱ^1 *Sagittarii*) the right ascension is said to be deduced from 3, and the declination from 5 observations: but there are 5 complete observations of the former, and 6 complete observations of the latter. Many other similar examples might be adduced. See also the note to No. 694.

‡ Where the number of observations is too large to be inserted in this column, the references will be found in the *Notes*.

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still in possession of Mayer's son at Göttingen. Owing to some misunderstanding on this point, the late Board of Longitude, at first printed only the observations for the *subsequent* years; and were just on the eve of publishing them, when the error was discovered. The original manuscripts of the observations for 1756 were therefore obtained from Mayer's son (not from the Royal Library at Göttingen, as erroneously stated in the Preface): and, as it was necessary that the sheets containing the observations of this year should *precede* the others (already printed off), it was formed into another and a separate part. This is attended with no other inconvenience than as tending to produce some confusion in referring to the *pages* of the work. In order to obviate any errors arising from this source, I have supposed all the pages in the *second* part of the work to be increased by 100; so that pages 1, 2, 3, &c. in the *second* part, are denoted by 101, 102, 103, &c.: and it is in this manner that all the pages are to be understood in the last column of the present catalogue, when they exceed 100.

I have stated that Mr. Vince's edition of Mayer's catalogue, contained in the second volume of his *System of Astronomy*, is erroneous and imperfect: and it may be considered requisite to adduce some proofs of this assertion. In the first place, it is not strictly a true copy of Mayer's catalogue; but rather Mayer's catalogue *reduced to the year* 1790, for the convenience of modern observers: whereby the results are mixed up with all the errors arising from proper motion, incorrect precession, &c. &c. Secondly, the numbers affixed to the stars do not in any instance (after the first 16) accord with the numbers of Mayer's catalogue. For Mayer's catalogue consists of 998 stars: whereas Mr. Vince has got only 992: and this arises from his having omitted nine of Mayer's stars (viz. Nos. 17, 41, 240, 397, 571, 598, 915, 964, 968), and from having inserted three, which are not to be found in Mayer's catalogue (viz. Nos. 113, 671, and 934, of his own catalogue). I would add also that Mr. Vince's catalogue gives the north polar distances, instead of the declinations.

In order to shew, at one view, the several alterations which I have made in Mayer's catalogue, I have brought together, in the following list, the whole of the corrections which I have introduced: where it is to be observed that those alterations, which are marked with an asterisk, are in some measure conjectural, or founded on the authority of the catalogues of Bradley, and Piazzi; the rest are warranted by a comparison of the

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observations themselves. In applying these corrections to the southern declinations in Mayer's catalogue, regard must be had to the *signs*. I have not made any allowance for the difference in the effect of refraction, caused by the correction of the declinations: for in most of the cases this will be very trifling in amount, and in the four principal cases (Nos. 195, 676, 704, and 982) it may be doubted whether those corrections have not already been properly applied; since the error may be only in transcribing.

Alterations made in Mayer's Catalogue.

In Right Ascension.		In Declination.	
No.		No.	
78	−1° 0′ 0″	9	sign changed.
207	−0 0 30	11	sign changed.
292	−0 7 54*	92	−0° 0′ 10″,0
328	−0 15 0	117	+0 11 —*
600	+0 1 30	195	+1 0 0,0
625	−0 7 30*	224	+0 1 0,0*
733	+0 0 15	244	+0 2 0,0*
772	−0 15 0	329	+0 3 30,9*
782	−0 15 0	338	+0 21 5,6
830	−0 15 0*	428	−0 1 0,0
831	−0 15 0*	653	−0 2 11,8*
833	−0 15 0*	667	−0 0 15,0
892	−0 0 24	676	−7 2 —
922	+0 1 0	681	+0 3 30,9*
970	−0 10 0	704	−1 0 0,0
		838	+0 10 0,0
		839	+0 10 0,0
		842	−0 3 30,9*
		929	−0 1 0,0
		937	+0 1 0,0
		944	−0 1 0,0
		966	−0 0 10,0
		982	−5 7 1,9
		983	−0 1 0,0

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Independent of these alterations, however, there are some others which appear to be requisite, in order to perfect the catalogue: but, as these are founded on a comparison with Piazzi's catalogue *only*, and may consequently be mixed up with some unknown proper motion of the star, I have not ventured to introduce them. Yet as subsequent observations may throw some additional light on this subject, I shall here subjoin a list of such presumed corrections, for the convenience of future astronomers.

Alterations suggested in Mayer's Catalogue.

In Right Ascension.		In Declination.	
No.	$-0^{\circ}\,15'\,0''$	No.	$-0^{\circ}\,5'\,0''{,}0$
197		159	
261	$-0\ 7\ 49$	234	$+0\ 12\ 0{,}0$
307	$-0\ 0\ 8$	307	$-0\ 3\ 30{,}9$
460	$-0\ 0\ 30$	378	$-0\ 1\ 45{,}5$
496	$-0\ 16\ 0$	399	$-0\ 6\ 0{,}0$
499	$-0\ 7\ 30$	455	$-0\ 1\ 0{,}0$
696	$-0\ 0\ 15$	501	$+2\ 48\ 45{,}0$
759	$-0\ 16\ 30$	508	$-0\ 3\ 30{,}9$
854	$-0\ 15\ 54$	783	$+0\ 3\ 30{,}9$
		951	$+0\ 0\ 52{,}7$

Besides these, there are eleven *lost stars:* that is, such as cannot now be found in the places assigned to them in Mayer's catalogue: neither can they be reconciled to any existing stars by any plausible conjecture. These are Nos. 41, 127, 146, 153, 165, 221, 231, 357, 379, 385, and 395. But, as I cannot find any recorded observation of Nos. 146, 153, 165, 357, 385, or 395, there are only the following five stars in the catalogue whose positions cannot now be identified, or conjectured. The places of these stars, reduced to the year 1830, would be as follow: viz.

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Lost stars, reduced to January 1830.			
No.	Mag.	R in time.	Declination.
		h m s	° ′
41	7	1 6 24	+ 6 13
127	7·8	3 39 17	+23 52
221	8	5 38 37	+ 9 41
231	.	5 53 23	+17 49
379	9	8 45 21	+ 8 53

Mayer's quadrant was not well adapted for determining with minute accuracy the absolute *right ascensions* of the stars; more especially of those having considerable northern declination. We therefore find on this point a greater difference from Bradley's values than we probably should experience had he been furnished with a regular transit instrument. Still, we are enabled to determine, by means of the printed observations, the *relative* positions of most of the stars, with a considerable degree of accuracy and precision. He determined the deviation of his instrument from the meridian, by means of equal altitudes, taken with a smaller quadrant of 15 inches radius. By this method, and also by a comparison of several bright stars with the sun, when on the same parallel, he determined the absolute right ascension of some of the principal ones, and filled up his catalogue by a comparison with these fundamental stars. The stars, which he adopted for this purpose, appear to be the following: viz.

192 β Orionis.	220 γ Leporis.	539 α Virginis.
200 γ ———	222 κ Orionis.	554 η Ursæ Maj.
204 β Leporis.	225 α ———	566 α Bootis.
206 δ Orionis.	266 α Canis Maj.	714 γ Draconis.
208 α Leporis.	299 α Geminorum.	743 α Lyræ.
210 ε Orionis.	306 α Canis Min.	804 α Aquilæ.
212 σ ———	312 β Geminorum.	852 α Cygni.
213 ζ ———	434 α Leonis.	942 α Piscis Aust.

On the other hand, the *declinations* have a remarkable degree of accordance (scarcely surpassed by more modern instruments of far superior note), indicative, at once, of the skill and attention of this illustrious astronomer.

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Yet, on looking down the column of differences in declination, we cannot but be struck with the circumstance, that Bradley's north polar distances, in almost every case, *exceed* those given by Mayer. There are very few exceptions as to this point: and those very trifling in amount. The mean of the 610 stars compared is 4″,27.*

In the preface to the printed observations, M. Mossotti has entered into an explanation of certain figures inserted in the *first* column of the journal, and which are affixed opposite to the state of the barometer and thermometer: but he has not explained the values given in the *seventh* (or penultimate) column, and which appear still to be misunderstood by several excellent astronomers.† M. Bessel has imagined, after Delambre and Zach, that they relate to the correction of the zenith distance, arising from the index (or other unexplained) error of the instrument: and each of these authors has so treated it in reducing the observations of Sept. 25, 1756, for the purpose of determining the position of *Uranus*, observed by Mayer on that day. But, it has nothing to do with the instrumental error, and is a correction for the refraction only. For we should keep in mind the remark of M. Mossotti, "that Mayer divided his table of "refractions into two columns: one that gave the mean refraction when the "thermometer (Reaumur) stands at 10°, and the barometer at 27 inches "8 lines (French):" and the other which gave the corresponding *correction of refraction for the changes in the thermometer and barometer.* The values in the seventh column, above alluded to, are the *corrections* here mentioned: and which are to be applied to the *mean* refractions computed on Mayer's assumption. This will be evident on a bare inspection of the observations:‡ for on July 4, 1756, when the thermometer was 10°, and the barometer at 27 inches 8 lines (which are the mean quantities above alluded to), no correction was required, although the quadrant had traversed

* Mayer was of opinion that the declination of those stars, of which there was only one observation, might be doubtful to 10″: whilst the uncertainty of those observed ten times might be reduced to 2″.

† The columns here alluded to commence with May 23, 1756, in page 28, and continue to the end of the volume; with the exception of pages 46, 47, 49, and 50, when the instrument was reversed: and where this column contains the *reduction to the meridian.*

‡ As well as from the remark made by M. Lichtenberg, in page 92 of Mayer's *Opera Inedita.*

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through more than 70° of altitude: whilst on the next day, when the thermometer had risen 6°, there is a correction of upwards of 6″ from the highest to the lowest star: and similar variations and corrections are noted on other days, exactly corresponding to the changes in the barometer and thermometer. The place of *Uranus*, therefore, as deduced by M. Delambre in his *Astronomie*, vol. ii. page 535; by Baron Zach in the *Zeitschrift für Astronomie*, vol. iii. page 16; and by M. Bessel in his *Fundamenta Astronomiæ*, page 284, will be slightly affected by this mistake.

In Baron Zach's *Correspondance Astronomique*, vol. vii. page 335, it is stated that M. Berenger Labaume, of Marseilles, had formed a new catalogue of Mayer's stars, reduced from the manuscript observations which had been lent to him by Baron Zach; and which, I presume, are the same manuscripts as those alluded to in the preceding part of this memoir. This catalogue has not yet been printed: but, from the specimen given of it by Baron Zach, there is no doubt it would be a valuable addition to the library of the astronomer. The reductions are founded on Carlini's tables of refraction, and on Zach's tables of precession, aberration, and nutation. The following is the specimen alluded to, shewing the difference, in the right ascension of 8 stars, between the catalogue of Labaume and Mayer, and of Labaume and Bradley:

No.	Star.	Labaume and Mayer.	Labaume and Bradley.
21	62 Piscium	36″,0	3″,7
307	(170) Canis min.	16,4	4,8
921	γ Aquarii	12,9	2,1
922	51 ——	46,6	5,8
925	ζ ——	12,6	3,0
945	β Piscium	10,1	0,3
980	19 ——	10,2	0,4
987	24 ——	15,4	2,2

There is some ambiguity about the difference in the first star in this list, as the right ascension of 62 *Piscium*, given by Mayer, is almost identical with Bradley's value; the difference being only 0″,2. The error

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in 51 *Aquarii* is corrected in the present catalogue, and the difference reduced to 5″. The difference also of No. 307 is reduced to 3″,5 by the correction pointed out in the note to that star. As to γ and ζ *Aquarii*, although Mayer's values differ so much from Bradley's (viz. 10″,8 and 9″,6 respectively), yet they accord within 3″ of Piazzi's values; and are, moreover, almost identical with Mr. Pond's recent determinations. I cannot throw any light on the discordancy of the remaining three stars.

On examining the volume of printed observations, so frequently referred to in this memoir, I have met with several stars observed by Mayer, which are not inserted in his catalogue. Some of these are of considerable magnitude, and have been observed many times: such as γ and β *Aquilæ*; ε, η, and β *Aurigæ*; &c. And although these cannot be called zodaical stars, yet we find stars inserted in the catalogue equally distant from that zone: such as β and α *Persei*, α *Aurigæ*, α *Bootis*, &c. &c. I have given a list of these omitted stars, in a *Supplementary Catalogue* at the end, with their approximate positions at the beginning of the year 1756, as well as references to the pages of the printed observations. Amongst them we shall find some that ought to have found a place in a zodaical catalogue; but which appear to have been overlooked by Mayer.

I have also subjoined a list of 10 occultations of stars by the moon; which are scattered through the observations: and which may now, by this arrangement, be easily referred to.

N.B. The dots, annexed to the right ascension and declination of some of the stars in the following Catalogue, denote uncertainty in the observations: and the larger the number of dots, the greater the uncertainty.

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MAYER'S

CATALOGUE OF STARS, CORRECTED.

No.	Names.	Mag.	Right Ascension, 1756.	Declination, 1756.	Diff. of Bradley's Catalogue.		Reference to the *pages* of the printed Observations.
					AR	Dec.	
1	γ Pegasi	2	0° 10′ 29″,6	+13° 49′ 37″,9	— 2″,1	— 3″,8	62, 68, 132, 136.
2	35 Piscium	7	0 36 34,8	+ 7 27 54,7	— 4,6	— 0,4	68.
3	36 ———	7	1 0 54,1	+ 6 53 7,0	— 7,6	— 5,3	68.
4	(26) ———	8	1 2 33,5	+ 0 29 39,5	....	....	62, 68, 136.
5	(33) ———	7	1 19 15,2	+ 0 19 53,1	....	....	62, 68, 136.
6	41 ———	6	2 1 2,7	+ 6 50 4,9	— 9,2	— 5,4	62, 68, 70, 132, 136.
7	(60) Ceti	7	3 0 38,6	— 3 34 7,4	....	....	63, 136.
8	44 Piscium	6·7	3 13 43,0	+ 0 35 12,8	— 8,6	— 0,8	68, 70, 132.
9*	10 Ceti	7	3 31 58,8	— 1 24 6,9	—13,8	— 3,5	63, 68, 70, 132.
10	(73) Piscium	8	3 42 37,2	+ 1 27 45,7	....	....	63, 136.
11*	12 Ceti	6·7	4 24 0,4	— 5 18 22,8	— 8,8	— 7,3	63, 136.
12	51 Piscium	6·7	4 57 30,7	+ 5 36 20,1	— 4,6	— 2,8	132, 136.
13	(107) ———	9	5 15 16,3	— 1 57 15,2	....	....	136.
14	(120) ———	6·7	5 45 37,2	— 1 50 49,4	— 7,2	....	132, 136.
15	15 Ceti	7·8	6 24 18,4	— 1 50 47,0	— 4,8	— 6,4	132, 136.
16	(146) ——	6	7 4 30,6	— 5 41 53,4	....	....	132, 136.
17	(157) ——	9	7 38 59,7	— 5 11 44,0	....	....	136.
18	(167) Piscium	8	8 9 30,4	— 1 4 51,9	....	....	70, 132, 136.
19	60 ———	6	8 42 2,5	+ 5 24 23,9	— 5,7	— 6,4	63.
20	(189) ———	6·7	8 54 12,2	+ 4 1 21,4	....	....	132, 136.
21	62 ———	7·8	8 54 52,1	+ 5 57 50,5	— 0,2	— 0,8	69, 70, 71, 132.
22	δ ———	4	9 0 49,1	+ 6 15 13,8	— 7,1	— 5,0	63, 69, 70, 71, 132.
23	(207) ———	7·8	9 41 32,4	+ 2 3 32,2	....	— 3,3	63, 70, 71, 132.
24	20 Ceti	6	10 8 26,0	— 2 28 20,7	— 9,9	— 6,3	63, 136.
25	(216) Piscium	8	10 11 47,8	+ 2 45 33,1	....	....	70, 71.
26	(227) ———	8·9	10 40 31,7	+ 5 31 40,3	....	....	71.
27	(231) ———	7	10 50 46,4	+12 37 32,8	....	....	70.
28	(243) ———	7	11 17 5,3	+12 22 21,0	....	....	70, 71.
29	(246) ———	7·8	11 25 26,7	+ 5 31 24,6	....	....	70, 71.
30	(252) ———	7	11 48 9,3	+ 5 9 43,9	— 6,2	....	70, 71.

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No.	Names.	Mag.	Right Ascension, 1756.	Declination, 1756.	Diff. of Bradley's Catalogue.		Reference to the *pages* of the printed Observations.
					AR	Dec.	
31	ε Piscium	4	12° 34′ 38″,4	+ 6° 34′ 21″,1	−10″,5	− 4″,4	70, 71.
32	(269) ———	8	12 47 15,7	+ 5 27 3,0	....	....	71.
33	73 ———	7·8	13 3 56,4	+ 4 20 37,7	− 7,1	− 6,1	70, 71.
34	77 ———	7·8	13 18 27,6	+ 3 36 16,6	− 8,9	− 5,8	70, 71.
35	(297) ———	8	13 54 37,4:::	+ 8 35 59,0	....	....	71.
36	80 ———	5	13 57 25,0	+ 4 21 14,5	− 2,6	− 2,9	70, 71.
37	(4) ———	8	14 32 10,0	+ 8 14 38,6	....	....	70, 71.
38	(8) ———	7·8	14 41 0,7	+ 8 59 22,8	....	....	71.
39	ζ^1 ———	6	15 15 16,5	+ 6 16 46,6	− 9,1	− 2,7	70, 71.
40	ζ^2 ———	7	15 15 38,9	+ 6 16 59,5	− 8,1	− 5,7	70, 71.
41*	88 ———?	7	15 38 11,1	+ 5 49 4,8	....	....	71.
42	89 ———	6	16 18 36,6	+ 2 19 26,8	− 4,9	− 4,6	70, 71.
43	(44) ———	8·9	16 42 4,0	+ 2 0 11,0	....	....	71.
44*	42 Ceti	6	16 50 24,0	− 1 47 45,8	−14,3	− 5,9	70.
45	(57) ——	7	17 31 15,7	+ 0 26 48,8	....	....	70.
46	(59) Piscium	8	17 31 48,0	+ 3 27 20,3	....	....	70.
47	(60) ———	7·8	17 33 24,3	+ 6 7 17,5	....	....	71.
48	ϱ ———	5	18 17 8,5	+17 53 44,6	+ 8,9	− 7,2	70, 71, 85.
49	94 ———	5	18 23 17,8	+17 58 8,5	+ 9,4	− 5,8	70, 72, 85.
50	(84) ———	7	18 49 44,6	+15 48 32,5	....	....	70.
51	μ ———	5	19 21 27,1	+ 4 52 47,0	− 3,7	+ 3,9	70, 72, 85.
52	η ———	4·3	19 36 56,8	+14 4 51,9	+ 2,9	− 6,2	70, 72, 79.
53	(101) ———	7·8	19 42 45,5	+ 9 37 27,7	....	....	79.
54	(107) ———	7·8	20 8 12,2	+ 6 56 59,4	....	....	70, 72.
55	(114) ———	8	20 31 46,1	+ 7 1 6,0	....	....	70.
56	π ———	5·4	21 2 58,6	+10 53 9,3	+ 0,2	− 3,8	70, 72, 79, 85.
57	(128) ———	8·9	21 10 57,7	+10 49 35,5	− 4,3	....	70, 72, 79.
58	(144) ———	7·8	21 56 30,4	+ 7 30 56,2	....	....	72, 79.
59	(149) ———	9	22 9 6,7	+ 7 49 49,5	....	....	72.
60	ν ———	5	22 11 27,7	+ 4 14 43,9	− 5,4	− 3,9	70, 70, 72, 85.
61	ο ———	5	23 8 10,2	+ 7 55 18,7	− 7,6	− 3,4	72, 79.
62	(169) ———	8·9	23 33 33,1	+ 9 36 54,6	....	....	72.
63	54 Ceti	7·8	24 29 19,1	+ 9 49 35,3	+ 1,6	− 2,8	70, 72, 79.
64*	γ^1 Arietis	4	25 2 46,6	+18 5 24,3	+ 4,0	− 2,8	70, 72, 79, 85.
65	γ^2 ———	.	25 2 48,5	+18 5 15,2	....	− 2,5	70, 72, 79, 85.

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					Æ	Dec.	
66	β Arietis	3	25° 18′ 4″,1	+19° 36′ 20″,5	+ 8″,9	− 4″,4	70, 85.
67	ι ———	5	26 0 51,8	+16 37 0,0	+ 6,4	− 3,4	70, 72, 79, 85.
68	(223) Piscium	8	26 36 3,0	+11 6 4,7	....	....	72, 85.
69	γ Andromedæ	2	27 15 14,1	+41 8 48,1	+15,7	− 1,8	70, 72, 79, 85.
70	α Piscium	3	27 21 50,8	+ 1 34 34,8	−13,9	− 5,1	70, 72.
71	κ Arietis	6	28 14 23,0	+21 28 27,9	+ 6,8	− 3,9	70, 72, 85.
72	α ———	2	28 22 1,5	+22 17 50,9	+ 5,7	− 3,8	70, 72, 79, 85.
73	(257) ———	8	28 36 10,8	+16 51 26,7	....	....	70, 72.
74	15 ———	7	29 17 6,6	+18 20 17,5	+ 8,1	− 3,5	70.
75	(1) ———	9	29 26 5,2	+20 12 55,3	....	....	72.
76	η ———	6	29 47 39,0	+20 3 10,0	+16,1	− 3,5	70, 72.
77	ξ^1 Ceti	4	30 1 37,1	+ 7 41 32,4	− 4,7	− 6,0	70, 72.
78*	19 Arietis	7	29 56 43,5	+14 7 30,2	+ 8,0	− 4,0	70.
79	θ^1 ———	6	31 8 52,4	+18 45 37,4	+ 9,5	− 3,1	70, 72.
80	(58) Ceti	7	31 51 32,7	− 5 28 36,2	....	....	70, 72.
81	ξ Arietis	5	32 56 39,8	+ 9 29 36,4	− 3,0	− 0,8	71, 72.
82	ξ^2 Ceti	4	33 48 23,8	+ 7 21 16,5	− 7,2	− 4,1	71, 72.
83	26 Arietis	7·8	34 14 57,1	+18 45 33,3	+12,2	− 5,8	72.
84	ν Ceti	4·5	35 46 33,5	+ 4 30 59,5	+ 1,5	− 5,3	72.
85	ν Arietis	6	36 15 5,5	+20 53 33,9	+ 6,6	− 4,6	72, 79.
86	δ Ceti	.	36 45 9,6	− 0 44 7,8	−14,0	− 5,4	72.
87	μ Arietis	6	37 9 42,9	+18 57 30,5	+10,3	− 6,3	72.
88	ο ———	6	37 47 4,1	+14 15 54,5	+ 6,8	− 4,5	72, 76.
89	μ Ceti	4	37 56 50,6	+ 9 4 14,0	− 1,2	− 4,6	71, 72, 76, 79.
90	π Arietis	6	38 55 41,0	+16 26 7,2	+ 8,1	− 6,8	72, 76, 79.
91	σ ———	6	39 30 50,9	+14 3 44,1	+ 7,5	− 2,8	72, 76.
92*	ϱ^2 ———	6	40 32 3,9	+17 19 41,1	+ 5,1	− 5,2	72.
93	ϱ^3 ———	.	40 40 32,7	+17 2 9,2	+ 2,6	− 8,5	72.
94	ε ———	5	41 19 31,7	+20 20 57,4	+ 5,2	− 4,6	72, 76, 79.
95	λ Ceti	4	41 40 6,4	+ 7 55 13,8	−10,2	− 4,0	72, 76.
96	α ———	2	42 23 23,5	+ 3 7 9,4	− 6,4	− 5,5	72, 76.
97	β Persei	3	43 5 37,0	+39 59 50,0	+15,1	− 5,2	72, 76, 79, 103.
98	(261) Arietis	8	43 50 48,0 :	+19 48 55,2 : :	....	....	72.
99	(264) ———	7	43 55 59,3	+18 25 56,4	....	....	103.
100	δ ———	4	44 25 44,4	+18 47 13,1	+ 4,2	− 4,0	72, 76, 103.

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					Æ.	Dec.	
101	ζ Arietis	5	45° 13′ 44″,5	+20° 7′ 27″,1	+ 7″,7	−6″,4	72, 76, 103.
102	α Persei	2	46 45 40,2	+48 58 12,9	− 9,0	+0,3	72, 76, 103.
103	τ^1 Arietis	5	46 47 38,8	+20 15 2,4	+ 9,2	−3,8	72, 76, 103.
104	τ^2 ——	6	47 11 13,4	+19 51 7,8	+11,7	−5,0	72, 76, 103.
105	65 ——	7	47 36 7,0	+19 55 8,2	+ 4,4	−0,4	103.
106	ο Tauri	4	47 55 48,0	+ 8 9 13,6	− 6,7	−3,4	2, 72, 76, 103.
107	ξ ——	4	48 29 44,3	+ 8 51 54,0	− 4,0	−1,3	2, 76, 103.
108	(67) ——	7	48 49 40,5	+10 31 48,9	....	....	76.
109	(70) ——	7·8	48 59 37,7	+15 54 14,1	....	....	103.
110	*s* ——	6	49 16 37,2	+10 28 54,5	− 5,1	−0,6	2, 76, 103.
111	*f* ——	5	49 21 33,4	+12 5 1,4	− 0,9	−3,2	72, 77, 103.
112	*t* ——	6	49 51 26,9	+ 8 31 55,1	− 1,6	−2,8	2, 77, 103.
113	(87) ——	7	50 4 38,8:::	+17 0 57,0	....	....	103.
114	(99) ——	7	51 2 0,7	+14 36 39,1	....	....	103.
115	16 ——	6	52 35 13,3	+23 30 9,4	− 2,3	−2,5	77, 103.
116	17 ——	5	52 36 28,9	+23 19 35,8	+ 2,8	−3,1	2, 4, 72, 77, 103.
117*	18 ——	7	52 39 38,7	+24 3 —	+12,6	....	77.
118	19 ——	5	52 40 56,9	+23 40 55,3	+ 4,2	−3,1	4, 72, 77, 103.
119	20 ——	6	52 50 17,8	+23 35 9,0	+ 3,3	−4,0	4, 72, 77, 103.
120	21 ——	7	52 51 14,7	+23 46 25,5	+ 1,9	−7,2	77.
121	22 ——	7	52 53 23,7	+23 44 48,5	+ 4,1	−4,0	77.
122	23 ——	5	52 58 23,7	+23 10 10,8	− 4,3	−6,7	77.
123	24 ——	7	53 13 20,7	+23 20 33,3	+ 6,0	....	77.
124	*η* ——	3	53 15 21,3	+23 19 51,7	+ 5,0	−2,5	2, 4, 72, 77, 103.
125	27 ——	5	53 40 28,0	+23 17 13,9	+ 4,1	−0,4	4, 77, 103.
126	28 ——	6	53 40 40,0	+23 22 17,2	+ 7,4	−2,8	4, 77, 103.
127*	——	7·8	53 42 58,3	+23 36 57,0	....	....	77.
128	*e* ——	5	53 43 49,6	+10 22 28,5	+ 2,6	−2,6	2.
129	(187) ——	7	54 48 43,1	+16 34 52,1	....	....	77.
130	32 ——	.	55 37 20,3	+21 45 19,8	....	....	2.
131	λ ——	4	56 47 56,8	+11 46 54,6	− 2,6	−3,0	2, 2, 4, 77, 105.
132	A^1 ——	5	57 34 38,4	+21 23 40,2	+ 2,9	−1,7	2, 4, 77, 105.
133	A^2 ——	7	57 43 55,8	+21 19 47,9	+ 2,0	−3,8	4, 77, 105.
134	ψ ——	5	57 59 25,6	+28 19 12,0	+ 7,4	−4,0	77, 105.
135	ω^1 ——	6	58 44 38,2	+18 56 37,2	+11,3	−2,6	4, 77, 105.

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					ℛ	Dec.	
136	*p* Tauri	6	59° 0′ 11″,1	+25° 49′ 21″,1	+ 3″,6	−3″,5	4, 77.
137	ω^2 ——	6	60 44 53,6	+19 57 25,3	+ 6,1	−5,1	2, 3, 4, 77.
138	φ ——	5	61 20 49,6	+26 44 41,2	+ 8,5	−4,8	2, 3, 4, 77.
139	γ ——	3	61 29 1,1	+15 1 3,9	+ 2,0	−3,1	2, 2, 3, 4, 7, 77.
140	h^1 ——	6·7	61 33 35,3::	+13 25 34,6	+10,4	−3,0	77.
141	h^2 ——	.	61 42 0,9	+14 29 26,3	− 1,7	−5,4	4.
142	(45) ——	.	61 47 46,1	+13 15 35,7	− 4,5	+0,5	77.
143	χ ——	5	61 56 29,6	+25 1 54,5	+ 7,3	−3,3	2, 3.
144	h^3 ——	.	62 5 0,8	+13 28 45,9	+ 3,8	−1,8	2, 77.
145	δ^1 ——	4	62 13 23,7	+16 56 56,9	+ 3,6	−3,1	3, 4, 7, 77.
146*	——	.	62 21 30,0:::	+16 0 —	....	....	No observation.
147	δ^2 ——	5	62 30 53,9	+16 51 27,0	+ 0,5	−3,5	2, 3, 4, 7, 77.
148	δ^3 ——	6	62 51 2,1	+17 20 53,7	+ 0,3	−4,0	2, 3, 4, 77.
149	υ^1 ——	5	62 56 0,8	+22 14 21,9	+ 8,1	−7,6	2, 3.
150	71 ——	.	63 6 57,5	+15 2 39,2	+ 9,9	−6,6	6.
151	υ^2 ——	6	63 10 59,1	+22 25 29,9	+ 2,6	−6,3	3, 4.
152	π ——	5	63 12 37,5	+14 8 27,0	+ 8,9	−2,8	7, 77.
153*	——	7	63 12 50,0:::	+16 0 —	....	....	No observation.
154	ϵ ——	3·4	63 35 57,1	+18 37 3,6	+ 3,4	−4,4	3, 4, 7, 77, 107.
155	76 ——	.	63 38 55,9	+14 10 36,9	− 1,7	−1,6	3.
156	θ^1 ——	5	63 39 57,4	+15 24 0,6	+ 8,4	−7,0	2, 2, 6, 77.
157	θ^2 ——	5	63 41 22,9	+15 18 32,3	− 0,5	−6,5	2, 2, 6, 77.
158	(95) ——	8	64 0 15,8	+19 17 11,8	....	....	107.
159*	80 ——	.	64 3 46,4	+15	+ 9,3	....	3, 4.
160	(99) ——	.	64 9 20,4	+15 38 31,2	....	−3,3	5, 6, 77, 107.
161	81 ——	.	64 11 22,4	+15 8 27,5	− 2,4	−7,2	5.
162	(102) ——	7	64 12 38,7	+15 35 50,3	....	....	77, 107.
163	(113) ——	7·8	64 55 31,5	+15 47 14,9	+ 3,0	....	5, 91, 107.
164	ϱ ——	5	65 0 29,3	+14 18 38,3	− 7,0	−4,4	6.
165*	——	8	65 15 0,0:::	+16 0 —	....	....	No observation.
166	(120) ——	.	65 21 35,7	+19 21 18,9	....	....	10.
167*	α ——	1	65 29 12,0	+15 59 48,1	+ 0,9	−3,0	25 observations.
168	89 ——	.	66 3 14,7	+15 31 22,2	0,0	−5,7	5, 6, 7, 91.
169	σ^1 ——	7	66 18 46,6	+15 17 49,6	− 2,3	−1,9	2, 5, 5, 7, 7, 77, 91, 107.
170	σ^2 ——	6	66 20 11,5	+15 24 46,3	− 1,7	−4,9	2, 5, 7, 7, 59, 77, 91, 107.

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					℞	Dec.	
171	τ Tauri	5	66° 54′ 27″,4	+22° 27′ 59″,7	+ 1″,4	− 4″,8	3, 3, 5, 5, 59, 77.
172	(179) ——	7	68 0 50,9	+18 16 15,2	....	....	5, 5, 7, 7, 91, 107.
173	(190) ——	8	68 36 34,1	+18 16 48,1	....	....	3, 5, 6, 7, 91.
174	i ——	6	69 16 51,1	+18 24 7,3	+ 3,9	− 2,7	3, 3, 7, 7, 91, 107.
175	o^1 Orionis	4·5	69 41 18,2	+13 49 21,1	+ 0,3	− 2,7	3, 77, 91.
176	(222) Tauri	9	69 59 33,2	+16 36 7,1	....	....	6.
177	(228) ——	8	70 13 47,6	+15 58 1,6	....	....	91.
178	(231) ——	8	70 19 38,3	+16 12 15,0	....	....	91.
179	(243) ——	6·7	70 45 30,8	+23 32 38,6	+ 0,2	....	3, 3, 91.
180	(246) ——	6	70 49 29,6	+16 44 53,3	+ 0,1	....	6, 7, 7, 110.
181	(257) ——	6·7	71 13 30,7	+14 8 50,8	....	....	91.
182	101 ——	7	71 26 22,3	+15 31 48,7	− 3,1	−17,5	7.
183	ι ——	4	72 8 1,8	+21 13 3,6	+ 0,4	− 0,8	3, 3, 6, 7, 7.
184	(282) ——	·	72 27 39,0	+20 54 44,8	....	....	6, 7, 7.
185	y^1 Orionis	·	72 39 41,8	+15 2 35,1	+ 0,3	− 8,0	2, 3.
186	(288) Tauri	·	72 47 34,2	+19 26 51,7	....	....	7, 7, 110.
187	m ——	6	73 15 41,0	+18 17 38,2	− 0,2	− 1,9	3, 6, 7, 7, 101, 110.
188	l^1 ——	6	73 20 50,5	+20 4 24,8	− 1,4	− 4,2	3, 6.
189	y^2 Orionis	6	73 56 16,7	+15 15 48,0	+ 1,2	− 6,6	3, 91, 110.
190*	α Aurigæ	1	74 40 34,9	+45 43 10,7	+ 0,9	− 0,6	32 observations.
191	108 Tauri	7	75 12 10,5	+21 58 55,4	+ 4,3	− 4,4	91.
192*	β Orionis	1	75 42 23,4	− 8 30 9,5	− 3,7	− 1,4	22 observations.
193	n Tauri	6	76 9 31,2	+21 49 13,7	− 0,7	−13,9	5, 6, 111.
194	(37) ——	7	76 12 16,2	+19 51 18,2	....	....	102, 111.
195*	(43) ——	8	76 28 52,5	+19 18 17,8	....	....	102, 108.
196	(48) ——	7	76 38 2,4	+19 32 35,7	....	....	91, 102, 108.
197*	——	·	76 :::	+27 41 4,7	....	....	6.
198	22 Aurigæ	7·8	76 59 12,5	+28 40 44,9	+ 2,2	− 6,1	108, 111.
199*	β Tauri	2	77 43 17,7	+28 22 32,3	− 0,9	− 0,3	15 observations.
200*	γ Orionis	2	78 0 58,5	+ 6 6 25,2	−11,0	− 1,2	10 observations.
201	115 Tauri	·	78 14 11,7	+17 43 39,6	+ 6,9	+ 0,3	102, 108.
202	o ——	5	78 14 54,0	+21 42 15,5	+ 2,1	− 3,4	5, 6, 7.
203*	χ Aurigæ	5	79 12 57,7	+31 59 6,0	− 1,9	− 3,2	5, 6, 7.
204	β Leporis	5	79 26 59,1	−20 58 15,6	− 1,7	− 2,0	7, 10, 91, 102, 108.
205	(125) Tauri	7·8	79 47 18,8	+20 16 39,2	....	....	5, 7.

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					ΔR	Dec.	
206*	∂ Orionis	2	79° 53′ 23″,1	− 0° 30′ 3″,0	− 9″,1	− 1″,8	13 observations.
207*	35 ———	6	80 0 40,0	+14 8 —	− 3,7	....	101.
208	α Leporis	3	80 29 40,8	−18 0 53,3	− 4,5	− 2,5	7, 10, 91, 102.
209	ζ Tauri	3	80 46 6,2	+20 58 10,9	+ 1,1	− 2,4	2, 5, 6, 7, 101, 109.
210	ε Orionis	2	80 57 43,7	− 1 22 40,2	− 5,6	− 3,5	11 observations.
211	125 Tauri	.	81 9 28,7	+25 44 7,5	− 3,9	− 4,4	5.
212	σ Orionis	4	81 37 42,8	− 2 45 38,8	− 5,6	− 4,2	5, 6, 7, 7, 8, 10, 91, 109, 113.
213*	ζ ———	2	82 6 55,0	− 2 5 30,2	− 8,2	− 3,7	12 observations.
214	(202) Tauri	.	82 43 5,0	+18 34 31,3	....	....	8, 9.
215	(210) ——	7·8	83 6 53,4	+20 9 47,9	....	....	5.
216	(214) ——	7·8	83 14 21,0	+24 33 54,1	....	....	102.
217	130 ——	.	83 18 12,6	+17 36 50,1	+ 6,9	− 3,7	8, 9.
218	(222) ——	.	83 27 23,6...	+20 45 40,3	....	....	5.
219	132 ——	6·7	83 30 46,4	+24 27 35,7	− 0,9	− 1,4	102.
220	γ Leporis	4·3	83 34 31,2	−22 32 40,0	− 1,5	− 2,0	7, 10, 106, 109.
221*	Orionis	8	83 37 30,5	+ 9 38 44,9	....	....	6.
222	κ ———	3	84 2 53,5	− 9 46 31,4	− 2,1	− 1,7	7, 10, 60, 106, 109, 113.
223	(251) Tauri	7·8	84 42 30,5	+20 13 3,0	−14,5	....	5.
224*	χ^1 Orionis	5	84 59 4,0	+20 12 26,7	+ 6,1	− 3,6	5, 6, 8, 9.
225	χ^2 ———	7	85 7 30,3	+19 40 38,5	+ 4,8	− 1,6	102.
226*	α ———	1	85 29 36,9	+ 7 20 18,9	− 5,3	+ 1,0	15 observations.
227	139 Tauri	.	85 42 52,7	+25 53 52,3	+ 2,0	− 1,2	5, 8, 9, 138.
228	140 ——	8	86 25 10,1	+22 51 40,8	....	− 6,2	8.
229	141 ——	7	86 44 26,5	+22 22 8,3	+ 3,5	− 1,1	8.
230*	χ^4 Orionis	5	87 15 8,5	+19 40 15,0	....	− 4,9	4, 139.
231*	———	6·7	87 15 19,7	+17 47 35,6	....	....	102.
232	1 Gemin.	4	87 19 25,1	+23 15 6,8	− 0,6	− 3,8	5, 6, 8.
233*	χ^3 Orionis	7	87 21 28,1	+20 7 12,7	+ 2,2	− 3,1	4, 5, 6.
234*	(329) Tauri ?	.	88 15 17,0	+22 30 —	....	....	5.
235	(338) ——	7·8	88 42 32,8	+22 12 14,9	....	....	102.
236	3 Gemin.	.	88 43 49,6	+23 7 43,6	− 5,5	− 1,9	4, 5.
237	4 ———	7·8	88 55 42,7	+23 1 13,5	−14,0	−12,9	5.
238	5 ———	6	89 8 36,1	+24 26 57,3	+ 1,2	− 4,1	102.
239	6 ———	7·8	89 22 56,2	+22 56 21,5	− 1,9	− 4,6	4, 5, 8.
240	68 Orionis	6	89 23 34,1	+19 49 11,1	− 3,1	− 0,4	102.

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					AR	Dec.	
241	η Gemin.	4	90° 2′ 13″,3	+22° 33′ 11″,5	+ 1″,6	−3″,5	4, 5, 6, 8, 102, 139.
242	71 Orionis	6	90 7 17,4	+19 12 53,7	+ 3,5	....	102.
243	8 Gemin.	.	90 21 7,3	+24 1 28,2	+ 6,8	−3,3	8.
244*	9 ———	.	90 31 20,0	+23 47 48,2	+ 5,5	−2,7	4, 8.
245	10 ———	.	91 0 35,0	+23 40 24,3	+ 2,4	−5,0	6, 8.
246	11 ———	4	91 7 2,9	+23 32 26,2	− 2,1	−3,1	6.
247	12 ———	.	91 8 7,2	+23 20 44,6	....	−0,2	6.
248	(62) ———	8	91 39 42,0	+21 13 1,1	....	....	8.
249	(64) ———	9	91 41 34,6	+21 17 10,3	....	....	8.
250	(67) ———	.	91 43 46,4	+23 50 59,4	....	....	6.
251	μ ———	3	92 2 51,0	+22 36 53,6	+ 4,0	−4,1	4, 6, 8.
252	14 ———	.	92 46 0,7	+21 45 19,7	+ 0,9	−1,1	6, 8.
253	15 ———	.	93 18 27,1	+20 54 58,6	+ 2,2	−7,9	5, 6, 8.
254	16 ———	.	93 21 25,8	+20 37 6,7	+ 2,1	+0,6	5, 6, 8.
255	ν ———	4	93 37 3,2	+20 20 35,4	+ 2,2	−5,4	4, 5, 6, 8.
256	20 ———	8	94 30 40,8	+17 55 40,8	+15,9	−2,7	4, 6, 8.
257	21 ———	7·8	94 30 57,1	+17 55 57,2	+12,7	−3,4	6, 8.
258	(152) ———	8	95 12 24,3	+16 22 17,8	....	....	6, 8.
259	γ ———	2·3	95 54 7,7	+16 35 4,5	+ 3,5	−3,8	3, 4, 5, 6, 8.
260	(181) ———	8	96 24 10,5	+19 51 30,5	....	....	6, 8.
261*	———	.	96 — —	+16 36 5,9	....	....	6, 8.
262	26 ———	6·7	97 2 46,4	+17 51 38,4	+ 6,2	−4,1	3, 4, 6, 8, 103.
263	ε ———	3	97 13 37,3	+25 20 51,6	+ 0,6	−2,0	3, 4, 6, 8, 103.
264	ξ^1 ———	5·4	97 33 23,4	+13 27 6,9	− 3,1	−3,1	4, 6, 8.
265	ξ^2 ———	.	97 53 53,1	+13 8 12,0	− 3,2	−3,1	3, 4, 5, 6, 8.
266*	α Canis maj.	1	98 35 53,0	−16 23 54,2	+ 1,8	−2,6	19 observations.
267*	35 Gemin. ?	.	99 0 —	+13 40 19,4	....	−7,0	8?
268	d ———	6	99 13 40,8	+22 1 29,2	− 0,7	−2,5	6, 8? 103.
269	e ———	6	100 13 5,8	+13 27 54,3	+ 2,6	−1,6	3, 4, 5, 6, 8, 106.
270	(270) ———	7·8	100 31 6,2	+18 1 50,4	....	....	5, 6, 8.
271	(281) ———	.	100 52 25,8	+18 11 59,7	....	....	6, 8.
272	39 ———	7·8	100 55 56,8	+26 22 43,2	+ 5,8	−8,4	106.
273	40 ———	7	101 5 41,5	+26 13 15,1	+ 5,6	−3,2	106.
274	(296) ———	9	101 27 55,0	+23 45 21,9	....	....	8.
275*	41 ———	8·9	101 33 24,3	+16 23 37,3	+ 5,0	−6,4	103.

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					R	Dec.	
276	ω^1 Gemin.	6	101° 52′ 55″,2	+24° 32′ 22″,2	+ 0″,9	− 3″,9	3, 4, 5, 6, 8, 106, 111.
277	ζ ———	3	102 24 18,0	+20 54 18,2	+ 1,9	− 2,2	3, 4, 5, 6, 8, 103, 106, 111.
278	ω^2 ———	.	102 39 0,0	+22 58 46,8	+ 0,7	− 5,0	3, 5, 6, 8, 106, 111.
279	(322) ———	8	103 1 28,2	+18 5 31,2	....	....	106.
280	o ———	7	103 35 24,5	+16 17 55,1	+ 1,5	− 5,5	113.
281	τ ———	5	103 53 43,8	+30 37 14,1	+ 0,7	− 4,6	3, 5, 6, 8, 103, 106.
282	m ———	6	104 23 48,4	+24 30 45,6	+ 5,2	− 4,5	3, 5, 8, 103, 106, 113.
283	51 ———	5	104 50 12,1	+16 33 2,6	− 2,5	− 4,4	3, 5, 8, 103, 106, 111, 113.
284	n ———	5	104 56 18,1	+25 17 5,3	+ 2,2	− 0,7	3, 5, 8, 103, 106, 111, 113.
285	(35) ———	7·8	105 29 12,5	+27 6 17,9	....	....	103.
286	(39) ———	7	105 40 56,6	+16 33 10,6	....	....	113.
287	λ ———	5	106 0 50,4	+16 57 30,1	− 2,4	− 2,7	3,5,6,8,15,103,106,111,113.
288	δ ———	3	106 22 54,8	+22 24 30,3	− 0,5	− 2,2	3, 5, 8, 103, 106, 111, 113.
289	q ———	6·7	106 52 56,1	+20 32 51,5	− 1,7	− 2,1	3, 5, 8, 103, 106, 111, 113.
290	A ———	5·6	107 8 40,0	+25 29 45,9	− 3,6	− 4,0	3, 5, 8, 103, 106, 111, 113.
291	59 ———	7	107 20 11,5	+23 5 3,8	+ 2,9	+ 0,1	103.
292*	(77) ———	7·8	107 13 2,0	+18 43 16,2	....	....	113.
293	ι ———	4·5	107 38 9,4	+28 15 32,6	− 3,0	− 2,8	3, 5, 8, 104, 106, 112.
294	(97) ———	7·8	108 5 49,7	+22 0 2,5	....	....	112.
295	p ———	6	108 18 28,7	+21 55 17,0	+ 2,1	− 3,2	3, 5, 8, 104, 106, 112, 113.
296	ϱ ———	5	108 20 40,9	+32 14 40,1	+ 7,7	− 2,6	3, 5, 8, 104, 106, 107, 113.
297	b^1 ———	6	108 31 38,9	+28 35 49,6	+ 1,9	− 2,5	5, 8, 104, 106, 107, 112.
298	b^2 ———	.	108 39 4,8	+28 23 45,4	− 0,5	− 4,2	5, 8, 104, 106, 107, 112.
299*	α ———	1·2	109 44 44,8	+32 23 53,1	+ 6,2	− 2,6	16 observations.
300	k ———	6	109 54 56,1	+16 19 46,2	+ 2,7	− 2,5	3, 8, 11, 104, 108, 112.
301	ν ———	5	110 12 46,5	+27 24 52,5	+ 1,4	− 1,8	3, 8, 11, 104, 109.
302	(146) ———	.	110 49 3,6	+19 26 47,1	....	....	11.
303	(153) ———	7	110 51 38,6	+24 53 0,3	....	....	109.
304	(161) ———	7	111 6 23,6	+24 45 10,8	....	....	109.
305	f ———	6	111 20 26,0	+18 12 33,7	+ 1,6	− 6,8	3, 8, 106, 113.
306*	α Canis min.	1	111 37 48,0	+ 5 49 51,3	− 3,5	+ 0,6	24 observations.
307*	(170) ———	7·8	111 47	+ 5	....	....	8.
308	σ Gemin.	5	112 0 23,2	+29 27 3,1	+ 1,0	− 2,2	3, 8, 11, 106.
309	(179) ———	7	112 12 5,0	+22 57 5,4	....	....	109.
310	c ———	6	112 18 0,0	+26 20 34,1	− 0,8	− 3,1	3,8,11,106,108,110,112,113.

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					AR	Dec.	
311	$\varkappa$ Gemin.	4·5	112° 25′ 16″,8	+24° 57′ 33″,8	+ 2″,6	+ 3″,2	3, 11.
312	β ———	2	112 35 12,7	+28 35 36,6	+ 4,3	— 3,5	14 observations.
313	g ———	6	112 59 34,2	+19 5 3,5	+ 2,4	— 5,1	9, 11.
314	(224) ———	.	114 26 0,0 :	+19 55 41,0	....	....	105.
315	φ ———	6	114 37 55,5	+27 22 28,1	+ 0,3	— 0,4	4, 11.
316	l ———	7	115 20 56,2	+20 30 25,7	+ 2,9	— 3,7	4, 11, 15.
317	ω^1 Cancri	6	116 31 56,9	+26 2 18,3	+ 3,1	— 0,2	4, 11, 105, 115.
318	6 ———	5	117 7 21,6	+28 27 22,2	+ 0,9	+ 0,8	4, 11, 15, 105, 115.
319	8 ———	.	117 51 56,2	+13 47 37,5	— 1,8	— 3,4	4, 15, 16, 105, 115.
320	(297) ———	7	117 58 30,7	+14 10 42,7	....	....	115.
321	μ^2 ———	5	118 20 33,1	+22 16 9,5	+ 1,9	— 1,2	4, 15, 16, 105, 115.
322*	ψ^1 ———	7	118 51 16,0	+26 32 28,7	+14,5	— 2,0	115.
323	ψ^2 ———	4	118 55 39,8	+26 13 36,3	+ 5,3	— 1,3	4, 15, 115.
324	(317) ———	.	119 0 52,4	+17 42 49,7	....	....	105.
325	ψ^3 ———	6	119 29 38,8	+30 21 59,2	— 1,8	— 2,2	4, 15, 15.
326*	ζ ———	5	119 32 50,8	+18 21 45,3	— 1,2	— 0,9	4, 14, 15, 15, 105, 115.
327	(6) ———	.	119 32 52,3	+18 21 48,3	....	....	105.
328*	(3) ———	7	119 29 16,6	+10 31 35,6	....	....	116.
329*	(14) ———	.	120 2 52,0	+18	....	....	105.
330	β ———	4·3	120 49 0,1	+ 9 55 7,9	— 2,3	— 1,1	4, 14, 15, 15, 105, 115, 116.
331	(33) ———	.	121 4 27,1	+ 9 36 9,6	....	....	116.
332	χ ———	6	121 17 55,7	+27 59 14,3	— 0,1	— 2,1	4, 14, 15, 15, 105, 115, 116.
333	λ ———	6	121 29 48,4	+24 46 15,5	+ 3,4	— 1,9	4, 14, 15, 15, 105, 115, 116.
334	d^1 ———	7	122 20 23,2	+19 5 47,9	+ 2,9	— 3,6	14, 15, 15, 16, 115, 116.
335	ϕ^1 ———	6·7	122 53 36,2	+28 40 34,4	+ 4,1	+ 0,6	4, 14, 15, 15, 105.
336	d^2 ———	7	122 59 46,5	+17 49 50,9	+ 6,0	— 0,1	14, 115, 116.
337	ϕ^2 ———	.	122 59 47,2	+27 42 44,0	+ 3,8	— 2,5	4, 15, 15, 105.
338*	v^1 ———	7	123 1 35,7	+25 19 2,6	+ 4,2	+ 1,9	116.
339	v^2 ———	6·7	123 31 33,8	+24 56 5,7	+ 3,0	+ 0,2	14, 15, 15, 105, 115, 116.
340	(80) ———	8	123 46 55,0	+26 59 9,6	....	....	14, 15.
341	(79) ———	7	123 47 9,1	+25 8 20,1	....	....	105.
342	v^3 ———	6	124 15 35,8	+24 53 4,2	+ 0,9	+ 0,5	13, 14, 15, 105.
343	θ ———	6·5	124 24 40,9	+18 54 4,1	+ 5,7	— 3,5	14, 15, 16, 115, 116.
344	(86) ———	.	124 24 48,0	+19 47 30,0	....	....	115, 116.
345	v^4 ———	.	124 38 6,8	+24 53 48,6	— 0,3	— 6,6	105.

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					AR	Dec.	
346	η Cancri	6·7	124° 38′ 26″,0	+21° 15′ 4″,5	+ 0″,7	− 0″,9	13, 14, 15, 15, 105.
347	(98) ———	.	125 3 6,8	+14 4 25,1	....	....	15, 16.
348	35 ———	8	125 18 53,4	+20 24 38,3	+ 4,8	− 2,7	14, 15, 105, 115, 116.
349	(104) ———	8	125 25 5,2	+20 35 38,2	....	....	115, 116.
350	(106) ———	8	125 36 11,0	+16 8 25,2	....	....	9, 105.
351	(112) ———	.	125 56 20,6	+20 5 56,5	....	....	14, 15, 15, 16, 115, 116.
352	c^1 ———	6	125 57 41,4	+10 29 7,8	+ 3,4	+ 2,6	13, 14.
353	c^2 ———	.	126 12 47,1	+10 24 36,8	− 1,4	− 3,3	12, 13, 14, 15.
354	o ———	7	126 24 52,9	+20 37 8,1	....	+ 2,1	12, 15, 115, 116.
355	(124) ———	7	126 27 10,0	+20 22 57,3	....	....	15, 16, 115.
356	39 ———	7	126 30 30,2	+20 51 5,6	+ 8,2	− 5,8	15, 116.
357*	———	.	126 30 —	+21 15 13,1	....	....	No observation.
358	40 ———	7	126 31 49,0	+20 48 53,7	+ 3,5	− 7,5	15, 116.
359	(129) ———	7	126 34 53,5	+20 30 52,5	....	− 0,9	15, 16, 115.
360	ε ———	7	126 36 19,5	+20 23 21,7	....	− 3,0	15, 16, 115.
361	42 ———	7	126 40 8,7	+20 33 56,2	....	− 4,2	15, 115.
362	(134) ———	7	126 43 40,9	+20 25 38,4	....	− 4,0	9, 15, 115.
363	(136) ———	7	126 56 45,5	+20 43 33,4	+ 2,0	....	16, 115, 116.
364	γ ———	4	127 16 55,7	+22 19 40,4	+ 0,7	− 6,2	11, 12, 13, 14, 15, 116.
365	A^1 ———	6	127 26 2,8	+13 32 19,2	− 2,3	− 2,4	11, 12, 13, 14.
366	δ ———	4	127 41 45,6	+19 2 2,0	− 0,2	− 2,2	[116. 11, 12, 13, 14, 15, 15, 16, 115,
367	b ———	6	127 52 18,7	+10 56 54,3	− 1,5	− 2,7	12, 13, 14, 15, 15, 16, 115, 116.
368	ι ———	5	127 58 13,6	+29 38 1,8	− 2,2	− 1,8	11, 14.
369	A^2 ———	6	128 22 59,8	+12 59 15,2	+ 3,4	+ 3,4	12, 16, 115, 116.
370	(170) ———	8	128 48 17,6	+13 25 42,4	....	....	14, 15.
371*	(179) ———	8	129 12 6,8	+18 53 41,0	....	....	9, 16.
372	(180) ———	7·8	129 12 21,1	+19 43 27,6	....	....	116.
373	54 ———	8	129 21 4,2	+16 14 20,5	+ 3,9	− 3,5	11, 11, 14, 15, 16, 115, 116.
374	(191) ———	7·8	129 51 12,8	+18 16 26,8	....	....	14, 15, 16, 115, 116.
375	(195) ———	.	129 58 48,2	+20 52 22,9	....	....	9, 116.
376	(196) ———	9	130 0 32,1	+18 27 4,7	....	....	14.
377	(197) ———	.	130 2 32,3	+15 18 57,3	....	....	11.
378*	(203) ———	9	130 13 15,9 :	+15 10 50,7:::	....	....	11.
379*	———	9	130 20 24,7 :	+ 9 9 38,1 :	....	....	12.
380	(206) ———	7	130 23 59,5	+18 8 36,5	....	....	9, 14, 15.

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					Æ	Dec.	
381	(208) Cancri	8·9	130° 31′ 2″,4	+15° 5′ 57″,8 :	....	....	11.
382	α^1 ———	6·7	130 38 38,1	+12 30 30,8	+ 1,4	— 0,2	16, 115, 116.
383	(217) ———	.	130 50 43,9	+18 3 58,8	....	....	9, 15.
384	o^1 ———	6	130 54 4,8	+16 14 32,1	+ 5,0	— 3,5	11, 11, 12, 13, 14, 16, 115, 116.
385*	———	.	130 56 —	+18 22 43,1	....	....	No observation.
386	o^2 ———	6	130 58 56,1	+16 30 5,2	+ 3,6	— 2,2	11, 11, 12, 13, 14, 16, 115, 116.
387	α^2 ———	4·3	131 16 45,2	+12 47 11,8	+ 0,1	— 1,9	9, 11, 11, 12, 13, 14, 15, 16,
388	(224) ———	7	131 20 24,9	+19 4 5,0	....	....	16. [115, 116.
389	(225) ———	.	131 30 6,4	+14 0 27,6	....	....	9, 11.
390	ν ———	6	132 6 21,8	+25 23 43,7	+ 4,1	+ 0,4	9, 11, 11, 12, 13, 14, 16, 16.
391	(244) ———	7·8	132 50 3,9	+11 48 14,7	....	....	11, 11, 12.
392	$\varkappa$ ———	4·5	133 37 36,3	+11 38 4,0	— 1,5	— 0,5	11, 11, 12, 13, 14, 16.
393	ξ ———	5·6	133 49 20,5	+23 1 0,4	+ 0,5	— 4,0	11, 11, 12, 13, 14.
394*	79 ———	.	134 4 19,3	+22 58 14,8	— 3,7	+ 0,4	11, 11, 12, 13, 14.
395*	(263) ———?	.	134 30 —	+12 32 39,7	....	....	No observation.
396	π ———	7	134 43 39,7	+15 57 52,6	+ 0,2	— 6,0	11, 11, 12.
397*	82 ———	7	135 25 54,0	+15 56 19,0	+ 2,4	— 4,7	11, 11, 12, 13, 14, 16.
398*	(35) Leonis?	7	136 1 —	+12 30 35,0	....	....	11, 12.
399*	(38) ———?	7	136 13 57,4	+27 22 51,0	....	....	9.
400	(46) ———	7·8	136 35 27,9 :	+10 48 16,1	....	....	11.
401	(50) ———	8·9	136 42 53,1	+20 6 33,7	....	....	14.
402	(62) Leo. min.	7	137 28 16,4	+26 57 8,1	— 0,9	— 6,5	11.
403	$\varkappa$ Leonis	4	137 35 50,5	+27 13 2,3	+ 3,9	— 0,8	11, 12, 13, 13, 14, 16.
404	(66) ———	7·8	137 37 12,3 :	+ 8 44 51,5	....	....	11.
405	ω ———	5	138 50 32,0	+10 6 20,8	— 0,3	— 0,2	9, 11, 12, 13, 13, 13, 14, 117.
406	α Hydræ	2	138 53 59,2	— 7 36 46,1	— 3,0	— 3,7	14, 15, 17, 114. [114, 117.
407	λ Leonis	4	139 26 14,1	+24 1 46,1	+ 5,3	— 1,0	9, 12, 13, 13, 13, 14, 16, 17,
408*	ξ ———	4	139 41 31,1	+12 22 1,0	+ 2,3	— 1,2	10 observations.
409	h ———	6	139 42 50,9	+10 46 43,2	— 0,9	— 2,1	9, 12, 13, 13, 14, 16, 115.
410	(120) ———	7·8	140 25 45,2	+13 43 46,2	....	....	13, 13, 14.
411	8 ———	6·7	140 53 8,4	+17 31 —	+ 5,6	....	16.
412	10 ———	.	141 4 41,2	+ 7 55 2,7	— 0,1	— 3,3	9, 12, 13, 13, 13, 14, 17.
413	(141) ———	.	141 30 5,7	+14 24 5,5	....	....	14. [21, 115, 117.
414	o ———	5·4	142 1 34,3	+10 59 24,1	+ 1,7	— 2,0	9, 12, 13, 13, 13, 14, 16, 17,
415*	ψ ———	6	142 36 9,7	+15 7 33,4	+ 2,9	— 2,8	12 observations.

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					AR	Dec.	
416	ε Leonis	3	142° 59′ 13″,0	+24° 53′ 5″,3	+4″,7	−0″,7	12, 13, 13, 13, 14, 16, 17, 21, [117.
417	18 ——	6·7	143 18 10,9	+12 55 19,2	+5,4	−5,5	10, 13, 13, 13.
418	(173) ——	8	143 29 50,6	+21 43 3,1	....	....	14.
419	19 ——	7·8	143 34 15,0	+12 41 6,8	+8,0	−3,9	12, 13, 14.
420*	(176) ——	6	143 36 50,0:::	+12 33 4,1	....	....	117.
421	21 ——	8	144 24 58,9	+12 58 18,7	+2,7	−8,7	9, 14, 117.
422	23 ——	7	144 26 59,6	+14 11 43,7	−0,1	−0,3	9, 10, 13, 13, 13, 14, 16.
423	(202) Sextantis	7·8	145 17 39,9	+ 9 12 53,0	....	....	14.
424	10 ——	6·7	145 52 10,1	+10 4 42,1	−3,9	−4,2	13, 13, 13.
425*	ν Leonis	4·5	146 16 1,2	+13 35 50,0	+1,5	−0,2	12 observations.
426	11 Sextantis	7	146 17 41,1	+ 9 28 5,5	+1,7	−2,1	10, 13, 122.
427*	π Leonis	4	146 49 28,8	+ 9 12 14,5	−0,9	−0,8	14 observations.
428*	(234) ——	8	147 38 16,6	+11 4 5,1	....	....	9, 10, 116.
429*	(237) ——	8	147 45 38,1	+12 47 55,5	....	....	14, 122.
430	(239) ——	8·9	148 2 28,7	+ 9 9 54,9	....	....	9, 10.
431	(240) ——	7·8	148 6 1,7	+16 55 51,0	....	....	21, 116, 120.
432*	η ——	3·4	148 29 52,9	+17 56 31,0	+5,6	−1,5	15 observations.
433	A ——	5	148 44 0,1	+11 10 59,6	+0,2	−1,6	9, 9, 13, 14, 16, 17, 21.
434*	α ——	1	148 50 15,7	+13 9 0,0	+2,0	−3,4	31 observations.
435	(255) ——	8	149 8 21,2	+10 46 46,0	....	....	10.
436	34 ——	7·8	149 37 9,5	+14 33 1,7	+6,4	....	13, 17.
437	(10) ——	8	150 15 20,6	+22 22 23,4	....	....	9, 10, 10, 13.
438	(13) ——	8	150 18 55,8	+17 20 21,9	....	....	13.
439	(23) ——	.	150 43 58,5	+18 56 42,1	....	....	10, 10, 117.
440	37 ——	6·7	150 53 15,9	+14 56 10,2	−0,1	−3,1	10, 10, 13.
441	(34) ——	7·8	151 20 19,0	+13 50 5,3	....	....	13. [117, 123.
442	40 ——	6	151 36 9,4	+20 41 58,7	+6,8	−1,7	9, 10, 10, 13, 17, 17, 18, 19,
443*	γ ——	2	151 37 8,4	+21 3 59,8	+6,5	−3,7	12 observations.
444	42 ——	7	152 10 11,3	+16 11 52,0	+8,8	−5,3	17, 18, 117.
445	(51) ——	7·8	152 20 17,3	+10 11 12,4	....	....	10, 10, 19, 117.
446	(60) ——	8	152 50 40,5	+11 48 54,7	....	....	10, 10, 117.
447*	44 ——	7	153 5 42,7	+10 1 0,3	....	....	9, 10, 10, 18, 19.
448	45 ——	7	153 41 6,2	+10 59 54,0	+0,7	−4,0	10, 10, 17, 19, 117.
449	(83) ——	6	153 55 55,1	+15 34 52,8	....	....	18.
450	(85) ——	7·8	154 4 8,0	+11 23 47,9	....	....	10, 19.

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					Æ	Dec.	
451	*i* Leonis	6	154° 47′ 6″,9	+15° 22′ 54″,4	— 0″,4	—1″,9	10, 10, 18, 19, 123.
452	*ϱ* ——	4	154 59 12,6	+10 33 15,9	— 5,8	—0,5	10, 10, 18, 19, 92, 117, 123.
453	48 ——	7	155 30 50,9	+ 8 12 10,5	— 2,8	—3,6	10, 10, 18, 19.
454	49 ——	7	155 33 15,2	+ 9 54 11,7	— 0,8	—0,2	10, 10, 19.
455*	(119) ——	9	155 9 34,3	+18 33 24,8:	....	....	10.
456	50 ——	7	156 26 48,9	+17 23 25,1	+ 4,6	—0,1	19.
457	(128) ——	9	156 43 27,0	+10 6 22,4	....	....	10, 19.
458	35 Sextantis	6	157 40 11,8	+ 6 1 16,2	— 8,0	—0,6	19.
459	(148) Leonis	.	158 12 4,6	+ 8 47 31,8	....	....	19.
460*	37 Sextantis	7·8	158 21 ::	+ 7 39 12,1	....	—3,3	19.
461	*k* Leonis	6	158 22 5,4	+15 28 32,0	+ 0,1	+1,6	18, 19.
462	38 Sextantis	8	158 39 18,0	+ 7 37 39,8	— 1,1	—2,3	19.
463	*l* Leonis	6	159 6 10,2	+11 49 49,5	— 0,4	—4,4	19.
464	(186) ——	8·9	160 31 22,2	+ 7 8 27,0	....	....	19.
465	*d* ——	5	161 59 23,7	+ 4 55 21,2	— 6,9	—1,4	18, 19.
466	*c* ——	5	162 1 24,4	+ 7 24 28,2	— 7,1	—3,6	19.
467	(229) ——	.	162 50 56,3	+ 4 56 56,0	....	....	19.
468	*χ* ——	4	163 6 19,9	+ 8 38 57,7	— 4,9	+3,4	17, 18, 19.
469	(9) ——	7·8	165 12 23,1	+21 27 38,5	....	....	18.
470	*δ* ——	2·3	165 16 21,6	+21 51 22,1	+ 1,7	+1,1	17, 18, 19, 31.
471	*θ* ——	3	165 21 8,8	+16 45 34,1	— 0,1	—4,0	17, 18, 19.
472	*n* ——	6	165 46 7,7	+14 38 4,7	+ 2,6	—1,0	17, 18, 19.
473	*φ* ——	4	166 4 7,4	— 2 19 14,9	—14,3	—3,9	18, 19.
474	*σ* ——	4·5	167 8 21,4	+ 7 21 48,5	— 9,8	—1,6	18, 19, 146.
475	*ι* ——	4	167 47 55,1	+11 52 11,6	— 5,7	+0,5	18, 19, 146.
476	79 ——	.	167 52 56,5	+ 2 44 41,2	—14,2	—2,2	18, 19.
477	83 ——	7	168 36 13,1	+ 4 20 27,4	— 6,3	—3,2	19.
478	*τ* ——	4	168 50 57,7	+ 4 11 52,3	—11,2	—2,2	18, 19.
479	*e* ——	4·5	169 27 57,1	— 1 39 33,5	— 9,9	—1,5	18, 19.
480	(94) Hyd.et Crat.	7·8	169 53 20,4	— 5 7 9,7	....	....	18.
481	(98) ——	7	170 6 7,4	— 6 28 57,3	....	....	18.
482	*υ* Leonis	4	171 7 1,8	+ 0 31 17,3	— 9,8	—0,2	18, 19.
483	*ω* Virginis	6	171 28 6,6	+ 9 29 0,6	— 3,7	0,0	19, 19.
484	(144) ——	8	172 24 48,2	+ 6 5 49,6:	....	....	19.
485	ξ^1 ——	5	173 10 31,8	+ 9 36 46,4	— 2,5	+0,6	19, 19.

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					Æ	Dec.	
486	ν Virginis	5	173° 19′ 49″,3	+ 7° 53′ 43″,2	−14″,2	+1″,5	19, 19.
487	ξ^2 ———	.	173 50 40,0	+ 9 35 59,3	− 8,2	+0,2	19, 19.
488	β Leonis	1·2	174 8 57,8	+15 56 6,1	− 0,4	−1,3	19, 19, 28, 42, 141.
489*	β Virginis	3	174 29 58,8	+ 3 8 15,7	−12,4	+5,2	19, 20, 28.
490	A ———	6	175 37 50,2	+ 9 48 0,2	+ 3,6	+1,4	20.
491	(187) ———	8	175 43 50,0	+ 2 27 21,1	....	....	20.
492	(203) ———	7	176 26 2,0	+ 4 50 30,1	−11,0	−3,0	118.
493	(207) ———	.	176 38 51,3	+ 1 53 12,7	....	....	20.
494	b ———	5·6	176 51 54,3	+ 5 0 52,8	−11,3	−1,0	17, 19, 20, 118.
495	π ———	5	177 5 32,2	+ 7 58 30,7	− 2,8	−0,3	17, 19, 20, 118.
496*	(213) ———	7·8	177 :::	− 0 24 29,4	....	....	20.
497	(222) ———	7	177 49 20,5	+ 6 55 22,6	....	....	118.
498	o ———	5	178 11 42,6	+10 5 20,2	− 9,7	+1,7	17, 20, 118.
499*	(230) ———	7·8	178	− 1 46 13,0	....	....	20.
500	(239) ———	.	178 52 55,6	+ 1 59 0,4	....	....	20.
501*	r ——— ?	6	179 18 6,0	+	−15,3	....	17, 20.
502	s ———	6	179 24 16,5	+ 7 9 50,3	+ 0,3	+2,5	17, 20.
503	(17) ———	7·8	180 26 45,8:::	− 4 21 58,0	....	....	20.
504	n ———	8	181 32 45,1	+ 0 34 17,3	−10,4	−0,2	20.
505	η ———	4·3	181 51 37,7	+ 0 41 27,6	− 9,7	+0,8	17, 20, 118.
506	c ———	5	181 59 32,7	+ 4 40 26,2	− 8,5	−2,0	17, 20, 118.
507	17 ———	6·7	182 32 0,7	+ 6 39 53,4	− 3,5	+0,5	17.
508*	(65) ———	7	182 40 56,5	− 3	....	....	118.
509	(69) ———	8·9	182 57 3,1	− 9 7 31,4	....	....	20.
510	(91) ———	7·8	183 50 28,4	− 3 15 39,5	....	....	20.
511	(95) ———	.	183 58 8,9	+ 5 44 58,4	....	....	17.
512	(104) ———	7	184 23 0,8	−12 2 12,6	....	....	20.
513	(108) ———	.	184 35 7,2	− 2 42 34,1	....	....	17.
514	(111) ———	7	184 46 51,9	− 3 42 11,4	....	....	17, 20.
515	q ———	6	185 18 14,0	− 8 6 7,7	− 4,9	−3,3	17, 20, 118.
516	(125) ———	.	185 28 35,2	− 0 3 32,3	....	....	17.
517	f ———	6	186 3 43,3	− 4 28 59,9	− 6,3	−0,3	17, 20, 118.
518	χ ———	5	186 40 13,4	− 6 38 53,9	− 6,5	−1,1	17, 20, 118.
519	(152) ———	.	186 44 6,1	− 4 45 13,8	....	....	17.
520	γ^1 ———	3	187 19 44,9	− 0 6 25,3	−10,8	+2,9	17, 20.

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					Æ	Dec.	
521	γ^2 Virginis	.	187° 19′ 48″,7	— 0° 6′ 30″,6	—10″,8	+2″,2	17, 20.
522	(183) ———	.	188 44 33,0	— 4 57 46,5	....	....	20.
523	(193) ———	.	189 23 2,1	— 6 18 —	....	....	20.
524	(196) ———	7	189 40 44,3	— 9 0 13,1	....	....	17.
525	38 ———	7	190 10 48,1	— 2 13 16,1	—13,0	—1,9	17.
526	ψ ———	5	190 25 26,7	— 8 12 28,5	— 7,8	—0,6	17.
527	δ ———	3	190 49 56,5	+ 4 43 40,4	— 8,8	+4,0	17.
528	k ———	6	191 46 50,0	— 2 29 23,7	—15,1	—0,5	17, 20.
529	ε ———	3	192 30 28,8	+12 16 35,2	— 2,9	—1,1	18, 20.
530	48 ———	7	192 50 24,8	— 2 20 33,5	— 4,3	—7,2	18.
531	g ———	5	193 47 15,1	— 9 25 44,5	— 8,0	—1,4	18, 20.
532	θ ———	4	194 20 16,5	— 4 13 46,3	—11,2	—0,9	18.
533	53 ———	.	194 46 45,8	—14 52 24,9	— 4,0	—5,8	18, 20.
534	(21) ———	7	195 23 15,3	+ 2 45 34,0	....	....	18.
535	61 ———	.	196 25 18,1	—16 56 48,5	— 4,0	—0,9	18, 20, 21, 23, 118, 120.
536	γ Hyd. con.	4	196 25 43,6	—21 52 33,2	— 6,1	—5,0	23.
537	(62) Virginis	9	197 19 9,7	—11 17 33,1	....	....	23.
538	63 ———	.	197 29 55,4	—16 26 53,7	— 1,9	—2,3	18, 20, 21, 23, 118, 120.
539*	α ———	1	198 5 38,1	— 9 52 45,2	— 3,3	—1,5	17 observations.
540	i ———	6	198 28 1,1	—11 25 45,5	— 3,3	—0,2	18, 20, 21, 23.
541	69 ———	.	198 37 10,3	—14 41 55,0	+ 0,7	—4,6	18, 20, 21, 23.
542	(95) ———	7	199 11 21,8	— 0 5 21,1	....	....	18.
543	l^1 ———	7	199 26 1,6	— 5 12 4,7	—10,8	—6,3	18, 21, 23.
544*	l^2 ———	5	199 49 43,3	— 4 59 11,8	—11,7	—5,0	18, 20, 21, 23.
545	h ———	6	200 2 19,7	— 8 53 52,7	— 6,0	—5,5	18, 20, 21, 23.
546	ζ ———	3	200 34 22,8	+ 0 39 38,5	—13,5	—4,1	18, 20, 21, 23, 31.
547	l^3 ———	6	200 42 56,6	— 4 8 35,1	— 9,1	—4,8	18, 20, 21, 23.
548	m ———	6	202 12 38,8	— 7 27 40,8	— 5,2	—1,4	18, 20, 21, 23.
549	(174) ———	7·8	202 48 35,2	— 4 15 32,9	....	....	20.
550	(177) ———	7	202 55 35,7	—12 58 36,5	....	....	21.
551	86 ———	.	203 14 41,6	—11 11 35,5	— 4,5	—3,4	18, 20, 21, 23.
552	87 ———	.	203 32 59,9	—16 37 34,2	— 0,6	—6,2	21, 23.
553	89 ———	.	204 9 56,8	—16 54 24,7	— 2,6	—5,5	21, 23.
554*	η Ursæ maj.	2	204 28 34,9	+50 32 20,7	— 8,3	0,0	14 observations.
555	p Virginis	6	205 33 8,3	— 0 17 29,2	—20,5	—1,3	18, 20, 21, 23, 29, 29.

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					Æ.	Dec.	
556	(270) Virginis	7	206° 48′ 50″,6	− 6° 57′ 44″,9	....	....	18.
557	(287) ———	7	207 52 8,7	− 8 4 26,2	....	....	18.
558	θ Centauri	2	208 6 18,6	−35 9 27,4	− 8,0	+11,8	21, 23, 29.
559	94 Virginis	7·8	208 21 18,0	− 7 42 53,1	− 9,8	− 1,0	18.
560	95 ———	6·7	208 27 41,8	− 8 8 13,2	− 3,3	− 3,2	18, 20.
561	(300) ———	8	208 29 48,8	−15 0 35,1	....	....	21, 23.
562	(317) ———	6·7	209 23 26,4	−15 8 9,6	....	....	18, 20, 22, 23, 29, 29.
563	$\varkappa$ ———	4	209 58 50,2	− 9 7 29,4	−10,7	+ 5,6	18, 20, 22, 23, 29, 29.
564	(19) ———	.	210 25 18,8	− 4 48 1,0	−14,1	....	20, 22, 29, 29.
565	ι ———	4	210 48 55,0	− 4 49 24,1	−13,8	− 4,3	18, 22, 23, 29, 33.
566*	α Bootis	1	211 8 1,3	+20 27 47,2	+ 6,0	+ 1,2	30 observations.
567	λ Virginis	4	211 29 16,1	−12 14 0,8	− 5,8	− 5,5	18, 20, 22, 23, 29, 30.
568	(44) ———	8	211 46 33,5	− 5 36 29,7	....	....	22, 23.
569	(62) Libræ	8	212 26 38,3	− 6 38 0,8	....	....	29.
570	2 ——	8	212 35 10,6	−10 35 6,5	− 8,6	− 2,5	22, 23, 29, 30.
571	(70) ——	8	212 54 12,0	−10 32 51,8	....	− 1,1	22, 23, 29, 30.
572	(76) Virginis	8	213 1 50,6	−12 14 4,2	....	....	22, 23, 29, 30.
573	(85) ———	8·9	213 38 32,6	−12 14 52,8	....	....	22, 23, 29, 30.
574	(89) ———	8	213 53 3,3	− 8 53 40,9	....	....	22, 23, 29, 30.
575	(116) Solitarii	7·8	215 17 28,0	−19 21 9,9	....	....	22, 23, 29, 30.
576	(127) Libræ	7·8	216 0 49,4	−11 15 11,0	....	....	22, 23, 29, 30, 31.
577	(137) Virginis	7·8	216 29 0,0	− 9 29 5,9	....	....	22, 23, 29, 30, 31.
578	(146) Libræ	8	217 12 40,0	−11 10 31,8	....	....	22, 23, 29, 30, 31, 123, 146.
579	μ Virginis	4	217 33 40,5	− 4 34 53,9	−14,2	− 4,2	22, 23, 29, 30, 31, 123.
580	(166) Libræ	7·8	218 5 57,7	−20 7 23,3	....	....	22.
581	(171) ——	7·8	218 21 12,5	−20 16 57,0	....	....	22.
582	μ ——	5	218 59 50,5	−13 6 54,5	− 5,8	− 6,1	22, 23, 29, 30, 32, 123, 146.
583*	α^1 ——	.	219 18 34,3	−14 57 54,5	− 3,7	− 6,4	22, 23, 30, 32, 123.
584	α^2 ——	2·3	219 21 26,4	−15 0 38,5	− 7,3	− 6,1	22, 23, 29, 30, 32, 32, 123.
585	ξ^1 ——	6	220 17 39,4	−10 53 8,0	− 3,0	− 4,2	22, 23, 29, 30, 32, 124.
586	ξ^2 ——	6	220 53 35,3	−10 24 27,3	− 5,0	− 3,3	22, 23, 29, 30, 32, 124.
587	17 ——	.	221 15 40,7	−10 9 28,4	− 3,9	− 3,2	22, 29, 32.
588	18 ——	6·7	221 26 6,6	−10 8 44,1	−11,3	− 1,1	22, 29, 30, 32.
589	δ ——	4·5	221 59 41,3	− 7 32 0,6	− 9,0	− 3,0	22, 23, 29, 30, 32.
590	20 ——	3	222 27 44,2	−24 18 12,0	− 1,5	− 8,9	22, 23, 30.

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					AR	Dec.	
591	ν^1 Libræ	5	223° 15′ 58″,3	−15° 17′ 30″,2	− 3″,7	− 6″,5	22, 23, 30, 148.
592	ν^2 ——	7·8	223 18 41,2	−15 31 14,8	− 2,6	− 6,9	22, 30.
593	ι^1 ——	4	224 35 28,3	−18 50 54,3	− 5,6	− 7,8	22, 23, 30.
594	ι^2 ——	7·8	224 52 3,5	−18 42 34,8	− 2,6	− 5,1	22, 30.
595	(19) Scorpii	7	225 34 25,5	−21 28 33,1	....	....	22.
596	β Libræ	2	225 58 48,2	− 8 27 51,6	− 9,3	− 4,7	22, 23, 29, 30, 33, 146, 148,
597	(32) ——	9	226 33 46,8	− 8 14 10,6	....	....	22. [149.
598	28 ——	8	226 46 36,5	−17 15 10,2	− 4,1	− 3,2	30.
599	o^1 ——	7	226 51 24,8	−14 38 56,4	− 4,5	− 7,7	22, 23, 30, 33.
600*	(54) ——	6·7	227 37 45,0 : :	−11 28 45,2	....	....	22, 30.
601	ε ——	4	227 45 12,5	− 9 25 33,4	− 4,8	− 6,3	22, 23, 30, 33, 146, 149.
602	ζ^1 ——	4	228 38 7,3	−15 50 44,2	− 6,5	− 4,1	22, 24, 30, 33.
603	ζ^2 ——	.	228 57 19,9	−16 34 37,6	− 1,6	−12,1	30.
604*	ζ^3 ——	.	229 14 18,9	−15 45 6,0	− 2,5	− 5,4	22, 24, 30, 33.
605	(91) ——	7·8	229 25 54,4 :	−19 18 36,1	....	....	22.
606	(96) ——	7	229 39 41,2	−18 49 5,4	....	....	22.
607	ζ^4 ——	.	229 47 43,0	−16 0 18,2	− 5,3	− 4,0	22, 24, 30, 33.
608	36 ——	.	229 58 23,4	−27 12 8,0	+ 1,8	− 8,3	24, 30, 33.
609	γ ——	3·4	230 28 47,3	−13 57 19,0	− 3,3	− 6,8	24, 30, 33, 148, 149.
610	39 ——	.	230 34 6,7	−27 18 14,5	− 1,2	− 7,7	22, 24, 30, 33.
611	(118) Scorpii	8	230 43 22,4	−25 26 56,1	....	....	24.
612	(125) Libræ	9	231 6 14,8 :	−13 40 —	....	....	30.
613	41 ——	.	231 13 37,1	−18 28 34,5	− 3,3	− 7,8	22.
614	(132) ——	8	231 13 52,3	−13 41 26,4	....	....	30.
615	42 ——	7	231 28 40,2	−23 0 9,2	− 3,4	− 6,3	24, 34.
616	$\varkappa$ ——	4	231 59 5,1	−18 51 58,8	− 6,7	− 6,2	22, 24, 30, 34.
617	(150) ——	8	232 16 21,9	−15 12 33,4	....	....	22, 30.
618	η ——	4	232 35 51,6	−14 52 26,7	−11,6	− 6,1	22, 24, 30, 34, 148.
619	α Serpentis		233 4 9,4	− 7 12 40,7	−11,0	− 4,2	22, 24, 30, 34.
620	b Scorpii	6	234 5 20,1	−24 59 10,5	+ 2,6	− 6,2	22, 24, 30, 34.
621	A^1 ——	5	234 45 10,8	−24 34 29,1	+ 3,3	− 9,6	22, 24, 30, 34.
622	λ Libræ	4	234 48 12,1	−19 24 53,1	− 0,6	− 7,8	22, 24, 30, 34.
623	θ ——	4	234 59 35,5	−15 59 27,0	− 6,9	− 6,7	24, 30, 34, 35, 149, 149.
624	A^2 Scorpii	7·8	235 0 48,7	−24 29 47,6	+ 5,6	....	22.
625*	47 Libræ	8	235 14 21,1 : :	−18 38 22,2	+ 8,3	− 6,7	22.

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					ΔR	Dec.	
626	ϱ Scorpii	4·3	235° 28′ 5″,2	−28° 28′ 37″,4	+3″,4	−8″,4	24, 30, 34, 35.
627	π ———	3	236 2 3,6	−25 23 14,8	+3,3	−6,5	22, 24, 30, 34, 35.
628	ψ Libræ	.	236 8 28,7	−13 33 13,1	−4,4	−5,3	24, 30, 34.
629	δ Scorpii	3·2	236 29 16,1	−21 54 12,9	−1,3	−8,5	22, 24, 30, 34, 35, 149, 149.
630	(237) ———	7	237 9 42,0	−25 9 38,4	....	....	30, 34, 35.
631	ξ Libræ	4·5	237 44 49,5	−10 40 42,0	−4,4	−6,0	22, 24, 30, 34, 36.
632	β^1 Scorpii	4	237 49 20,5	−19 6 52,1	−0,7	−6,0	22, 24, 30, 34, 36, 149, 149.
633	β^2 ———	8	237 49 29,4	−19 6 39,6	....	....	22, 24, 30, 34, 36.
634	ω^1 ———	5	238 8 40,6	−19 59 4,0	−6,8	−8,3	24, 30.
635	ω^2 ———	5	238 17 7,9	−20 11 8,2	−6,1	−7,5	22, 24, 30.
636	c^1 ———	6	239 18 32,3	−27 45 24,9	+4,5	−7,5	22, 24, 31, 34, 36.
637	c^2 ———	6·5	239 19 48,8	−27 16 3,3	−4,5	−9,0	22, 24, 31, 34, 36.
638	(3) ———	8	239 27 32,6	−18 47 32,1	....	....	22, 31, 34, 36.
639	ν ———	4	239 27 51,0	−18 48 11,9	−5,2	−6,5	23, 31, 34, 36.
640	(14) ———	8	240 2 8,4	−24 50 0,8	....	....	34, 36.
641	*d* ———	6·5	240 48 11,9	−27 58 51,2	....	....	23, 24, 31, 34, 36.
642	ο ———	.	241 30 1,9	−23 33 24,1	−0,9	−1,5	36, 37, 39.
643	σ ———	4	241 36 1,7	−24 58 55,1	−0,2	−9,9	23, 24, 31, 34, 36, 39, 150.
644	(60) ———	8	242 20 43,0	−29 6 23,5	....	....	34, 36.
645	ψ Ophiuchi	5	242 27 58,5	−19 26 30,9	−3,7	−5,3	23, 24, 31, 34, 36, 37, 39.
646	*g* ———	.	242 44 58,4	−22 51 35,7	−3,3	−8,9	23, 24, 31, 34, 36, 39.
647	χ ———	5	243 13 48,3	−17 52 44,6	−2,0	−5,0	23, 24, 31, 34, 36, 37, 39.
648	α Scorpii	1	243 37 19,5	−25 51 54,8	−1,0	−4,7	23, 24, 31, 34, 36, 37, 39, 67,
649	(93) ———	7·8	244 6 42,2	−25 58 57,4	....	....	39. [80, 135, 150.
650	φ Ophiuchi	5	244 18 9,2	−16 3 23,7	−9,6	−6,6	24, 31, 34, 36, 37. 39.
651	ω ———	5	244 25 40,9	−20 55 8,6	−3,7	−9,3	24, 31, 34, 36, 37, 39.
652	τ Scorpii	4	245 11 0,8	−27 40 58,3	0,0	−9,4	24, 31, 34, 36, 37, 39.
653*	(128) ———	8	246 5 23,9	−17 42 20,7	....	....	39.
654	(137) ———	8	246 33 24,3	−19 54 26,1	....	....	36.
655	(142) ———	7·8	246 47 50,8	−17 33 38,1	....	....	34.
656	*m* ———	6	246 52 26,7	−17 14 42,9	−3,3	−6,9	34, 36, 39.
657	(145) ———	7	246 53 51,4	−19 25 58,4	....	+1,0	39.
658	(159) ———	7	247 26 45,8	−28 1 46,9	....	....	34, 36, 39.
659	ε ———	·	248 36 5,1	−33 49 29,8	+1,4	−7,6	37, 39.
660	18 Ophiuchi	8	248 43 44,4	−24 11 6,8	....	....	34, 36.

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					ΔR	Dec.	
661	(196) Ophiuchi	8	249° 13′ 48″,7	−16° 6′ 6″,7	....	....	36.
662	(214) Scorpii	7	249 45 41,7	−19 58 55,7	....	....	34, 36.
663	27 ———	.	250 20 1,0	−32 50 41,2	....	....	38, 39.
664	24 Ophiuchi	6·7	250 31 47,5	−22 44 10,9	− 3,3	....	34.
665	(236) Scorpii	7·8	250 41 22,6	−19 7 45,0	....	....	34.
666*	(248) Ophiuchi	7	251 15 51,1	−24 41 40,8	−17,3	....	34, 39.
667*	26 ———	6·7	251 18 40,5	−24 35 26,9	+ 8,4	− 1,7	34, 39.
668	29 ———	7·8	251 54 11,8	−18 30 7,3	− 5,3	− 1,6	39.
669	28 ———	8	252 15 19,9	−25 19 25,3	....	....	34, 36.
670	31 ———	8	252 26 8,0	−25 16 14,0	− 2,0	....	34, 36.
671	(273) Scorpii	7·8	252 35 3,0	−20 7 37,1	....	....	39.
672*	28 ———	7·8	252 54 53,5	−21 12 0,0	− 3,3	− 3,7	36, 39.
673	(284) Ophiuchi	7·8	252 56 55,3	−26 9 20,0	....	....	34, 36, 39.
674	(297) ———	6·7	253 31 31,8	−17 15 37,7	....	....	34, 36, 39.
675	η ———	3	254 6 12,4	−15 23 50,8	− 5,9	− 7,5	34, 36, 39.
676*	A ———	5	255 5 36,0	−26 13	+ 0,9	....	34, 36, 38, 39.
677	30 Scorpii	.	255 18 49,1	−26 10 0,8	....	− 3,4	39.
678	39 Ophiuchi	.	255 47 19,4	−23 59 37,6	+ 1,2	− 5,4	34, 36, 39.
679	(33) ———	8	255 48 37,2	−23 46 33,5	+ 1,4	....	34, 36, 39.
680	ζ ———	4	256 36 4,2	−20 49 30,9	− 4,3	− 2,6	34, 39.
681*	32 Scorpii	8	256 41 17,0	−24 37 54,5	+ 5,0	− 6,6	36.
682	θ Ophiuchi	3	256 45 44,5	−24 43 42,2	− 1,0	− 5,8	34, 36, 38, 39.
683	43 ———	7	257 0 24,9	−27 52 46,5	+ 1,8	0,0	39.
684	(76) Scorpii	.	257 32 2,2	−21 11 13,2	....	....	34.
685*	33 ———	7	257 33 10,1	−23 59 36,1	+ 1,2	− 4,8	34, 39.
686	*b* Ophiuchi	5	257 52 22,2	−23 55 26,0	− 1,6	− 4,5	34, 38, 39, 150.
687	e^2 ———	5	259 8 12,8	−23 44 46,9	− 2,9	− 4,8	34, 39, 52.
688	λ Scorpii	2·3	259 16 5,4	−36 53 50,2	− 7,5	− 4,9	39.
689	(128) Serpentis	.	259 42 6,9	−17 17 37,4	....	....	34, 39.
690	52 Ophiuchi	8	260 9 45,8	−21 51 7,8	− 0,5	− 2,1	34, 39.
691	(156) Serpentis	7	260 54 20,5	−15 23 46,4	....	....	39, 150.
692	α Ophiuchi	2	260 54 26,8	+12 45 27,4	− 7,7	− 3,4	34, 38, 39, 52.
693	ξ Serpentis	.	260 54 31,6	−15 13 9,9	− 4,5	− 5,8	35, 39.
694*	β Draconis	3	261 14 38,2	+52 29 31,3	−37,1	− 1,3	42, 46, 47, 49, 52, 52, 52.
695	(188) Serpentis	7	262 10 13,0	−15 24 44,8	....	....	35.

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					ΔR	Dec.	
696*	*d* Ophiuchi	6	262° 12′ 42″,0 ::	−21° 32′ 13″,0	....	−14″,2	35.
697	*p* Sagittarii	6	263 3 15,3	−27 42 36,0	+ 7,4	− 2,6	35, 38, 39, 42.
698	(223) ———	.	263 18 13,1	−26 51 28,3	....	....	39.
699	(247) ———	7·8	264 5 1,9	−22 49 3,6	....	....	42.
700	(257) ———	7·8	264 29 16,1	−19 1 49,7	....	....	42.
701	(265) Ophiuchi	6	264 52 45,0	−10 48 48,4	....	....	43.
702	(270) Serpentis	6	265 8 14,3	−11 15 36,1	....	....	43.
703	(277) Ophiuchi	6·7	265 23 42,0	−18 43 59,0	....	....	35, 42.
704*	(279) Sagittarii	7	265 25 16,1	−21 52 57,2	....	....	42.
705	(281) Serpentis	6·7	265 34 24,9	−15 44 32,5	....	....	35, 43.
706	4 Sagittarii	6	266 13 36,8	−23 45 58,0	− 0,3	− 6,1	35, 38, 39, 42.
707	*i* ———	.	266 18 36,6	−24 14 6,9	− 3,4	....	42.
708	(304) ———	7·8	266 22 25,8	−20 17 35,6	....	....	43.
709	(312) ———	6·7	266 46 58,5	−22 44 47,1	....	....	39, 43.
710	*a* ———	.	266 58 39,6	−24 15 10,9	+ 3,1	− 4,2	38, 42.
711	(326) ———	8	267 3 53,2	−22 41 25,1	....	....	39, 43.
712	9 ———	.	267 13 49,2	−24 20 15,2	+ 3,4	− 4,8	39, 42.
713	γ^2 ———	3	267 32 7,7	−30 23 56,3	− 2,1	+ 2,2	38, 128.
714	γ Draconis	2	267 44 35,0	+51 31 42,2	−23,6	− 2,4	41, 42, 43, 46, 46, 47, 49, 52,
715	(356) Sagittarii	7·8	268 8 30,4	−21 26 30,8	....	....	39. [52, 52, 126.
716	(359) ———	6	268 9 31,4	−28 27 16,3	....	....	39.
717	(367) ———	6·7	268 35 28,2	−30 44 17,5	....	....	38, 42.
718	(386) ———	6	269 12 29,2	−23 43 21,6	+ 8,9	....	39, 42, 43.
719	μ^1 ———	4	269 47 43,3	−21 5 44,5	− 3,0	− 5,3	38, 39, 42, 126, 128.
720	14 ———	7	269 54 8,5	−21 45 0,8	− 0,8	− 7,9	38, 42, 43.
721	μ^2 ———	4	270 9 59,8	−20 46 25,3	+ 0,9	− 7,1	40, 41, 42, 43, 126, 128.
722	16 ———	7	270 10 30,8	−20 25 59,4	− 1,6	− 5,4	40, 42, 43.
723	δ ———	3	271 20 32,0	−29 54 10,0	+ 6,8	− 5,5	38, 40, 41, 42, 43, 64, 126.
724	ε ———	2·3	271 59 37,7	−34 28 13,6	− 0,2	− 6,5	38, 40, 41, 42, 43, 64, 127,
725	21 ———	6	272 42 20,4	−20 38 42,2	− 0,7	− 8,3	40, 43, 155. [147.
726	λ ———	4	273 13 38,9	−25 31 43,8	+ 1,1	− 2,2	38, 40, 41, 43, 64, 127, 157,
727	(75) ———	7·8	273 34 42,9	−25 22 59,8	....	....	38, 40, 41. [158.
728	(82) ———	7	273 57 51,9	−18 51 27,4	....	....	40, 41, 58, 127.
729	(88) ———	6	274 15 8,2	−19 2 9,6	....	....	38, 40, 41.
730	(92) ———	7	274 17 9,0	−18 32 35,5	....	....	40, 41, 58, 127.

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					Æ	Dec.	
731	(95) Sagittarii	8	274° 32′ 1″,5	−19° 7′ 14″,6	....	....	38, 40, 41.
732	(101) Clyp. Sob.	6·7	274 41 51,2	−15 1 4,4	+2,2	....	58.
733*	(102) Sagittarii	.	274 42 48,1	−18 31 8,0	....	....	41.
734*	24 ———	7	274 44 39,7	−24 11 19,4	+7,2	+ 2,8	127.
735	25 ———	8	274 54 12,1	−24 22 58,0	−9,4	− 0,2	127.
736	(107) ———	6·7	274 55 40,7	−15 0 38,0	+3,8	....	58.
737	(112) ———	7	275 15 3,3	−19 25 58,1	....	....	38, 40, 41.
738	(121) ———	7	275 41 10,3	−19 23 5,9	....	....	38, 40, 41.
739	(125) ———	.	275 49 23,1	−21 34 21,4	+7,2	....	41, 58, 127.
740	(129) ———	7	275 55 2,7	−23 41 10,0	−3,2	− 4,3	58.
741	(128) Clyp. Sob.	7·8	275 55 23,7	−17 24 42,7	....	....	38, 40, 41.
742*	(131) Sagittarii	7	276 5 5,0	−21 13 25,8	−8,8	....	40, 41, 58.
743*	α Lyræ	1	277 10 2,5	+38 34 16,4	+9,2	− 2,5	15 observations.
744	φ Sagittarii	4	277 36 3,0	−27 12 51,0	−3,2	− 2,1	38, 40, 41, 53, 64, 73, 127, 155,
745	(162) ———	7·8	277 54 9,6	−19 50 5,7	....	....	59. [157, 158.
746	(175) ———	8	278 20 41,5	−20 30 40,4	+5,9	....	38, 41.
747	29 ———	.	278 47 48,3	−20 34 32,2	−4,5	− 5,1	38, 40, 53, 59, 73, 127, 150, 157.
748	30 ———	8	279 2 35,7	−22 24 56,2	−5,1	− 3,2	53, 59.
749	31 ———	8	279 22 14,3	−22 10 48,1	−6,9	−10,8	53, 59.
750	33 ———	.	279 51 12,5	−21 37 58,1	−5,6	− 5,3	40.
751	ν^1 ———	5	279 51 30,2	−23 1 7,1	−1,8	− 3,6	38, 40, 42, 53, 59, 61, 73, 127.
752*	σ ———	3	280 1 52,3	−26 34 19,6	−1,6	− 3,6	9 observations.
753	ν^2 ———	5	280 5 26,6	−22 56 57,3	−3,2	− 6,9	38, 42, 53, 59, 73, 127.
754	ξ^1 ———	7	280 42 31,9	−20 56 55,7	−0,5	− 5,8	38, 42, 53.
755	ξ^2 ———	4	280 47 31,9	−21 24 1,0	−4,0	− 7,4	38, 42, 53, 59, 73, 127, 150.
756*	(238) ———	8	280 55 37,7 :	−20 43 21,5	....	....	53.
757	(255) ———	6·7	281 43 45,3	−23 0 47,2	....	....	38.
758	ζ ———	3	281 46 2,9	−30 12 4,0	+1,2	− 2,4	38, 42, 53, 59, 61, 73, 127, 127,
759*	(261) ———	7	282	−25 9 21,6	....	....	53. [155.
760	o ———	4	282 30 48,9	−22 4 22,3	−2,8	− 5,4	38, 42, 53, 59, 61, 73, 127, 127, [150.
761	τ ———	4	282 55 23,1	−27 59 59,1	−0,9	− 4,6	38, 42, 53, 59, 73, 127, 127.
762	(293) ———	7	283 1 57,0	−28 58 58,3	....	....	42.
763	(294) ———	8	283 4 18,3	−22 50 45,5	....	....	61.
764	(301) ———	7·8	283 19 50,8	−25 0 37,0	....	....	38, 42, 59. [127, 155.
765	π ———	3·4	283 48 40,7	−21 23 7,8	−3,8	− 7,5	38, 42, 53, 59, 61, 73, 127,

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					AR	Dec.	
766	(346) Sagittarii	7·8	283° 51′ 4″,1	−20° 9′ 46″,6	....	....	38, 53, 59.
767	(4) ———	8	284 28 11,4	−22 2 13,6	....	....	61.
768	(5) ———	8	284 30 24,1	−14 57 52,4	....	....	59.
769	(7) ———	6·7	284 32 49,8	−26 17 13,8	....	....	42, 127.
770	ψ ———	6	285 8 29,0	−25 39 2,7	− 3,1	− 6,6	42, 53, 59, 73, 127, 128, 151, [155.
771	(22) ———	7	285 10 6,9	−24 34 5,8	....	....	38.
772*	(20) ———	9	285 10 29,8 :	−17 44 31,8	....	....	61.
773	*d* ———	6	285 50 16,0	−19 21 43,2	− 5,5	− 7,6	38, 42, 53, 61, 127, 128.
774	(39) ———	8·9	285 58 36,8	−19 16 32,2	....	....	38, 53.
775	(50) ———	6	286 16 13,9	−15 56 5,6	....	....	42.
776	(61) ———	7	286 30 0,9	−22 49 49,8	....	....	61, 73.
777	ϱ^1 ———	5	286 52 40,5	−18 16 52,3	− 5,1	− 8,5	42, 53, 61, 73, 127, 128.
778	ϱ^2 ———	6	286 54 4,0	−18 44 9,7	− 4,8	− 8,5	42, 53, 61, 73, 127, 128.
779	υ ———	6	286 56 11,5	−16 23 17,4	− 5,6	− 4,4	42, 53, 128.
780	χ^1 ———	5	287 36 10,0	−24 57 23,0	− 2,7	− 5,4	53, 61, 127, 151.
781*	χ^3 ———	5	287 40 40,6	−24 24 48,5	− 6,0	−12,3	42, 53, 61, 127, 128.
782*	50 ———	7	287 56 18,1	−22 14 3,0	− 3,5	− 6,5	61.
783*	(107) ———	7	288 4 18,4	−15	....	....	60.
784*	Same as 782.	7·8	288	−22 14 3,0	....	....	53.
785	(124) ———	7·8	288 40 31,8	−15 34 27,8	....	....	60, 61.
786	(126) ———	.	288 41 17,4	−27 27 26,7	....	....	42.
787	(132) ———	8	288 54 47,6 :	−15 50 9,7	....	....	61.
788*	(138) ———	8	289 6 6,0 :	−21 47 37,9	....	....	60.
789*	Same as 788.	7·8	289		....	....	61.
790	(159) ———	8	289 57 18,3	−24 21 39,8	....	....	53, 60, 61, 71.
791	h^1 ———	5	290 17 54,3	−25 13 40,7	− 6,5	− 9,0	53, 59, 61, 71, 127.
792	h^2 ———	5	290 27 36,9	−25 23 50,7	− 6,4	− 4,7	53, 59, 61, 71, 127, 128, 151,
793	(176) ———	8	290 32 44,2	−19 21 56,8	....	....	61, 74. [156.
794	(180) ———	8	290 43 17,0	−18 44 57,2	....	....	61.
795*	53 ———	8	291 17 4,2	−23 57 28,6	− 3,0	−11,3	53.
796	(201) ———	7·8	291 21 28,8	−23 57 39,2	− 5,9	−14,8	53.
797*	e^1 ———	6	291 40 58,2	−16 49 43,8	− 2,9	− 7,9	14 observations.
798*	e^2 ———	6·5	292 8 12,3	−16 40 20,2	− 0,7	− 6,1	13 observations.
799	(230) ———	6	292 24 25,1	−16 0 43,3	....	....	42, 53, 55, 59, 60, 61, 71, 74,
800*	*f* ———	6	293 1 42,6	−20 19 25,0	− 2,9	− 7,7	13 observations. [82, 127, 130.

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					Æ	Dec.	
801	(260) Sagittarii	8	293° 24′ 2″,8	−21° 31′ 59″,6	....	....	53.
802	(265) ———	7·8	293 34 57,6	−14 16 50,3	....	....	55.
803	(271) ———	.	293 48 47,5	−12 54 8,4	....	....	55.
804*	α Aquilæ	1	294 43 10,9	+18 14 36,6	− 3,5	− 4,5	31 observations.
805	ω Sagittarii	5	295 12 57,5	−26 55 17,3	− 3,3	− 8,6	53, 55, 151.
806	*b* ———	5	295 29 9,9	−27 47 29,5	− 2,8	− 7,2	53, 55, 82, 131, 133, 135.
807	*a* ———	5	296 0 54,8	−26 49 52,6	− 2,4	− 5,8	53, 55, 133, 135, 151.
808	*g* ———	5	296 1 24,7	−16 6 56,5	− 0,4	− 9,5	53, 55, 74, 131, 133.
809*	*c* ———	6	296 54 19,9	−28 21 51,4	− 4,7	− 4,4	13 observations.
810	63 ———	7	297 4 18,1	−14 17 31,2	+ 3,9	− 3,0	57.
811	(369) ———	8	297 18 49,0	−23 15 25,0	....	....	55.
812	(372) Capricorni	8·9	297 25 48,8	−16 4 23,3	....	....	53.
813	(377) Sagittarii	.	297 38 36,8:::	−21 58 48,0 ∴	....	....	73.
814	64 ———	7·8	297 54 0,9	−12 16 6,1	− 2,7	− 4,5	74, 79.
815	65 ———	7	297 57 47,1	−13 19 58,8	+ 4,9	− 8,5	57, 57, 78.
816	(402) Capricorni	8	298 31 25,6	−19 29 15,4	....	....	55, 57, 57, 73, 74.
817	(404) ———	8	298 40 27,1	−15 42 29,6	....	....	53.
818	(406) ———	7·8	298 47 34,6	−10 44 52,0	....	....	79.
819	(410) Sagittarii	.	298 49 4,0	−21 16 31,9	....	....	73.
820	(417) Capricorni	9	299 3 57,1	−20 4 15,0	....	....	55.
821	1 ———	6	299 36 22,8	−13 5 44,9	+ 1,1	− 2,9	[75, 58. 53, 55, 57, 57, 61, 64, 73, 74,
822	ξ ———	6	299 42 16,9	−13 18 40,5	− 2,1	− 3,2	53, 55, 57, 57, 61, 64, 73, 74,
823*	3 ———	4	300 42 48,3	−13 3 45,0	− 2,6	− 8,7	12 observations. [75, 78, 79.
824	α^1 ———	.	301 1 36,7	−13 14 27,8	− 2,0	− 6,6	53, 55, 57, 57, 61, 64, 74, 75,
825*	α^2 ———	3	301 7 28,5	−13 16 49,0	− 1,1	− 5,0	12 observations. [78, 79, 85.
826	σ ———	6	301 19 22,8	−19 51 28,2	− 7,3	− 8,6	55, 57, 65, 74.
827	β^1 ———	6·7	301 45 41,1	−15 32 0,0	+ 0,9	−12,4	53, 55, 57, 57, 61, 74, 78, 79.
828	ν ———	6	301 46 40,0	−13 30 22,3	− 0,2	− 4,2	53, 55, 61, 65, 74, 75, 133.
829	β^2 ———	3	301 49 13,8	−15 31 49,3	− 1,3	− 9,5	53, 55, 57, 57, 61, 66, 74, 78,
830*	(102) ———	7·8	302 26 15,1 ::	−15 1 2,5	....	....	[79. 54.
831*	(107) ———	7·8	302 38 48,4	−14 52 42,1	....	....	54.
832	(114) ———	8	302 55 16,8	−12 28 33,5	....	....	78.
833*	(109) ———	.	302 45 27,5	−20 12 4,4	....	....	55.
834	π ———	6	303 19 58,2	−18 59 25,2	− 3,5	− 8,9	54, 55, 57, 66, 74, 78, 133.
835	ϱ ———	6	303 43 46,2	−18 35 58,3	− 0,1	− 6,5	54, 55, 57, 66, 74, 75, 78, 79, [133.

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					ΔR	Dec.	
836	(144) Capricorni	8	303° 45′ 46″,2	−18° 39′ 19″,7	− 0″,7	....	55, 57, 66, 74, 75, 78, 79, 133.
837	(145) ———	8	303 45 46,2	−18 13 18,2	....	....	58.
838*	o^1 ———	8	303 57 52,4	−19 22 19,4	+ 2,4	....	55, 58, 74.
839*	o^2 ———	6	303 58 15,4	−19 22 11,9	+ 1,1	− 7,2	54, 55, 66, 74, 79.
840	(170) ———	8·9	304 34 41,2	−25 44 46,3	....	....	55.
841	(172) ———	8	304 40 13,9	−17 24 52,5	....	....	58.
842*	(174) Aquarii	6	304 45 42,7	−10 39 57,1	....	....	66.
843	(187) Capricorni	7	305 8 48,2	−14 31 21,3	....	....	54, 79.
844	(194) ———	7·8	305 25 36,1	−17 20 33,8	....	....	54, 55, 58.
845	(200) ———	8	305 34 17,9	−21 24 27,7	....	....	57.
846	13 ———	8	305 54 40,5	−15 58 17,8	+ 0,9	−12,0	54, 79.
847	(213) ———	8	305 59 28,6	−17 57 3,2	....	....	55, 58.
848	τ ———	6	306 24 4,6	−15 47 26,6	− 1,0	− 5,6	54, 56, 57, 58, 86, 156.
849	υ ———	6	306 32 0,1	−18 58 38,2	− 0,1	− 9,4	56, 57, 58, 61, 74, 79, 86, 133,
850	(240) ———	7	306 42 0,8	−16 58 17,7	....	....	54. [151, 152.
851	ψ ———	5	307 54 8,3	−26 7 37,0	− 2,6	− 6,0	56, 58, 81, 83, 83, 86, 151, 152,
852	α Cygni	1	308 16 36,7	+44 25 11,6	+12,8	− 2,5	20 observations. [156.
853	ε Aquarii	5	308 36 44,1	−10 22 13,6	− 0,6	− 6,9	56, 57, 58, 81, 83, 83, 86.
854*	(310) Capricorni	7	309	−18 54 57,5	....	....	54.
855	ω ———	6	309 18 13,3	−27 48 40,5	− 2,2	− 5,0	56, 57, 58, 75, 81, 83, 83, 151, [152.
856	(341) Aquarii	8	309 45 23,8	−14 6 9,6	....	....	58.
857	μ ———	4·5	309 52 6,6	− 9 52 49,4	+ 0,6	− 6,2	56, 57, 58, 75, 81, 83, 84, 86,
858	(351) ———	7	309 55 51,9	−12 28 39,0	....	....	86. [132.
859	19 Capricorni	7	310 14 43,6	−18 49 47,0	− 4,4	− 4,6	54, 56, 58, 83, 84, 86.
860	(370) ———	7·8	310 33 45,0	−27 12 20,2	....	....	56.
861	(386) ———	7	310 59 47,5	−16 57 7,8	....	....	58, 75, 83.
862	20 ———	7·8	311 25 37,1	−19 57 44,9	− 6,3	− 4,3	56, 58, 75, 83, 86.
863	21 ———	7	311 46 31,2	−18 27 49,9	− 3,0	− 6,6	56, 58, 75, 83, 86.
864	9 Aquarii	7·8	311 55 5,4	−14 27 56,6	− 7,5	− 7,5	56.
865	(423) ———	7·8	312 9 53,2	−12 38 2,2	....	....	58.
866	η Capricorni	5	312 37 18,9	−20 48 2,5	− 4,8	− 7,1	56, 58, 66, 76, 83, 84, 86, 133.
867	θ ———	5	313 3 3,4	−18 11 4,5	− 4,2	− 4,2	56, 58, 66, 69, 76, 83, 84, 86, 133,
868	a ———	6	313 12 14,9	−25 57 44,0	− 3,6	− 7,6	56, 58, 66, 76, 83, 86. [151, 152.
869	χ^1 ———	6	313 38 16,6	−22 9 19,9	− 6,7	− 9,0	56, 58, 66, 69, 76, 83, 84, 86, 133.
870	χ^3 ———	6	313 53 29,5	−21 31 2,8	− 5,9	− 8,0	56, 58, 66, 69, 76, 83, 84, 86, 133.

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					Æ	Dec.	
871	ν Aquarii	5	314° 4′ 12″,8	−12° 20′ 32″,9	+ 1″,6	− 6″,0	56, 58, 64, 66, 69, 76, 83, 84,
872	(7) ———	7·8	314 32 49,3	−15 27 6,8	....	....	56. [86, 132.
873	(18) Capricorni	7·8	314 59 36,4	−23 11 58,5	....	....	56, 69, 86.
874	φ ———	6	315 25 40,7	−21 38 47,5	− 2,3	− 9,2	56, 64, 66, 69, 84, 86, 132, 151,
875	30 ———	6	316 3 37,0	−18 59 24,5	− 2,4	− 6,0	64, 66, 69, 85, 86. [153.
876	(57) ———	7·8	316 8 32,3	−21 20 23,8	....	....	64, 66, 86.
877	(66) Aquarii	7·8	316 24 57,7	−17 11 16,1	....	....	86.
878	(75) Capricorni	8·9	316 46 52,0	−21 49 58,4	....	....	64, 66.
879	ι ———	5	317 9 32,3	−17 51 22,9	− 8,4	− 8,9	56, 64, 66, 67, 69, 84, 86, 132,
880	(97) ———	8	317 31 56,9	−23 46 29,1	....	....	56. [156.
881	33 ———	7	317 34 22,9	−21 52 17,9	− 3,7	− 8,2	56, 64, 66, 67, 69, 84.
882	18 Aquarii	6	317 42 30,6	−13 54 33,7	− 1,2	− 3,4	86. [151, 153, 156.
883*	ζ Capricorni	5	318 10 32,0	−23 26 50,8	− 8,5	−19,5	56, 64, 66, 67, 69, 84, 86, 132,
884	b ———	6	318 41 38,6	−22 51 9,8	− 6,3	− 6,3	56, 64, 67, 69, 84, 86.
885	(134) Aquarii	7	318 44 54,3	−12 36 36,8	....	....	86.
886	(145) Capricorni	7·8	319 3 58,0	−20 11 44,9	....	....	56, 64, 67, 69, 84.
887	(154) Aquarii	8	319 19 12,8	−15 20 36,1	....	....	67, 69.
888	(158) Capricorni	9	319 25 24,0	−20 17 29,4	....	....	56.
889	β Aquarii	3	319 40 32,7	− 6 37 46,6	− 6,2	− 6,5	56, 64, 67, 69, 84, 86.
890	(171) Capricorni	9	320 2 23,9	−17 15 21,5	....	....	56.
891	37 ———	6·7	320 16 42,8	−21 9 20,5	− 5,8	− 6,5	56, 64, 67, 69, 84.
892*	38 ———	.	320 17 23,2	−21 19 0,0	+10,7	−12,1	64. [156.
893	ε ———	4	320 50 52,0	−20 32 34,8	− 8,9	− 7,1	56, 64, 67, 69, 84, 152, 153,
894	ξ Aquarii	5	321 11 14,8	− 8 56 0,6	− 4,8	− 5,9	56, 64, 67, 69, 84, 154.
895	γ Capricorni	4·3	321 38 11,0	−17 44 56,5	− 8,3	− 6,8	56, 64, 67, 69, 84, 153.
896	d^1 ———	.	322 3 50,3	−15 7 13,8	− 1,1	− 8,3	56, 64, 67, 69, 84.
897	$\varkappa$ ———	5	322 15 3,1	−19 57 47,3	− 2,7	− 5,9	56, 64, 67, 84, 152, 153.
898	(243) ———	7·8	322 23 11,5	−20 43 7,3	....	....	56, 64.
899	c^1 ———	6	322 59 42,3	−10 11 19,0	− 4,3	− 8,3	56, 64, 67, 84.
900	λ ———	5	323 20 43,7	−12 28 36,8	− 3,2	− 5,4	56, 64, 67, 84, 152, 153, 154.
901	δ ———	3	323 23 15,4	−17 13 10,6	− 5,9	− 7,9	56, 64, 67, 84, 155.
902	(291) Aquarii	7·8	324 7 12,3	−13 50 46,8	....	....	64, 67.
903	(294) Capricorni	8	324 11 31,6	−17 58 3,7	....	....	56, 64.
904	(303) ———	8	324 31 46,4	−19 44 42,6	....	....	56, 67.
905	μ ———	5	324 59 34,4	−14 41 10,4	− 8,8	− 6,7	56, 64, 67, 67, 84, 153, 154.

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					AR	Dec.	
906	(323) Capricorni	8	325° 25′ 17″,1	−16° 23′ 43″,9	....	....	67.
907	(332) ———	8·9	325 49 28,9	−19 2 32,0	....	....	64, 67, 67, 133.
908	(338) ———	9	326 7 17,2	−16 16 16,6::	....	....	67.
909	(343) Aquarii	7	326 16 19,4	−22 20 2,7	....	....	84.
910	(344) ———	8	326 18 25,0	−13 49 11,4	....	....	64.
911	(361) ———	8	327 11 8,1	−19 3 39,0	....	....	64, 67, 134.
912	o ———	5	327 40 21,5	− 3 19 16,5	− 7,6	− 5,1	64, 67, 69, 84, 134.
913	ι ———	4	328 18 33,3	−15 2 25,7	− 3,7	− 6,6	64, 67, 84, 134, 152, 153, 154,
914	α ———	3	328 18 49,2	− 1 29 36,3	− 8,7	− 5,0	64, 67, 69, 134. [155, 156, 157.
915	37 ———	7·8	329 22 24,3	−12 0 30,7	+ 0,8	− 9,6	67.
916	e ———	6	329 23 26,8	−12 45 8,4	− 9,0	− 7,5	64, 67, 84, 134, 154, 157.
917	40 ———	7·8	330 5 35,8	−13 7 10,7	− 1,0	− 8,9	67.
918	θ ———	4	330 59 12,2	− 8 59 11,5	− 6,6	− 6,5	64, 67, 134, 152, 153, 157.
919	(46) ———	7	330 59 39,2	−10 14 38,8	....	− 5,8	67.
920	ϱ ———	5·6	331 50 15,2	− 9 2 6,4	− 5,0	− 5,5	64, 67, 134, 152.
921	γ ———	3	332 15 49,5	− 2 36 24,9	−10,8	− 4,0	64, 67, 153.
922*	51 ———	6	332 50 59,6	− 6 3 36,3	− 5,0	− 8,0	64.
923	(89) ———	7	333 0 6,1	− 2 24 54,2	....	....	64.
924	54 ———	7·8	333 25 45,4	−12 27 26,9	− 6,4	− 8,9	64.
925	ζ ———	4	334 4 6,6	− 1 15 27,4	− 9,6	− 8,6	64, 67.
926*	σ ———	5	334 25 45,7	−11 54 58,5	− 2,7	−13,2	64, 67, 134.
927	58 ———	7·8	334 41 1,6	−12 8 47,4	− 1,3	− 3,5	67.
928	η ———	4	335 42 21,1	− 1 21 55,0	− 9,0	− 7,0	64, 67, 145.
929*	ϰ ———	5	336 16 42,1	− 5 28 36,8	− 4,1	− 8,1	64, 67, 145.
930	(176) ———	8	336 48 41,4	−10 37 23,3	....	....	64.
931	(178) ———	8	336 52 6,9	− 7 47 41,4	....	....	67.
932	65 ———	8	337 32 36,4	−11 22 17,1	− 8,4	− 7,9	65.
933	(200) ———	7	337 33 57,2	− 9 34 43,1	....	....	65.
934	(201) ———	8·9	337 36 34,8:::	− 8 29 3,0	....	....	68.
935	67 ———	7	337 37 20,3	− 8 13 53,1	− 2,1	− 6,9	68.
936	(209) ———	9	338 7 38,7:::	−10 55 12,3::	....	....	68.
937*	τ^1 ———	6	338 40 58,8	−15 19 59,6	+ 3,6	− 8,6	65, 68, 88, 145.
938	τ^2 ———	6	339 9 47,7	−14 52 17,7	− 2,5	− 8,4	65, 68, 76, 88.
939	(230) ———	.	339 30 40,2	− 8 35 43,8	....	....	80.
940	λ ———	4	339 58 9,8	− 8 52 10,8	− 1,0	− 5,9	65, 68, 76, 80, 88, 145.

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					AR	Dec.	
941	δ Aquarii	3	340° 25′ 12″,3	−17° 6′ 35″,9	− 5″,2	− 8″,9	65, 68, 76, 80, 88.
942	α Piscis Aust.	1	341 1 46,0	−30 54 24,9	− 4,1	− 6,0	65, 68, 76, 80, 88, 90, 137, 145.
943	(272) Aquarii	7	341 53 39,8	−10 10 49,2	....	....	68, 88.
944*	81 ———	6·7	342 10 32,0	− 8 21 49,4	− 1,9	− 7,2	76, 88.
945	β Piscium	4	342 52 4,1	+ 2 30 46,2	− 9,9	− 4,1	65, 68, 76, 80, 84, 90.
946	β Pegasi	2	342 59 37,7	+26 45 56,4	+ 2,4	− 6,0	65, 68, 76, 80, 88, 90.
947	h^1 Aquarii	.	343 6 28,8	− 9 0 12,3	− 5,8	− 8,1	76, 80, 90, 145.
948	h^2 ———	7	343 9 3,0	− 9 5 —	− 4,5	....	90.
949	α Pegasi	2	343 9 21,5	+13 53 54,8	− 0,6	− 5,9	65, 68, 76, 80, 88, 90.
950	h^3 Aquarii	6·7	343 17 34,2	− 9 14 50,8	− 4,4	− 3,5	90.
951*	h^4 ———	9	343 37 33,9:	− 9 1 ::	−11,1	....	68.
952	A Piscium	6	344 2 54,8	+ 0 48 20,3	− 6,7	− 4,4	65, 68, 76, 80, 84, 88, 90, 145.
953	(316) ———	7	344 13 50,6	+ 0 49 36,0	− 4,7	....	90.
954	(2) Aquarii	8	344 30 40,0:::	− 7 16 43,2	....	....	68.
955	φ ———	5	345 25 15,0	− 7 21 29,3	− 6,0	− 6,8	62, 65, 68, 76, 80, 89, 90.
956	ψ^1 ———	5	345 46 31,5	−10 24 38,5	− 9,0	− 7,3	62, 65, 68, 76, 80, 89, 91.
957	χ ———	6	346 2 58,7	− 9 3 4,7	− 6,6	− 6,8	62, 65, 68, 76, 80, 89, 91.
958	γ Piscium	4	346 8 0,5	+ 1 57 18,1	−11,9	− 3,9	62, 68, 76, 80, 91.
959	ψ^2 Aquarii	5	346 18 14,2	−10 30 30,4	− 7,4	− 7,1	62, 65, 68, 76, 80, 89, 91.
960	ψ^3 ———	5	346 33 55,4	−10 56 16,5	− 4,7	−10,4	62, 65, 68, 76, 80, 89, 91.
961	b Piscium	5·6	346 58 53,5	+ 4 3 19,0	− 5,2	− 8,3	62, 68, 76, 80, 89, 89, 91.
962	(68) ———	6·7	347 45 22,8	− 1 2 35,6	....	....	89, 89, 91.
963	(69) ———	7·8	347 46 38,1	− 9 47 35,9	....	....	91.
964*	*Uranus*	.	348 0 20,2	− 6 2 3,0	....	....	68.
965	$\varkappa^1$ Piscium	5	348 36 34,2	− 0 4 33,1	−11,9	− 2,0	62, 68, 76, 89, 89, 91.
966*	$\varkappa^2$ ———	6·7	348 41 25,5	− 0 12 47,1	− 9,1	− 5,1	76, 89, 89.
967	θ ———	5	348 54 8,8	+ 5 2 34,1	− 7,8	− 2,8	62, 68, 89, 89, 91.
968	(96) ———	7	349 13 50,7	− 5 21 24,8	....	....	89.
969	12 ———	8	349 15 3,9	− 2 22 27,6	− 9,7	− 5,1	68.
970*	11 ———	7	349 13 58,6	− 3 7 43,3	− 5,4	− 8,9	62.
971	(103) ———	7·8	349 43 52,6	− 5 24 57,4	....	....	68, 89, 89.
972	13 ———	7	349 51 43,3	− 2 25 42,9	− 6,8	− 8,3	62, 68, 89, 89.
973	14 ———	6·7	350 24 13,2	− 2 35 26,3	− 8,0	− 6,8	62, 68, 89, 89, 91.
974	(126) Aquarii	7·8	350 44 13,2	− 8 48 38,0	....	....	62, 68, 89, 91.
975	15 Piscium	7	350 45 16,9	− 0 1 48,0	− 9,9	− 6,9	85.

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					AR	Dec.	
976	16 Piscium	6·7	350° 59′ 15″,3	+ 0° 45′ 7″,6	−10″,0	− 5″,3	62, 68, 91.
977	ι ———	5	351 51 17,7	+ 4 18 28,8	−11,3	− 6,1	62, 68, 85, 89, 90, 91, 135.
978	λ ———	5	352 24 10,7	+ 0 26 26,3	− 9,9	− 4,0	62, 68, 85, 89, 90, 91, 135.
979	(170) ———	8	353 5 46,2	+ 5 50 28,7	....	....	90, 91.
980	19 ———	6·7	353 29 9,2	+ 2 8 9,9	−10,5	− 5,4	62, 68, 90, 91.
981	(185) Aquarii	6·7	353 40 28,3	−13 15 28,9	....	....	85.
982*	20 Piscium	6·7	353 51 10,7	− 4 7	− 9,9	....	62.
983*	(190) Aquarii	7	354 0 4,5	− 7 43 55,7	....	....	85.
984	(193) Piscium	7	354 5 15,8	+ 0 51 43,6	....	....	68, 90.
985	21 ———	6·7	354 14 43,6	− 0 16 34,0	−11,2	− 2,9	62, 68, 90.
986	(200) Pegasi	6	354 24 45,3	−11 19 50,0	....	....	90, 135.
987	24 Piscium	7	355 6 3,0	− 4 30 28,6	−11,2	− 6,7	68, 85, 90, 135.
988	(227) ———	6·7	355 34 34,6	− 1 14 46,5	....	....	68, 90, 135.
989	26 ———	6·7	355 39 55,3	+ 5 43 0,5	− 1,7	− 6,8	62, 68, 132.
990	27 ———	6·7	356 32 52,4	− 4 54 28,7	− 6,5	....	62, 68, 85, 90, 132, 135, 154.
991	ω ———	5	356 42 4,2	+ 5 30 49,8	−10,2	− 3,8	62, 68, 85, 90, 132, 135.
992	29 ———	5	357 19 58,4	− 4 23 1,4	− 8,0	− 7,3	62, 68, 85, 90, 132, 135.
993	30 ———	5	357 21 46,6	− 7 22 5,1	− 8,8	− 7,7	62, 68, 85, 90.
994	(257) ———	.	357 23 8,9	− 4 7 22,0	− 3,3	....	132.
995	c^2 ———	5·6	357 30 42,3	+ 7 7 51,9	− 7,6	− 3,5	68, 90.
996	33 ———	5	358 12 47,8	− 7 4 15,5	−10,0	− 1,5	62, 68, 85, 90, 132, 136, 154.
997	α Andromedæ	2	358 57 20,1	+27 44 37,6	+ 3,3	− 5,0	62, 68, 85, 90, 132, 136.
998	(286) Piscium	8	359 21 33,6	− 3 55 0,5	....	....	68, 132, 136.

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SUPPLEMENTARY CATALOGUE OF OMITTED STARS.

No.	Names.	Mag.	Right Ascension, 1756.	Declination, 1756.	Reference to the *pages* of the printed Observations.
1	λ Cassiopeæ	.	4° 37′	+53° 10′	63, 68, 70.
2	(118) ———	.	5 40	+52 49	63, 68, 70.
3	ζ ———	.	5 53	+52 33	63, 69, 70, 71.
4	α ———	.	6 42	+55 12	63, 70, 71.
5	α Ursæ min.	.	10 58	+88 0	46, 47, 49, 50, 50.
6	τ Ceti	.	23 11	−17 13	70.
7	——	.	33 44	+ 8 19	102.
8	τ Persei	.	39 17	+51 45	72, 79.
9	Tauri	.	61 1	+13 13	2.
10	——?	.	68 7	+	2.
11		.	70 10	+	7.
12		.	70 16	+	2, 2.
13		.	70 24	+	7.
14	ε Aurigæ	.	71 8	+43 26	46, 59, 77, 107.
15	ζ ———	.	71 22	+40 41	59, 77, 107.
16	———	6	71 34	+41 4	108.
17	η ———	.	72 22	+40 53	46, 59, 77, 91, 107, 110.
18	*h* Orionis?	.	74 —	+	2, 2.
19		.	75 8	+	2.
20	12 Leporis	7	83 0	−22 31	109.
21	γ^1 ———	7	83 34	−22 31	7, 106.
22	β Aurigæ	.	85 24	+44 54	46, 60, 106, 109.
23	Hydræ	6	156 —	− 9 51	143.
24	χ ———	.	163 23	−25 59	143.
25	(85) Leonis	.	168 16	+ 8 57	146.
26	Virginis	.	196 8	−10 24	143.
27	η Ursæ min.	.	246 14	+76 19	46.
28	ε ———	.	257 46	+82 24	46, 49.
29	Herculis	.	264 6	+17 49	43.
30	Draconis	.	271 27	+54 13	49.

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31	Draconis	.	276° 23′	+51° 7′	43, 46, 49, 52, 64.
32	———	.	277 6	+50 53	46, 46, 49, 52, 52, 64.
33	∂ Ursæ min.	.	282 39	+86 31	46, 46, 49.
34	ψ Aquilæ	.	293 18	+12 44	57, 57.
35	γ ———	.	293 39	+10 2	57, 57, 59, 61, 62, 65, 71, 74, [74, 75, 82, 87, 88.
36	———	.	295 26	+ 6 31	57.
37	ξ ———	.	295 36	+ 7 51	57, 65, 71.
38	β ———	.	295 49	+ 5 49	57, 57, 61, 62, 65, 71, 74, 75, 75,
39	Capricorni	.	306 19	−20 6	66. [78, 79, 82, 87, 88, 130.
40	7 Aquarii	.	310 55	−10 37	132.
41	ν Cygni	.	312 1	+40 14	57, 66, 69.
42	12 Aquarii	.	312 47	− 6 47	132.
43	———	.	330 46	−10 24	154.
44	(282) Ceti	.	359 3	− 3 35	68.
45	——	.	359 28	− 2 53	154.

N.B. The two stars, Nos. 31 and 32, in this supplementary list, are the stars by means of which (together with β and γ *Draconis*) MAYER determined the position of his quadrant, when he reversed it in July and August 1756. They were not observed by BRADLEY; neither have they been since observed by PIAZZI: but I have found an observation of each of them in the *Histoire Céleste*, p. 300, as under; viz.

No. 31. $\mathfrak{R} = 18^h\ 27^m\ 18^s,7$ $Z = 86°\ 51'\ 0''$

32. $\mathfrak{R} = 18\ 29\ 5,5$ $Z = 86\ 37\ 13$

This last is a double star; but I have taken the brightest of the two.

List of Occultations, observed by Mayer.

1756.	Sept.	3	Anon.
		15	Tauri, 6 mag.*
	Oct.	11	γ Tauri.
		15	Anon.
		27	Anon., 7·8 mag.
1757.	Mar.	24	γ Tauri.
	April	3	γ^1 Virginis.
		3	γ^2 ———
	June	21	α Tauri.
1759.	May	1	∂ Geminorum.

* The position of this star is stated by Mayer to be $\mathfrak{R} = 4^h\ 58^m$, and D = +18° 10′,6; but I cannot find such a star in any catalogue.

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NOTES

TO THE PRECEDING CATALOGUE.

No.

9. The declination of this star is erroneously printed *north* in Mayer's catalogue: but the error is corrected at the end of the volume.

11. The declination of this star is also erroneously printed *north* in Mayer's catalogue: but, on reference to the printed observations, it will be seen that it should be *south*.

41. If we correct the observation of this star 30^s (in time), or, which is nearly the same thing, if we suppose that Mayer recorded the wrong wire, the right ascension would agree with 88 *Piscium*: still, however, the declination would be too great by upwards of 7′; unless we suppose likewise that the reading of the 96 quadrant was erroneously recorded 2 divisions. As I cannot suppose that two such errors would be committed in one and the same observation, I must consider it as a star which has not yet been observed by any other astronomer.

44. By comparing the *time* of the transit of this star with that of No. 36 on the same day, it would appear that its right ascension in the catalogue is about one second (in time) too great: but I have not made any alteration.

64. M. Bessel states that Christian Mayer, in the year 1778, made 30 observations of this double star, and found that the southernmost of the two preceded in right ascension. But Tobias Mayer and Piazzi make the northern one to precede.

78. The right ascension of this star in Mayer's catalogue is 30° 56′ 43″,5: but by comparing the *time* of the transit, in the printed observations, with others on the same day, it is evident that an error of 1° in right ascension has been made in Mayer's catalogue: which is here corrected.

92. The declination of this star in Mayer's catalogue is +17° 19′ 51″,1; but there appears to be an error of 10″ in reducing the reading of the 96 quadrant to sexagesimals: as 36 7 8,2½ is equal to 34° 11′ 25″,4 instead of 34° 11′ 15″,4. I have therefore deducted 10″ from Mayer's value.

117. This star was imperfectly observed in declination both by Bradley and by Mayer: and, as the observation stands in Mayer's journal, I think there must be an error in recording it. If we suppose the reading of the 96 quadrant in the printed observations to be 29 5 instead of 29 8, the zenith distance will be 27° 29′ instead of 27° 40′: and the declination would then accord with the catalogues of Lacaille and Piazzi. I have adopted this correction in the present catalogue: but the observation is still an imperfect one in declination.

127. This star is not to be found in the catalogue of Bradley or Piazzi; nor in the *Histoire Céleste*.

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146. I cannot find any observation, recorded in Mayer's printed observations, either of this star, or of No. 153, or of No. 165: and this is the more singular, as they all appear to have the same declination, although differing somewhat in right ascension. The right ascensions of all the three stars are marked as doubtful with six dots: and the space for the number of observations is left blank. In the *Histoire Céleste*, page 193, there is a star marked " 146 Mayer," but it differs from the position of that star, as laid down in Mayer's catalogue, $1\frac{1}{2}$ minute in right ascension (in space), and $2\frac{1}{2}$ minutes in declination.

153. See the preceding note.

159. The right ascension of this star agrees very well with 80 *Tauri;* but the declination (which in Mayer's catalogue is stated to be $+15^\circ$ 10′,—and at the same time imperfect) is about 5 minutes too great. In the printed observations, the right ascension only is given: as the zenith distances are lost.

165. See the note to No. 146.

167. The 25 observations of this star are to be found in the following pages: viz. 2, 2, 3, 3, 5, 5, 6, 7, 9, 14, 16, 21, 23, 31, 59, 77, 91, 107, 111, 114, 115, 119, 121, 138, 140.

190. The 32 observations of this star are to be found in the following pages: viz. 3, 5, 6, 7, 7, 9, 10, 14, 20, 21, 28, 31, 33, 44, 47, 49, 59, 77, 88, 91, 101, 108, 110, 112, 114, 119, 121, 122, 138, 140, 140, 141.

192. The 22 observations of this star are to be found in the following pages: viz. 2, 7, 20, 21, 33, 44, 60, 77, 91, 101, 102, 108, 110, 112, 119, 120, 121, 121, 138, 140, 141, 141.

195. In Mayer's catalogue there are two different declinations given to this star, viz. 18° 14′ 46″,9 and 18° 18′ 17″,8. But, in the first place, the *degrees* are wrong in both cases; for, by comparing the two observations (from which they are deduced) with others made on the same day, it will be evident that they should in each case be 19°. Then with respect to the minutes and seconds, I think it is equally clear that the latter value (deduced from the observation made on February 19, 1757) is the correct one: not only because it corresponds more nearly with the true position of the star, but also because there is every appearance of an error in the register of the 96 quadrant on January 3, 1757. It is there stated to be 34 56 13,1: but there could be no such reading on the limb, since the divisions did not exceed 16. I apprehend, therefore, that Mayer wrote down the two figures 5 6, with a doubt (at the time) *which* of them was most correct: and his subsequent observation of the same star shews that the figure 5 should have been taken instead of the figure 6, in reducing the value of the 96 quadrant, to the sexagesimal notation. The value of one division of the 96 quadrant ($=3'$ 30″,9) is exactly equal to the difference between the two values in Mayer's catalogue.

197. The *time* of the transit of this star is marked in the observations as doubtful, with four dots: in the catalogue with six dots. Piazzi suspects that there is an error of one minute (in time) in recording the observation; and that the right ascension instead of 76° 41′ 47″,7 should be 76° 26′ 47″,7: in which case it would agree with No. 41 in his catalogue. I think that this conjectural emendation is extremely probable, but I have not ventured to introduce it.

199. The 15 observations of this star are to be found in the following pages: viz. 2, 5, 6, 7, 7, 10, 20, 60, 91, 101, 102, 108, 111, 112, 140.

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200. The 10 observations of this star are to be found in the following pages: viz. 2, 7, 60, 91, 105, 108, 111, 113, 120, 140.

203. This star is called χ *Tauri* in Mayer's catalogue: but it is evidently situated in the constellation *Auriga*.

206. The 13 observations of this star are to be found in the following pages: viz. 2, 6, 7, 10, 60, 91, 102, 105, 109, 111, 113, 121, 140.

207. In Mayer's catalogue the right ascension of this star is stated to be 80° 1′ 10″,0: but by comparing it with the observation either of β or ζ *Tauri*, made on the same day, it will appear that there is an error of 30 seconds (in space) in the reductions. I have not hesitated therefore in making the correction.

213. The 12 observations of this star are to be found in the following pages: viz. 6, 7, 8, 9, 10, 60, 91, 102, 106, 109, 113, 140.

221. This star cannot now be identified, as the original observations are lost, and only the right ascension preserved. Piazzi has suggested that it may be No. 239 in his catalogue: but that star differs nearly 32 minutes (in space) in right ascension, and nearly 8 minutes in declination, from the place assigned by Mayer.

224. The declination of this star is stated in Mayer's catalogue to be + 20° 11′ 26″,7; but from a comparison with the catalogues of Bradley and Piazzi, I think that there is an error of one minute, which I have not hesitated to correct. The observed zenith distances of this star are not preserved.

226. The 15 observations of this star are to be found in the following pages: viz. 7, 10, 18, 20, 41, 60, 106, 109, 113, 121, 124, 140, 141, 142, 142.

230. Mayer calls this star χ^2: but agreeably to Piazzi and Bessel I have denoted it by χ^4, and No. 233 by χ^3; although I am of opinion that this designation is incorrect. It is stated by Bode, Herschel, and others, that 64 and 65 *Orionis* (denoted by χ^4 and χ^5) were not observed by Flamsteed: I apprehend, however, that they were both observed by him, but that they have been incorrectly reduced in his catalogue; each of them being erroneous 3 minutes in time, or 45 minutes in arc. By diminishing the values in the British Catalogue by that quantity, it will be seen that χ^3 and χ^5 are the same star: and that the right ascension of χ^4 ought to be 86° 16′ 40″.

231. This star is not now to be found.

233. See the Note to No. 230.

234. The declination of this star in Mayer's catalogue is +22° 30′ —: which is imperfect. Piazzi thinks that it is the same as No. 329 in his catalogue: but that star exceeds the present one 12 minutes in declination. And as the zenith distances are lost, we cannot now reconcile the discordancy.

244. The declination of this star in Mayer's catalogue is +23° 45′ 48″,2: but from a comparison with the catalogues of Bradley and Piazzi it appears that this is erroneous 2 minutes. The zenith observations are now lost; but I have ventured to make the correction.

261. This star is thus given in Mayer's catalogue: and is said to have been deduced from two observations; which must be the ones referred to in the present catalogues: but the *times* do not agree, unless we suppose that in the first observation the time of the wrong wire was recorded, and that it should be diminished 31^s,3. With this correction, the

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star will correspond with one observed by Lalande in the *Histoire Céleste*, page 262: viz. $\mathcal{R} = 6^h\ 29^m\ 27^s$ and $Z = 32°\ 14'\ 23''$.

266. The 19 observations of this star are to be found in the following pages: viz. 3, 3, 4, 6, 8, 21, 33, 33, 35, 35, 36, 37, 60, 103, 106, 111, 116, 128, 142.

267. I cannot find any observation of this star, except it be the one in page 8 of the printed observations, whose $\mathcal{R} = 6^h\ 35^m\ 55^s,5$: but if this be the one in question, there is evidently some error in the *time*, as it does not correspond either with No. 267 or 268 of Mayer's catalogue.

275. Piazzi calls another star (No. 294 of his catalogue) 41 *Geminorum*: but M. Bessel has shewn that this is erroneous.

292. The right ascension of this star in Mayer's catalogue is 107° 20′ 56″,0: but, on comparing the observation with Piazzi's catalogue, and with the observation in the *Histoire Céleste*, page 255, it appears evident that Mayer must have recorded the transit at the wrong wire; and that $7^h\ 16^m\ 37^s,0$ should be $7^h\ 16^m\ 5^s,4$. I have therefore deducted the quantity (in space) equivalent thereto, viz. 7′ 54″, and the result will then correspond with the observations of Piazzi and Lalande.

299. The 16 observations of this star are to be found in the following pages: viz. 3, 8, 11, 15, 62, 104, 106, 107, 109, 112, 113, 119, 125, 128, 130, 143.

306. The 24 observations of this star are to be found in the following pages: viz. 8, 15, 29, 40, 41, 43, 43, 43, 44, 44, 62, 104, 106, 108, 109, 110, 112, 113, 118, 119, 125, 128, 130, 143.

307. The position of this star in Mayer's catalogue, is $\mathcal{R} = 111°\ 47'\ 27'',6$ and $D = +5°\ 49'$ —. It was observed both by Bradley and Piazzi: but the declination does not agree within 3 minutes of the approximate value given by Mayer. Perhaps there is an error of 1 division of the 96 quadrant, equal to 3′ 30″,9, and that the declination should be nearly +5° 46′: but as the record of the zenith distance is lost, we cannot throw any light on the subject. The right ascension appears to be too great by about 8 seconds (in space), if we compare the *time* of the transit with that of *α Canis Minoris* on the same day.

322. If the right ascension of ψ^2 *Cancri* in Mayer's catalogue is correct, the right ascension of this star should be 118° 51′ 20″,3: which would diminish the difference between Mayer and Bradley.

326. This and the following star form the double star 90 H and S. It will be seen that, in the catalogue, the southern star precedes; but, in the printed observations, it is the northern one: which thus corresponds with Piazzi's catalogue.

328. The right ascension of this star, as given by Mayer, is 119° 44′ 16″,6; but by referring to the observation, it will be manifest that Mayer has made an error of 1 minute (in time) in reducing it. I have, therefore, deducted 15 minutes (in space) from the above value, and it now corresponds with Piazzi's catalogue.

329. The declination of this star, as stated in Mayer's catalogue, is +18° 20′ 0″,1; but I apprehend there is an error in recording the observation. If we read the zenith distance, by the 96 quadrant, 35 5 8,3 instead of 35 6 8,3, the apparent zenith distance in sexagesimals would be diminished 3′ 30″,9; and consequently the declination increased by the same quantity: in which case it would correspond with Piazzi's catalogue.

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338. The declination of this star in Mayer's catalogue is 24° 57′ 57″,0; which gave rise to the remark of Piazzi, in the note to No. 76 of his catalogue, " that Mayer observed another star nearly in the same parallel." But, on reference to the observation, it will be found that the zenith distance by the 96 quadrant is erroneously reduced; and that it should be in sexagesimals 26° 12′ 39″,0 instead of 26° 33′ 44″,6. The difference is 21′ 5″,6 (or 6 divisions of the 96 quadrant), which being added to the value above stated will make the observations of Mayer, Bradley, and Piazzi, in good accordance.

357. Piazzi states that No. 135 of his catalogue may be this star: but as no observation of it is to be found in Mayer, it is fruitless to attempt to reconcile such discordant results.

371. In Mayer's catalogue there are two different declinations given to this star, viz. 18° 57′ 11″,8 and 18° 53′ 41″,0; evidently arising from a doubt in reading off the 96 quadrant, since the difference is equal to 1 division or 3′ 30″,9. That the latter quantity is the correct one, will appear from a comparison with Piazzi's catalogue: and I have therefore preserved it in the present catalogue. The observations of zenith distance are not in existence.

378. The right ascension of this star is marked as doubtful in Mayer's catalogue with two dots, and the declination with six dots. If it is the same star as No. 203 in Piazzi's catalogue, the declination is too great by $1\frac{3}{4}$ minute, or 8 divisions of the vernier.

379. This star cannot now be found: and unfortunately the observations of zenith distance do not exist, so that we cannot ascertain whether any error has been committed in the reduction.

385. This star is not now to be found: neither can I discover any observation of it amongst the printed observations.

394. This is called ξ^2 *Cancri* by Mayer.

395. I cannot find any observation of this star: neither does it exist in the place assigned for it in Mayer's catalogue. But the right ascension is only given approximately: and if we suppose an error of 23 minutes (in space), that is, if we read 134° 7′ instead of 134° 30′, it will agree with No. 263 in Piazzi's catalogue.

397. This star is called π *Cancri* by Mayer: but that designation is given to the preceding star, by every other astronomer.

398. The *times* of the transit of this star, in pages 11 and 12 of the printed observations, do not correspond: which is probably the reason why the right ascension is given only approximately. Piazzi thinks it is No. 35 in his catalogue, as the declination agrees very well with that star.

399. Piazzi considers this as the same star No. 38 in his catalogue. The right ascension certainly agrees very well with it, but the declination in Mayer's catalogue must be diminished above 6 minutes in order that they may accord. As the original zenith distances are lost, I have not ventured to make the alteration.

408. The 10 observations of this star are to be found in the following pages; viz. 9, 12, 13, 13, 13, 14, 16, 17, 114, 117.

415. The 12 observations of this star are to be found in the following pages: viz. 9, 10, 12, 13, 13, 13, 14, 16, 16, 17, 21, 117.

420. The right ascension of this star is marked as doubtful, in Mayer's catalogue, with six dots. It appears, from a comparison with Piazzi's catalogue, to be about 43″ in space too great.

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425. The 12 observations of this star are to be found in the following pages: viz. 9, 10, 12, 13, 13, 13, 14, 16, 16, 18, 19, 21.

427. The 14 observations of this star are to be found in the following pages: viz. 9, 9, 10, 12, 13, 13, 14, 16, 17, 18, 19, 21, 120, 122.

428. The declination of this star in Mayer's catalogue is 11° 5′ 5″,1: but, on examining the observations in page 116 of the printed observations, it will be found that this is one minute too great. I have therefore corrected it.

429. There are two values given for the declination of this star in Mayer's catalogue; viz. 12° 47′ 55″,5 and 12° 51′ 26″,4: but the former appears to be the correct one, as it corresponds with Piazzi and Lalande: and I have therefore adopted it. The reading of the 96 quadrant in page 122 of the printed observations ought probably to have been 41 4 14,9; which would have made the zenith distance 38° 43′ 35″,1.

432. The 15 observations of this star are to be found in the following pages: viz. 9, 9, 10, 12, 13, 14, 16, 16, 17, 19, 21, 116, 117, 120, 122.

434. The 31 observations of this star are to be found in the following pages: viz. 9, 9, 10, 12, 13, 13, 13, 14, 16, 16, 17, 17, 18, 19, 21, 28, 28, 37, 56, 60, 78, 92, 116, 117, 118, 119, 120, 122, 122, 125, 141.

443. The 12 observations of this star are to be found in the following pages: viz. 9, 10, 10, 13, 17, 17, 18, 19, 28, 117, 123, 125.

447. Piazzi appears to have considered this star to be the same as No. 67 in his catalogue; but it is 44 *Leonis*.

455. In Mayer's catalogue, the declination of this star is marked as doubtful, with two dots. It appears to be 1 minute too great, by Piazzi's catalogue: but as the original zenith distances are lost, I have not ventured to make any alteration.

460. In Mayer's catalogue, the right ascension of this star is stated to be 158° 21′ 15″,1: but it is at the same time marked as doubtful, with four dots: and it appears from the catalogue of Bradley and Piazzi to be too great by about 2 seconds (in time). I have therefore considered its right ascension as not accurately determined.

489. Piazzi has suggested that the erroneous determination of the right ascension of this star by Mayer, has affected the reduction of many of the neighbouring stars.

496. The right ascension of this star in Mayer's catalogue is 177° 24′ 10″,0: where it is marked as doubtful, by six dots. In fact, by comparing it with Piazzi's catalogue, it appears to be too great about 16 minutes (in space).

499. The right ascension of this star in Mayer's catalogue is 178° 30′ 22″,1: but on comparing it with No. 230 in Piazzi's catalogue, it appears that there is an error of about 30 seconds (in time) in excess. Probably the wrong wire was recorded.

501. The declination of this star, in Mayer's catalogue, is +0° 27′ 22″,0: but no such star is now to be found. The original observations are lost, and we have only the right ascensions recorded in the printed observations. In one place the time is marked as doubtful, with two dots; and in the other place the *star* itself is marked as doubtful, with four dots: so that after all it may not be *r Virginis* that was observed. From the observations of Bradley, the difference in declination is nearly 2° 49′: and if we presume that the reading of the 96 quadrant was recorded too small, by 3 of the large divisions

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(equal to 2° 48′ 45″ sexagesimal) it would account for the error: and the declination would be +3° 16′—; but, I have not ventured to make this alteration.

508. The declination of this star, as given in Mayer's catalogue is —3° 33′ 27″,0; but on comparing it with Piazzi's catalogue it will be seen that this is too small by 3½ minutes. Now, if we suppose that the reading of the 96 quadrant is erroneous 1 division: that is, if we suppose it to be 58 12 14,2 instead of 58 11 14,2 we shall have Z = 55° 7′ 48″,4 instead of 55° 4′ 17″,5. In other words we must add 1 division (equal to 3′ 30″,9 sexagesimal) to the above declination, in order to make it accord with Piazzi; but I have not ventured to make this alteration.

539. The 17 observations of this star are to be found in the following pages: viz. 18, 20, 21, 23, 32, 44, 55, 58, 83, 87, 118, 120, 126, 129, 143, 144, 146.

544. This star is called l^1 by Mayer; and No. 547 is called l^2: but I have adopted the notation of Flamsteed and Bradley.

554. The 14 observations of this star are to be found in the following pages: viz. 18, 20, 21, 23, 29, 29, 31, 33, 35, 44, 55, 63, 81, 83.

566. The 30 observations of this star are to be found in the following pages: viz. 18, 20, 22, 23, 29, 30, 31, 32, 33, 35, 43, 44, 44, 54, 55, 58, 64, 78, 80, 81, 81, 82, 83, 86, 87, 87, 125, 126, 130, 134.

583. In Mayer's catalogue, this star is called of the 2·3 magnitude; and α^2 has no designation: but I have reversed this order.

600. The *time* of both the observations of this star, is marked as doubtful by Mayer, with four dots. The right ascension appears to have been reduced from the observation in page 30; which is erroneous 6 seconds (in time); as $15^h\ 10^m\ 10^s$ should be $15^h\ 10^m\ 16^s$. This alteration being made, the two observations will be in accordance; and will agree very well with the catalogue of Piazzi. I have therefore added 1′ 30″ in space (equal to 6 seconds in time) to the right ascension as given in Mayer's catalogue.

604. This star is called ζ^2 by Mayer, and No. 607 is called ζ^3: but I have adopted the notation of Flamsteed and Bradley.

625. The right ascension of this star in Mayer's catalogue is 235° 21′ 51″,1: but it is marked as doubtful, with four dots. In fact, by comparing the observation of Mayer with the catalogues of Bradley and Piazzi, it appears that there is an error of 30 seconds (in time) in recording the observation. I have accordingly deducted 7′ 30″ from Mayer's value.

653. The declination of this star in Mayer's catalogue is —17° 40′ 8″,9: but, on comparing it with Piazzi's catalogue, it appears to be erroneous upwards of 2 minutes. I apprehend therefore that the reading of the 96 quadrant has been erroneously recorded; and that it should be 73 12 15,3 instead of 73 12 5,3; which would increase the zenith distance from 69° 9′ 34″,9 sexagesimal, to 69° 11′ 46″,6. The observation of Piazzi is confirmed by Lalande; and I have therefore increased the declination 2′ 11″,8; corresponding to 10 divisions of the vernier of the 96 quadrant.

666. There is only one observation of this star by Bradley: and I suspect that it cannot be wholly relied on.

667. The declination of this star in Mayer's catalogue is —24° 35′ 41″,9: but on comparing the observations with those of other stars on the same days, it is evident that an error has

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been made in the reduction, of about 15″; which I have therefore deducted from the value in Mayer's catalogue.

672. The *time* of the first of the two observations of this star is apparently very erroneous. The right ascension in the catalogue is deduced from one observation only.

676. The declination of this star in Mayer's catalogue is −19° 11′ 29″,1: but it is manifestly erroneous; and it is difficult to conceive how an error of upwards of 7 degrees should have escaped the computer. By comparing the 4 observations of this star, with others observed on the same days, it will be clearly shewn that its declination is very near −26° 13′: which agrees very well with the catalogues of Bradley and Piazzi. I have however left the declination as imperfect.

681. The declination of this star in Mayer's catalogue is −24° 41′ 25″,4: but I think that there is an error in recording the reading of the 96 quadrant, which should probably be 81 2 12,8 instead of 81 3 12,8: in which case the zenith distance, expressed in sexagesimals, would be 76° 6′ 5″,5. I have therefore deducted 3′ 30″,9 from the declination as above given, and the observation will then accord with the catalogues of Bradley and Piazzi.

685. There are two values given for the right ascension of this star, in Mayer's catalogue; viz. 257° 48′ 10″,1, and the value retained in the present catalogue. That the latter is the most correct will appear by comparing it with the catalogues of Bradley and Piazzi. The error has probably arisen from a mistake of 1 minute (in time) in registering the observation of June 21, 1756.

694. The position of this star in Mayer's catalogue appears to have been deduced from only one observation: but there are five complete observations of it, in right ascension. The right ascension of this star however, as well as that of γ *Draconis*, differs very materially from the catalogue of Bradley.

696. The right ascension of this star is marked as doubtful: and by comparing it with Bradley, the error appears to be about 1 second (in time) in excess.

704. The declination of this star in Mayer's catalogue is stated as −20° 52′ 57″,2: but this is erroneous 1°, as may be verified by comparing the observation with those of other stars on the same day.

733. There appears to be an error of 1 second (in time) in the reduction, to the middle wire, of the observation of this star: which would increase the right ascension in Mayer's catalogue 15 seconds (in space); and thus make it accord more nearly with the catalogue of Piazzi. I have made the requisite addition.

734. There is an error of −9′ (in space) in the right ascension of this star in Flamsteed's catalogue, which has misled Piazzi, in designating No. 99 in his catalogue, as 24 *Sagittarii;* whereas it is No. 105 in his catalogue, which should be so called.

742. Piazzi says that there is certainly an error of one minute in the declination of this star in Mayer's catalogue: and, since the preceding sheets have been printed off, I find that I have, on that authority, inadvertently altered Mayer's value, which is −21° 12′ 25″,8. But there are three complete observations of the star, agreeing very well with each other: and although there appears to be a slight error in the reduction, I do not make the difference so great as that stated by Piazzi.

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743. The 15 observations of this star are contained in the following pages: viz. 38, 40, 41, 43, 52, 52, 53, 58, 64, 73, 81, 92, 126, 127, 128.

752. The 9 observations of this star are contained in the following pages: viz. 38, 42, 53, 59, 73, 127, 155, 157, 158.

756. The right ascension of this star is marked as doubtful: and on comparing it with the catalogue of Piazzi, it appears to be about 1 second (in time) too great.

759. The right ascension of this star in Mayer's catalogue is 282° 9′ 21″,0: but, by comparing it with the catalogue of Piazzi, there appears to be an error of above a minute (in time) in recording the observation. Probably the time recorded is the time of the star's passing the last wire of the transit instrument: from which therefore we must deduct $1^m\ 6^s$ or 16′ 30″ in space.

772. The right ascension of this star in Mayer's catalogue is 285° 25′ 29″,8: but on comparing the observation, with that of other stars on the same day, it is evident that an error of 1 minute (in time) has been made in the reduction. I have therefore deducted 15′ from the above value.

781. There appears to be an error of a few seconds in the reduction of the declination of this star. For if we compare the three corresponding observations of this and the preceding star, we shall find that (allowing for the difference of refraction) the *difference* in their declinations ought to be only 32′ 31″: which agrees more nearly with the catalogue of Bradley.

782. The right ascension of this star in Mayer's catalogue is 287° 56′ 33″,1: but on referring to the observation it will be seen that the reduction to the middle wire is erroneous 1 second (in time). I have therefore deducted 15 seconds (not *minutes*, as erroneously printed in page 397) from Mayer's value: and it will then very nearly accord with Bradley and Piazzi.

783. The declination of this star in Mayer's catalogue is −15° 34′ 14″,8: but, by comparing it with the catalogue of Piazzi, this appears to be about $3\frac{1}{2}$ minutes too great. There is probably therefore an error in recording the reading of the 96 quadrant; and that 71 8 8,65 should be 71 7 8,65, which would reduce the observed zenith distance to 67° 0′ 15″,7 in sexagesimals.

784. The right ascension of this star in Mayer's catalogue is 288° 12′ 29″,0: at the same time it is there stated that it is probably the same as No. 782. In fact, if we suppose that Mayer erroneously recorded the transit of the last wire, instead of the middle wire, the two observations may be easily reconciled.

788. The right ascension of this star is marked as doubtful, in Mayer's observations, with two dots: and the zenith distance, with five dots. See the following note.

789. The right ascension of this star, in Mayer's catalogue, is 289° 12′ 1″,0: but at the same time it is remarked that it seems to be the same as the preceding star. As no other star is to be found, on this parallel, in the neighbourhood, this is probably the case. The right ascension in Mayer's catalogue appears to be inaccurately computed: and the two observations of declination are united; although one of them is marked as very incorrect.

795. The two observations of this star in declination, by Bradley, disagree 9″,6 from each other: so that the difference between Mayer and Bradley cannot be wholly relied upon.

797. The 14 observations of this star are to be found in the following pages: viz. 42, 53, 55, 57, 60, 61, 71, 74, 74, 82, 127, 128, 130, 130.

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No.

798. The 13 observations of this star are to be found in the following pages: viz. 42, 53, 55, 59, 60, 61, 71, 74, 74, 82, 127, 128, 130.

800. The 13 observations of this star are to be found in the following pages: viz. 53, 55, 59, 60, 62, 71, 73, 74, 82, 127, 128, 130, 151.

804. The 31 observations of this star are to be found in the following pages: viz. 42, 52, 53, 55, 57, 57, 59, 61, 62, 65, 71, 74, 75, 75, 79, 82, 87, 88, 89, 90, 104, 107, 108, 109, 127, 128, 130, 131, 133, 135, 137.

809. The 13 observations of this star are to be found in the following pages: viz. 53, 55, 57, 57, 61, 64, 74, 78, 79, 130, 131, 133, 135.

823. The 12 observations of this star are to be found in the following pages: viz. 53, 55, 57, 57, 61, 64, 73, 74, 75, 78, 79, 85.

825. The 12 observations of this star are to be found in the following pages: viz. 53, 55, 57, 57, 61, 64, 74, 75, 78, 79, 85, 147.

830. The right ascension of this star is stated in Mayer's catalogue to be 302° 41′ 15″,1: but it is marked as doubtful, with four dots; and, on comparing it with Piazzi and Lalande, it appears that there is an error of 1 minute (in time). I have therefore deducted 15 minutes from the value given by Mayer. See the note to No. 833.

831. The right ascension of this star, in Mayer's catalogue, is 302° 53′ 48″,4: but, on comparing it with Piazzi and Lalande, it appears to be too great by 1 minute (in time). I have therefore deducted 15 minutes from the value given by Mayer. See the next note.

833. The right ascension of this star in Mayer's catalogue is 303° 0′ 27″,5: but, on comparing it with Piazzi and Lalande, it appears that this is too great by 1 minute (in time). I have therefore deducted 15 minutes from the value given by Mayer. I apprehend that the right ascension of this star, as well as that of No. 830 and 831, has been deduced from the right ascension of *π Capricorni:* and that one common error has been committed in the reductions.

838. } The declination of both these stars is too great, by 10 minutes, in Mayer's catalogue; as
839. } may be readily seen by a comparison of the zenith distances of any of the observations, with the observation of other stars made on the same days.

842. The declination of this star, in Mayer's catalogue is −10° 36′ 26″,2: but, on comparing it with Piazzi and Lalande, it appears probable that there is an error of one division of the 96 quadrant, and that the zenith distance 66 3 15,0 should be 66 4 15,0. I have therefore added 3′ 30″,9 to the value given by Mayer.

854. The right ascension of this star, in Mayer's catalogue is 309° 7′ 56″,2: but on comparing it with the catalogue of Piazzi, there appears to be an error of nearly 16 minutes (in space). I apprehend therefore that the time recorded ($20^h\ 28^m\ 0^s,0$) is that of the *last* wire, and that $1^m\ 3^s,6$ should be deducted therefrom. I have left the observation as an imperfect one.

883. There is a strong presumption that the declination of this star has been erroneously reduced: for, if we examine the six corresponding observations of this and the following star, the *difference* (allowing for the difference of refraction) should be 35′ 34″,3; which corresponds with Bradley's catalogue.

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892. The right ascension of this star in Mayer's catalogue, is 320° 17′ 47″,2: but there is evidently some error. It differs 2 seconds (in time) from the catalogue of Bradley: and this difference is confirmed by Piazzi. It was observed at the fourth wire only, and the time appears to be incorrectly reduced to the middle wire: for the interval (at the declination of this star) is $32^s,2$; and not $30^s,6$ as stated in the printed observations. I have therefore deducted 24 seconds (in space) from the value in Mayer's catalogue. Still it does not accord with Bradley's catalogue: but it appears, from a note of M. Bessel's, that the two observations of Bradley disagree 10″,2 from each other.

922. The right ascension of this star in Mayer's catalogue is 332° 49′ 59″,6: but, on comparing the observation with that of other stars on the same day, it is evident that an error of 1 minute (in space) has been committed in the reduction; I have therefore corrected it.

926. Although the declination of this star differs so much from Bradley, it agrees very well with Piazzi; unless there is some unknown proper motion.

929. The declination of this star in Mayer's catalogue is −5° 27′ 36″,8: but, on comparing the observations with those of other stars made on the same days, it is evident that it should be increased 1 minute. I have therefore corrected it.

937. The declination of this star, in Mayer's catalogue, is −15° 20′ 59″,6: but on comparing the observations with those of other stars made on the same day, it is evident that it should be diminished 1 minute. I have therefore corrected it.

944. The declination of this star in Mayer's catalogue is −8° 20′ 49″,4: but, on comparing the observations with those of other stars made on the same days, it is evident that it should be increased 1 minute. I have therefore corrected it.

951. The right ascension of this star, in Mayer's catalogue, is marked as doubtful, with two dots; and the declination with four dots. There appears indeed to be an error of upwards of 50″ in the declination: which, in Mayer's catalogue is stated to be −9° 1′ 6″,4. But, I think it is very probable that some mistake has been committed in recording the reading of the 96 quadrant. In fact if we suppose it to have been 64 8 9,1 instead of 64 8 13,1 the whole will be reconcilable by deducting the difference (=52″,7 sexagesimal). I have not ventured however to make this conjectural emendation.

964. This star is the planet *Uranus*, which was observed by Mayer on September 26, 1756. The position is given as it stands in his catalogue: which, of course, cannot be correct.

966. The declination of this star in Mayer's catalogue is −0° 12′ 37″,1: but on examining the three observations it will be found that the reductions of the 96 quadrant are in each case erroneous 10″. I have consequently applied that correction.

970. The right ascension of this star in Mayer's catalogue is 349° 23′ 58″,6: but on comparing the observation with that of other stars on the same day it will be seen that this is erroneous 10 minutes (in space); and I have therefore deducted that quantity.

982. The declination of this star, in Mayer's catalogue, is +1° 0′ 21″,2: but there are two errors in the reduction. For, in the first place, by comparing the observation of it with that of other stars made on the same day, it will be seen that an error of 5° has been made in the declination: and secondly the zenith distance 59 5 3,5½ by the 96 quadrant is equal to 55° 37′ 6″,5 in sexagesimals, instead of 55° 30′ 4″,6. When these corrections (=5° 7′ 1″,9) are made, the star will agree with 20 *Piscium*.

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No.

983. The declination of this star in Mayer's catalogue is $-7^\circ\ 42'\ 55'',7$: but on comparing the observation with that of other stars on the same day, it will be seen that it should be increased 1 minute; a correction which I have accordingly made.

The Reader is requested to correct with his Pen the following Errata, which have been discovered since the Sheets were printed off; viz.

No.	For	Read
181	$71^\circ\ 13'\ 30'',7$	$71^\circ\ 17'\ 30'',7$
733	274 42 48,1	274 43 3,1
742	— 21 13 25,8	— 21 12 25,8
837	303 45 46,2	303 45 56,2
968	— 5 21 24,8	— 5 51 24,8

And in page 397, against No. 782, read 15 *seconds*, instead of 15 minutes.

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REPORT

OF THE

COMMITTEE

OF THE

ASTRONOMICAL SOCIETY OF LONDON,

RELATIVE TO

The Improvement

OF

THE NAUTICAL ALMANAC:

ADOPTED BY THE COUNCIL NOVEMBER 19, 1830;

APPROVED BY

THE RIGHT HONOURABLE THE LORDS COMMISSIONERS OF THE ADMIRALTY,
AND ORDERED BY THEM TO BE CARRIED INTO EFFECT.

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NAMES OF THE COMMITTEE.

*Professor Airy.
Hon. Lord Ashley.
*C. Babbage, Esq.
*F. Baily, Esq.
P. Barlow, Esq.
*Capt. F. Beaufort, R.N.
Capt. F. W. Beechey, R.N.
Lieut.-Gen. Sir T. M. Brisbane, K.C.B.
Right Rev. Bishop of Cloyne.
Lieut.-Colonel Colby, R.E.
A. De Morgan, Esq.
Hon. Capt. Dundas, R.N.
Davies Gilbert, Esq., P.R.S.
Dr. Gregory.
Capt. Basil Hall, R.N.
Professor Hamilton.
T. Henderson, Esq.
*J. F. W. Herschel, Esq.
Capt. Heywood, R.N.
Capt. James Horsburgh.
Rev. Dr. Inman.
Capt. Kater.
Dr. Lee.
J. W. Lubbock, Esq.
T. Maclear, Esq.
Rev. G. Peacock.
Rev. Dr. Pearson.
*J. Pond, Esq.
E. Riddle, Esq.
Professor Rigaud.
*Rev. Dr. Robinson.
Rev. R. Sheepshanks.
Capt. Shireff, R. N.
Capt. W. H. Smyth, R.N.
*Sir James South, *President*.
*Lieut. W. S. Stratford, R.N.
*Professor Struve.
Dr. Tiarks.
E. Troughton, Esq.
J. Wrottesley, Esq.

N.B.—Those Members, to whose names an asterisk is prefixed, formed the Sub-Committee.

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XXI. *The* COMMITTEE *appointed by the* COUNCIL *of the* ASTRONOMICAL SOCIETY, *to take into consideration the Letter addressed to them by the Right Honourable the* LORDS COMMISSIONERS *of the* ADMIRALTY, *relative to the improvement of the* NAUTICAL ALMANAC, *have agreed on the following*

REPORT.

1. The attention of the Committee was, in the first instance, directed to a subject of general importance, as affecting almost *all* the results in the Nautical Almanac; viz., whether the quantities therein inserted should in future be given for *apparent* time (as heretofore), or for *mean solar* time. Considering that the latter is the most convenient not only for every purpose of Astronomy but also (from the best information they have been able to obtain) for all the purposes of Navigation; at the same time that it is less laborious to the computer, and has already been introduced with good effect into the national Ephemerides of Coimbra and Berlin, the Committee recommend the abolition of the use of *apparent* time in all the computations of the Nautical Almanac; excepting only the place, &c. of the sun at the time of his transit over the meridian, which must necessarily be computed for the time of *apparent* noon; but which, by the arrangement proposed in the accompanying Specimen* (and which the Committee request may be considered as part of this Report), can never be mistaken for his place as computed for *mean* noon. The Committee are aware that in recommending this important change in the mode of reckoning time, in all computations connected with nautical astronomy, it may appear to some persons that a temporary inconvenience may be experienced: they trust, however, that, upon more mature consideration, this will be found not likely to take place. It is true that, when the Nautical Almanac was first formed, *apparent time* was the only mode of reckoning that could be properly introduced; as the seaman had no other method of obtaining his time than by observations of the *sun;* nor any other mode of carrying it on from day to day than by ordinary watches.

* This specimen cannot conveniently be printed as part of the present volume.

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Other modes, however, are now resorted to for obtaining the time; and the great perfection of chronometers and their extensive use in the sea service have led to the more general use and adoption of *mean time;* which has now become easy and familiar in many of the most common nautical problems, and equally convenient in all. Moreover the Committee are of opinion that there is a great advantage in assimilating the practical operations in nautical astronomy with those pursued in the observatory; with which in fact they become identified, the moment the navigator commences the requisite observations on shore in order to verify the rate of his chronometers, or to determine the accurate position of his place. This change has indeed, for many years past, been made in the eclipses of Jupiter's satellites: and, from the necessary use, in many cases, of astronomical problems, must sooner or later be more generally introduced: and no time appears so well adapted for such an alteration as the present, when a general revision of the work is in contemplation. And should this alteration be adopted, the Committee recommend that the words MEAN TIME be inserted at the head of every page, where it may be applicable, in order that the seaman may be constantly apprised of the change which has been made.

2. The next point of consideration was of minor importance, and of a less general nature; viz. the proposal to abolish the use of *signs,* as indicating arcs of 30° in the division of the circle. With the view therefore of preserving uniformity in the arrangement of the values in the Nautical Almanac, and considering it in most cases more convenient in practice, the Committee recommend that the use of signs should be abolished also, and that the degrees should in all cases be reckoned from 0 to 360.

3. The Committee having before them a printed specimen of the monthly arrangements of the articles forming the Nautical Almanac for the year 1833, forwarded to the Council by the Lords Commissioners of the Admiralty, and also having before them a copy of the Nautical Almanac and of the Supplement for the present year (1830), next proceeded to examine and discuss *seriatim* the various parts into which the work is divided: and, having agreed on certain preliminary arrangements, appointed a *Sub-Committee* to examine them more in detail, as well as to examine and digest the various hints and suggestions which had been forwarded to them, not only by members of their own body who were unable to attend the

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meetings, but likewise by other correspondents, relative to this subject. The *Sub-Committee* having made a report of their labours, it was ordered to be printed; and a copy of the same having been forwarded to each member of the Committee, a distant day was appointed for their taking the same into consideration: by which means every opportunity and facility have been afforded for the most ample and open discussion of the several points in question. The final result of their deliberations will be seen from the following summary of the alterations and additions proposed and recommended; and also from the Appendix to this Report, which contains a synoptical view of *all the articles* proposed to be inserted in the Nautical Almanac.

4. And here perhaps it may be proper to remark, that, although in these discussions, the Committee have constantly kept in view the principal object for which the Nautical Almanac was originally formed, viz., the promotion and advancement of *nautical* astronomy, they have not been unmindful that, by a very slight extension of the computations, and by a few additional articles (of no great expense or labour), the work might be rendered equally useful for all the purposes of *practical astronomy*. For the Committee cannot omit this opportunity of expressing their decided opinion, that it is not by the mere helps with which the seaman is furnished for the purpose of determining the position of his vessel *at sea*, that the full intent and purpose of what is usually called *nautical* astronomy are answered; since this object is a *part* only of that comprehensive and important subject, and may be effected by a very cheap publication, and without the use of very expensive instruments. An equally important and more difficult portion of it consists in the exact determination of the position of various interesting points on the surface of the earth (equally essential and almost solely applied to the purposes of *navigation*),—such as remarkable headlands, ports, and islands; together with the general trending of the sea-coast between well-known harbours,—and which may properly be designated by the name of *nautical geography:* this can only be effectually and properly executed by methods not available on board a ship, and by delicate instruments placed firmly on solid ground. And the observer in such cases requires all the astronomical aid which can be afforded him from the best tables, arranged in the most convenient form for *immediate* use. This was evidently Dr. Maskelyne's view of the subject, when he first

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proposed the formation of the Nautical Almanac, as appears from his "Explanation and Use of the Articles" annexed to that work: and the propriety and accuracy of his opinion have been confirmed by the repeated wants and demands of those distinguished navigators who have been employed in several recent scientific expeditions. There are moreover many individuals in various parts of the world, attached to the science of astronomy, who, by the encouragement and facilities thus given, render considerable assistance to the improvement of astronomy and geography by their exertions: and neither private nor *national* observatories, on which many thousands are annually expended, can proceed with activity or good effect, unless some aid of this kind is afforded them.

5. Impressed with these considerations the Committee proceeded to the discussion of the subjects in question. And although in the course of this investigation, some objects of minor importance have presented themselves, the Committee have not thought them unworthy their attention: since they considered it desirable that as perfect an arrangement and disposition as possible of *all* the parts should be effected at one and the same time, not only in order to avoid the frequency of alterations, which must in all cases be attended with inconvenience and disadvantage, but more especially that the work may *at once* appear in its most approved form, and thus more decidedly mark the epoch of the alterations that have been introduced.

6. To the class of minor subjects above mentioned belong the arrangement of the *calendar*, and the various articles which usually occupy the first page of each month. The Committee will advert more at large to this subject in the sequel; and at present merely observe that they recommend the abolition of the column entitled "Sundays and other remarkable days:" and a partial suppression, accompanied with a totally new arrangement, of the column entitled "Other phenomena;" in order to make room for more important matter.

7. With respect to the other more essential parts of the Almanac (in the order in which they stand) the Committee recommend that the computations of the *Sun's* longitude, right ascension and declination, together with the equation of time, (the three latter computed for *apparent* noon, as well as *mean* noon,) should be extended to one place of decimals further than in the printed specimen for 1833 above alluded to: that the hourly difference in right ascension be added, and that the *hourly* dif-

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ference in declination and in the equation of time be substituted for the *daily* difference. And they suggest the propriety of having a running correction at the bottom of the page, for converting (from sidereal to mean time) the interval of the time in which the sun's semidiameter passes the meridian. They also recommend an additional column, containing the "Mean solar time of the transit of the first point of Aries," calculated to 2 places of decimals: together with a column containing the fractional part of a year, for every day in the year, to three places of decimals: as well as the retention of the column containing the days of the year in numerical order from Jan. 1 to Decem. 31. On the other hand they recommend the suppression of one place of decimals in the sun's semidiameter, as the values would then be sufficiently exact for every purpose required: also the suppression of the time of the rising and setting of the sun and moon, as being for the most part wholly useless to the navigator, and of no essential service to the astronomer.

8. They further recommend that the computations of the *Moon's* longitude, latitude, declination, equatorial horizontal parallax, horizontal semidiameter, age, and time of passing the meridian, be extended to one place of decimals further than in the before-mentioned specimen: and that the time of the moon's perigee and apogee, to the nearest hour, be inserted at the foot of one of the pages. Whilst on the subject of the moon's place, the Committee cannot omit the opportunity of expressing their great approbation of the introduction, by Mr. Pond, of the right ascension and declination of the moon for *every third hour* into the Nautical Almanac for 1833; a measure which affords accuracy and convenience to the mariner on many occasions. The Committee have had much discussion on the propriety and advantage of extending those places still further to *every hour:* and, considering the very extensive use to which they may be practically applied in various parts of nautical astronomy, they have finally decided to recommend that important addition: as well as a column containing the differences of declination for 5 minutes, if it can be conveniently introduced.

9. The attention of the Committee was next called to the form in which the positions of the *Planets* are given in the printed specimen above alluded to, which they consider to be too much abridged to be of any essential service either to the astronomer or the navigator. The Committee are aware that the positions of the four principal planets (Venus,

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Mars, Jupiter, and Saturn) for every day in the year, are annually published in English, and partly at the expense of this government, by the Royal Danish Sea-Chart Office at Copenhagen; together with the distances of those planets from the moon, for every third hour; under the direction of Professor SCHUMACHER. But, notwithstanding the ability with which that work is conducted, the Committee are of opinion that it is not so generally diffused in the navy as its merits deserve; arising probably from its not being sufficiently known. And as there can be no question, at the present day, about its utility and importance to navigation; and as every method ought to be encouraged and promoted that will tend to assist the mariner in determining the position of his vessel at all times, and more especially at a time when the ordinary methods may fail; the Committee recommend that the above articles, computed for mean time, be incorporated with, and form part of the Nautical Almanac: by which arrangement, both the navigator and the astronomer will be furnished with the addition of much valuable and important information, at a much less expense than they can now procure it; and the mariner (by thus having the means constantly at hand) will be more likely to adopt a practice which cannot fail of being oftentimes of very essential and perhaps vital importance. The Committee however recommend some slight additions, and a few alterations in the arrangement of the articles: the most important of which is the substitution of the *heliocentric* longitude and latitude, for the *geocentric;* with the hourly difference in right ascension and declination of Venus, if it can be conveniently introduced; together with the introduction of the logarithm of the *radius vector*, calculated to 7 places of decimals, the mean time of the transit of the planet, to the nearest minute, and the other computations carried to the same extent as in the Berlin Ephemeris. To which should be added the horizontal parallax and *polar* semidiameter of each planet, calculated to 2 places of decimals, for every 5th day of the year: the ratio of the two diameters (if known) being stated. And the Committee recommend that in the geocentric places of the planets, the effect of aberration should be included.

10. The Committee, at the same time that they recommend this great accession of strength to the purposes of navigation, would think themselves deficient in the duty which they owe to the interests of that science which they are more particularly called upon to protect and

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advance, if they did not claim from the hands of a liberal and enlightened government, the *same* information with respect to the two other principal planets (Mercury and the Georgian); as well as a less extended account of the motions and positions of the four newly discovered planets (Vesta, Juno, Pallas, and Ceres), together with an ephemeris, at the time of their expected re-appearance, of the two Comets of short period, and of the comet of Halley, which are now known to belong exclusively to our system. The amount of these proposed additions will be seen in the Appendix: and they will occupy forty pages of the Almanac. It might perhaps be urged that these cannot be available for any purposes of *nautical* astronomy. But, surely the frequent transits of Mercury over the sun's disc cannot be considered as wholly unconnected with the general improvement of astronomy and geography, the two loadstars of navigation: and if it were only on this account, it is requisite that the tables of the planet should be as accurate as possible. And in a system where each body is mutually dependent on the others, where the beauty and harmony of the whole cannot be elicited or explained without a minute examination of the motions of each planet in detail, and where much has been, and may still be, done by private observers towards this great end, the trifling expense, incurred by the additional information here alluded to, must not be considered as wholly lost to the country, but may be repaid with interest at some future period. The remarkable anomaly in the motion of the satellites of the Georgian, noticed by Sir William Herschel; the singular discrepancies in the orbits and motions of the four newly discovered planets, situated at nearly an equal distance from the sun; and the suspicion of the existence of a highly rarefied medium in which the planets perform their revolutions, indicated by the retarded motion of one of the above-mentioned comets,—may derive new light from future observations, and tend to enlarge our views of the system of the universe.

11. Considering the importance of the *Eclipses of Jupiter's satellites* in determining the longitude of places, and that it is consequently desirable to aim at the greatest perfection of the tables, the Committee recommend that there be given the time of the *contact* of the satellites with the planet, and likewise the time of the *contact of their shadows*, when the satellites pass over the disc of the planet. The Committee are aware that these phenomena can only be observed by powerful instruments; but since, in the opinion of some profound mathematicians, they present

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the best means of determining some of the elements in the theory of Jupiter's satellites, whereby the Tables may consequently be rendered more accurate and complete, they have not hesitated to recommend a measure which, at a very trifling expense, may induce such astronomers, as are possessed of the requisite instruments, to enter on a series of observations connected with this delicate and important branch of astronomy. They further recommend that the computations of the time of the contacts above mentioned be calculated in sidereal time to the nearest minute, and that the time of the eclipses be extended to one place of decimals in the seconds; and given in *sidereal* as well as in *mean solar* time: and that for the convenience of observers there be annexed diagrams in each month, in lieu of the co-ordinates, for shewing the position of each satellite with respect to Jupiter, at the time of immersion and emersion.

12. Although not immediately in the order of the subjects, yet as being in some measure connected with what has just been stated, the Committee here recommend that the *Configurations* of Jupiter's satellites should be determined for the hour of mean *astronomical* time, and not for the hour denoted by the *civil* mode of reckoning as hitherto adopted; which has been found to lead to some confusion: and that as much explanation should be given at the foot of the page as can be conveniently done; with a notice that the positions are such as they would appear in a telescope that inverts.

13. The Committee further recommend that the two columns entitled "Logarithms of C, D" inserted in the late Supplements to the Nautical Almanac, be retained: and that there be added thereto the logarithms of A, B. The computations to be made for mean midnight.

14. On the subject of the *Lunar Distances*, the Committee have had much discussion as to the propriety and advantage of extending them to *every* hour in the day, instead of every *third* hour as at present. But, although this arrangement might, at first, appear more convenient to the seaman, as well as more accurate in the results, inasmuch as the effect of the second differences would in such case almost wholly vanish; yet, when the Committee considered that the seaman must in every instance make a computation for the fractional part of the interval, and that the correction for second differences, in the case of *three* hours, is in general very small, and by no means equal in amount to other corrections, too frequently and too notoriously omitted in practice; and moreover that this proposal would

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have the effect of adding 120 pages to the Nautical Almanac: they have thought that they should not be justified in recommending a measure of such doubtful advantage, and which would certainly be attended with a considerable increase of expense. They however recommend that the proportional logarithm of the first difference, to 4 places of decimals (or to 5 places, if practicable), be inserted, for the convenience of the seaman: as well as a small table for finding the correction on account of second differences, which will not occupy more than half a page, and by means of which the intelligent navigator will be enabled to find the correction which ought to be applied, when great accuracy is required; and obviate the necessity of any farther extension at present of the lunar distances. And, in compliance with the wishes of several officers of the Royal Navy, they suggest the propriety of extending the limits of each star a little farther, whenever it may appear to the computer that it can be done with good effect. The Committee also recommend that the lunar distances of the *planets* (already alluded to) be inserted amongst the other lunar distances in the monthly Ephemeris.

15. This completes the list of articles usually inserted in the *monthly* pages of the Nautical Almanac: and the Committee recommend that, for the convenience of taking out differences, there be inserted at the bottom of each page (when requisite) the quantities that follow next in order of succession on the first day of the following month. At the end of these monthly lists the Committee recommend that a page be set apart for the insertion of the following quantities, for every tenth day of the year, and computed to two places of decimals: viz. the apparent obliquity of the ecliptic, the parallax of the sun, the aberration of the sun, the equation of the equinoctial points in longitude, and also in right ascension (in time): together with the mean longitude of the moon's ascending node, to the tenth of a minute. And that there be also added, at the bottom, the mean obliquity of the ecliptic for January 1st: and the mean daily motion of the moon's node.

16. The Committee strongly recommend the insertion of the *List of moon-culminating stars*, given in the late Supplements to the Nautical Almanac, as affording one of the best modes of determining the longitude of distant places, when the navigator, furnished with a transit instrument, can obtain a landing. As it is absolutely essential, however, that *only one* list of such stars should be published for the use of navigators of all nations,

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and as Professor Encke proposes to discontinue his list as soon as he is assured that the British Government will permanently adopt one, the Committee trust that they may be excused for entering rather more minutely into the mode in which those stars should be selected. They recommend, therefore, that not more than 4 stars should be selected for one day, 2 of which are to precede and 2 to follow the moon: that the stars thus forming each pair be chosen so as not to be very distant from each other in right ascension, and nearly midway between the right ascension of the moon at the time of her transit on two consecutive days: that the 2 stars chosen to follow the moon on one day, be adopted as the 2 to precede the moon on the subsequent day: that no star be selected below the 5th, but on no account below the 6th magnitude: that the stars so chosen should not be situated more than 5 degrees from the path of the moon's true orbit: and that the list should be continued through each lunation within 4 days of the new moon: that the apparent right ascension (in time) of the star to two places, and the mean declination of the star to the nearest minute, be given. And the Committee further recommend that an asterisk be annexed to those stars in the list which are situated between 4° and 14° of north declination, for the purpose of indicating, to observers in the northern and southern hemispheres, such as are best situated for observing the difference of declination between them and the moon, with a view to the determination of her parallax.

17. And for the convenience of those computations which are connected with moon-culminating stars, the Committee likewise recommend that the column entitled the moon's "Semidiameter passing the meridian in sidereal time," as given in the late Supplements to the Nautical Almanac, be retained: but that it be extended to the time of the *lower* (as well as the *upper*) culmination: and that there be given also the right ascension (in time) of the moon's enlightened limb to two places, for her upper and lower culmination; together with the change in the same, corresponding to its transit over one hour of longitude; and also the moon's declination, to the nearest minute, at the time of her transit.

18. In lieu of the "Elements for computing the principal lunar occultations of the fixed stars," usually inserted at the end of the Nautical Almanac, the Committee recommend that there should be given: 1st. A list of predicted occultations of such of the planets (including the satellites, when Jupiter is occulted) and of the fixed stars (to the 6th

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magnitude inclusive) as may be visible at Greenwich, both in mean and sidereal time to the nearest minute: with the angle from the vertex, as seen in a telescope that inverts, and also from the most northern point of the moon's disc, each reckoned in degrees from right to left, round the circumference. 2nd. Elements for predicting such occultations of the planets and fixed stars (to the 5th magnitude inclusive) as may be visible in some habitable part of the globe: together with the limits of latitude beyond which they cannot be occulted, as in the Bologna Ephemeris; in order that navigators may know when and where to look out for the phenomona. And they likewise recommend that the apparent places of such stars, on the day of occultation, be given.

19. The Committee further recommend that the *Apparent places of the principal fixed stars* be, in future, given for the time of their transit at Greenwich, and not (as heretofore) for the time of noon: and that the co-efficients A . B . C . D and the *constants* given in the Catalogue of this Society, be adopted in the computations. The places of α and δ *Ursæ Minoris* for every day in the year: and the remainder (as usual) for every tenth day, with a column of differences: and that where the proper name of a star is retained, there be added the constellation to which it belongs, and its corresponding letter or number. And as it has been a frequent source of regret, by navigators frequenting the Southern Ocean, that there are so few *southern* stars inserted in the usual list; and as it would be also desirable to have the apparent places of a few more *circumpolar* stars, as well as of some others to fill up the *chasms* in the present list; the Committee proceeded to the selection of the stars proper for those purposes, and they now submit the following general list of stars (comprehending most of those inserted in the late Nautical Almanacs, which are here distinguished by an asterisk prefixed) as the list that, under all circumstances, would be most suited to the wants of the navigator and the astronomer: at the same time, leaving the insertion of any others for future consideration. The Committee also recommend that the mean places of all these stars, for January 1st of the current year, be inserted in a *separate* list: that the magnitudes and annual variations be annexed: that the *declinations* in all cases be given, instead of the *north polar distances:* and that such declinations when south be denoted by the letter S (for the convenience of mariners) instead of the negative sign.

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Stars.	Mag.	Æ h. m.	Dec. ° ′	Stars.	Mag.	Æ h. m.	Dec. ° ′
* γ Pegasi	2·3	0 4	+14 14	λ Ursæ Min.	5	9 8	+88 34
β Hydri	3	0 17	−78 13	ι Argus	2	9 13	−58 34
* α Cassiopeæ	3	0 31	+55 36	* α Hydræ	2	9 19	− 7 56
β Ceti	2·3	0 35	−18 55	θ Ursæ Maj.	3	9 21	+52 27
* α Ursæ Min.	2·3	0 59	+88 24	ε Leonis	3	9 36	+24 33
θ^1 Ceti	3	1 16	− 9 4	* α ——	1	9 59	+12 48
α Eridani	1	1 31	−58 6	η Argus	2	10 38	−58 48
* α Arietis	3	1 58	+22 39	* α Ursæ Maj.	1·2	10 53	+62 40
γ Ceti	3	2 34	+ 2 31	δ Leonis	3	11 5	+21 27
* α ——	2·3	2 53	+ 3 25	δ Hyd. et Crat.	3·4	11 11	−13 51
* α Persei	2·3	3 12	+49 15	* β Leonis	2·3	11 40	+15 31
η Tauri	3	3 37	+23 34	* γ Ursæ Maj.	2	11 45	+54 38
γ^1 Eridani	2·3	3 50	−14 0	β Chamæleontis	5	12 9	−78 22
* α Tauri	1	4 26	+16 10	α^2 Crucis	1	12 17	−62 9
* α Aurigæ	1	5 4	+45 49	β Corvi	2·3	12 25	−22 27
* β Orionis	1	5 6	− 8 24	12 Can. Venat.	2·3	12 48	+39 14
* β Tauri	2	5 16	+28 27	* α Virginis	1	13 16	−10 16
* δ Orionis	2	5 23	− 0 26	* η Ursæ Maj.	2·3	13 41	+50 10
α Leporis	3·4	5 25	−17 57	η Bootis	3	13 47	+19 15
* ε Orionis	2·3	5 28	− 1 19	β Centauri	1	13 52	−59 33
α Columbæ	2	5 33	−34 10	* α Bootis	1	14 8	+20 4
* α Orionis	1	5 46	+ 7 22	α^2 Centauri	1	14 28	−60 8
μ Geminorum	3	6 13	+22 36	* ε Bootis	3	14 38	+27 48
51 (Hev.) Cephei	5	6 18	+87 17	* α^2 Libræ	3	14 41	−15 20
α Argus	1	6 20	−52 36	* β Ursæ Min.	3	14 51	+74 51
* α Canis Maj.	1	6 38	−16 29	β Libræ	2·3	15 8	− 8 45
ε ——	2·3	6 52	−28 45	* α Cor. Bor.	2	15 27	+27 18
δ Geminorum	3·4	7 10	+22 17	* α Serpentis	2·3	15 36	+ 6 58
* α ——	3	7 24	+32 15	ζ Ursæ Min.	4	15 50	+78 19
* α Canis Min.	1·2	7 30	+ 5 39	β^1 Scorpii	2	15 56	−19 20
* β Geminorum	2	7 35	+28 26	* δ Ophiuchi	3	16 5	− 3 15
15 Argus	3·4	8 0	−22 49	σ Octantis	.	16 18	−89 25
ε Hydræ	4	8 38	+ 7 2	* α Scorpii	1	16 19	−26 3
ι Ursæ Maj.	3·4	8 47	+48 42	η Draconis	3	16 22	+61 54

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Stars.	Mag.	Æ.	Dec.	Stars.	Mag.	Æ.	Dec.
		h. m.	° ′			h. m.	° ′
α Triang. Aust.	2	16 31	−68 42	α Pavonis	2	20 12	−57 16
ε Ursæ Min.	4	17 4	+82 18	* α Cygni	1	20 36	+44 41
* α Herculis	3·4	17 7	+14 36	*(61)^1 ——	.	20 59	+47 56
* β Draconis	2	17 27	+52 26	ζ ——	3	21 6	+29 32
* α Ophiuchi	2	17 27	+12 43	* α Cephei	3	21 15	+61 52
* γ Draconis	2	17 53	+51 31	* β Aquarii	3	21 23	− 6 19
μ^1 Sagittarii	3·4	18 4	−21 6	* β Cephei	3	21 26	+69 49
* δ Ursæ Min.	3	18 27	+86 35	ε Pegasi	2·3	21 36	+ 9 6
* α Lyræ	1	18 31	+38 38	* α Aquarii	3	21 57	− 1 8
* β ——	3	18 44	+33 10	α Gruis	2	21 57	−47 47
* ζ Aquilæ	3	18 58	+13 37	ζ Pegasi	3	22 33	+ 9 57
* δ Aquilæ	3·4	19 17	+ 2 47	* α Piscis Aust.	1	22 48	−30 31
* γ ———	3	19 38	+10 12	* α Pegasi	2	22 56	+14 18
* α Aquilæ	1·2	19 42	+ 8 26	ι Piscium	4·5	23 31	+ 4 42
* β ———	3·4	19 47	+ 5 59	γ Cephei	3	23 32	+76 41
* α^2 Capricorni	3	20 9	−13 4	* α Andromedæ	1	24 0	+28 9

20. The Committee recommend that the several monthly lists of *Phenomena*, usually given in the first page of each month in the Nautical Almanac, be inserted *altogether* at some convenient part of the work: that the conjunctions of the fixed stars with the moon (as usually given) be wholly discontinued: that the conjunctions in future be confined to the planets with the moon and with such of the fixed stars as may afford any interesting results, and to the planets with each other: that such conjunctions be expressed in *right ascension* (and not in longitude as heretofore), to which should be added the difference of declination to the nearest minute: that the other phenomena which should be noted, be the times when the planets are in quadrature, conjunction, opposition, perihelion, aphelion, and nodes; as well as when stationary and at their greatest elongation and heliocentric latitude, with the amount of the former expressed to the nearest minute: also the time of the sun being in perigee and apogee; the time of the greatest brilliancy of Venus, of the maximum and minimum of the light of Algol and other variable stars, the maxima

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of the moon's libration, as well as notices of any remarkable phenomena that may be expected to take place, such as the transits of Mercury, the re-appearance of comets, &c. &c. And that at the end of this list there be given the elements for determining the geocentric form of Saturn's ring; together with elements for determining the illuminated portion of the discs of Venus and Mars.

21. The Committee likewise recommend the insertion of four tables, which may occasionally be found extremely useful and necessary to navigators and others, and which will not occupy much space: viz. 1st. A table for determining the latitude of a place by observations of the pole star at any hour of the day: 2nd. A table of the longitude and latitude of the principal observatories, from the latest information: 3rd. A table of the mean time of high water at London Bridge for every day in the year; and also at the principal ports, at the time of new and full moon: and 4th. Errata from time to time discovered in the principal logarithmic and other tables of repute. Together with Notices, from time to time, of important geographical information, comprising newly determined positions, magnetic variations, phenomena of the tides, &c.

22. Reverting to those articles of the Nautical Almanac which usually *precede* the monthly parts, the Committee recommend that the "Ember days" be discontinued: and that the following days be subjoined to the "Moveable feasts" or united with them under some other title: viz. Epiphany, Good Friday, King Charles's restoration, Gunpowder-plot, St. George, St. Andrew, St. Patrick, King's birth-day, accession, proclamation, and coronation, Queen's birth-day, Lady-day, Midsummer-day, Michaelmas-day, and Christmas-day, together with the commencement of the Jewish and of the Mohammedan year, and particularly the commencement of the fast of Ramadân (which may be occasionally useful to officers cruising in the neighbourhood of Mohammedan states), and such other days as the superintendent of the Nautical Almanac may think advisable.

23. In this part of the Nautical Almanac also is usually inserted the account of the *solar and lunar eclipses*. The Committee recommend that in the account of the solar eclipses, there should be given the elements employed in the computation, the line of the moon's umbra across the earth, together with a diagram of the same; and generally more particulars relative to the phenomena, as in the Berlin Ephemeris.

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24. The Committee, considering that the table of "Refractions," the table "For reducing sexagesimal time to the decimal fraction of a day, and the reverse," and the table of the "Equation of second differences" are of a permanent nature, and that the latter, in fact, will be of little use to the navigator, should the present alteration in the arrangements be carried into effect, recommend that they be discontinued in the Nautical Almanac: and that they be transferred to another work which they trust will be formed for the benefit and promotion of nautical astronomy, under the title of "Tables requisite to be used with the *new* Nautical Almanac." They recommend, however, the insertion of the short table of the equation of second differences for intervals of *three* hours, mentioned in the preceding part of this Report.

25. Such are the alterations and additions which the Committee, after the most mature deliberation and discussion, have considered it advisable to recommend for adoption. They are of a nature to satisfy not only the wishes of the astronomer, but also the demands of the navigator: and the Committee are of opinion that, with due economy, and such an arrangement of the parts amongst the several computers as will afford them constant employment, the *whole of the additional computations* may in a short time be obtained without much (if any) additional cost to the nation. But whether a comparer, in addition to the superintendent and computers, be absolutely necessary, or whether any considerable sum could be saved in the articles of paper and printing, the Committee do not take upon themselves to decide. They have, however, no hesitation in stating it as their opinion that very considerable savings might be effected: and they have ascertained that the cost of paper and printing the additions proposed will not exceed £360: an expense which, even if charged on the work, would be cheerfully paid in consideration of the additional information which it contains. But by not raising the present price of the work, the inducement for reprinting it in foreign countries would be in a great measure removed: whilst its important and valuable contents would insure it a place in almost every vessel that sails on the ocean; and by thus increasing the sale, not only repay the additional charges incurred in the computations, but probably relieve the country also from a considerable annual expense.

26. The Committee strongly recommend that any errors, discovered in the Nautical Almanac, should be printed immediately for general information, and be annexed to all the unsold copies: and that notice of the

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same be advertised in the London Gazette, and in some of the public papers, as early as possible.

27. Should the Lords Commissioners of the Admiralty think proper to adopt the alterations that may be ultimately agreed upon by the Council, the Committee recommend that the "Explanation," usually given at the end of the Nautical Almanac, be entirely re-composed in the plainest style possible, and new modelled so as to correspond with the proposed arrangements; with examples taken from the body of the work: and that a "Table of Contents" be prefixed. And they take this opportunity of expressing their decided opinion of the propriety and necessity of inserting in the "Preface" to each year's almanac, an account of all the tables and authorities depended upon in every computation, with an express notice of such equations as may be omitted, or of any corrections introduced; in order that any person may verify the calculations at his pleasure. Whether the names of the computers should be inserted, may be left to the discretion of the superintendent. The Committee however are of opinion that it would tend very much to the prevention and also the detection of errors in the computations, if *printed skeleton forms*, bound up in separate volumes of a sufficient magnitude for one year's use, were provided for the several computers: which when finished should be signed by them respectively, and afterwards deposited with, and preserved by, the superintendent for the purpose of reference.

28. The Committee also recommend that the publication of the Nautical Almanac be always four years in advance: and they consider that it would be highly desirable that the improvements, ultimately adopted in that work in consequence of this Report, should be ordered to appear in the volume for 1834, and by no means be deferred beyond that period: the Committee being confident that, by due exertion, this may be effected. And they recommend that notice of the same should be given in the Preface to the Nautical Almanac for 1833.

29. The Committee cannot close their labours, without acknowledging the valuable hints and suggestions contained in the several letters received from those members who could not conveniently attend the meetings: and who will see, from this Report, that every subject mentioned by them has regularly come under discussion.

30. The Committee are happy also in expressing their sense of the zeal and attention of one of the Associates of this Society (Professor

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STRUVE), who, during his short stay in England, devoted a considerable portion of his time to these proceedings: and from whose profound knowledge of every branch of practical and theoretical astronomy, the Committee have derived the most valuable assistance.

31. They likewise consider it their duty to notice the constant attendance of the Astronomer Royal at all their meetings; the readiness with which he afforded them every information relative to the various subjects that came under consideration; and the zeal with which he entered into all their views for improving this national work.

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APPENDIX,

CONTAINING A LIST OF THE ARTICLES PROPOSED TO BE INSERTED IN THE NAUTICAL ALMANAC.

N.B. Those *articles* which are now introduced for the first time (that is, which do not form any part of the Nautical Almanac or its Supplement for 1830, or of the Specimen for 1833) are printed in Italics: and the same mode is adopted to denote the *alterations* which have been made in the *extension of the computations* of the other articles. By this method, the additions and alterations proposed may be readily distinguished.

The use of *apparent* time to be abolished in all the computations, except in those immediately connected with the sun's transit.

The day of the week, repeated as often as convenient.
———— month, on every page.
———— year (or days elapsed since Jan. 1st), in numerical order.
The fractional part of the year, for every such day.
Equinoctial time for every day in the year.
Mean time of the transit of the first point of Aries, to two places, for every day.

SUN'S { Right Ascension in time (with *hourly motion*), to *two* places,
Declination (with hourly motion), to *one* place, ...
Sidereal time of semidiameter passing meridian, to two places, } at the time of Sun's transit.
Equation of time (with hourly differences) to *two* places, ...

SUN'S { *Right Ascension, to two places,* . .
Declination, to one place, ...
Longitude, to *one* place, ...
Latitude, to two places, ...
Semidiameter, to one place, . . } at mean noon.
Sidereal time, to two places, ...
Equation of time, to two places, ...
Logarithm of radius vector, to seven places,

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MOON'S

- Longitude, to *one* place, . . . } for noon and midnight.
- Latitude, to *one* place, . . .
- Horizontal parallax, to *one* place,
- Semidiameter, to *one* place, . .
- Mean time of transit, to the *tenth* of a minute.
- Age, to the *tenth* of a day, for noon.
- ☊ in time, to two places, } for *every* hour.
- Declination, to *one* place,
- ——— *with differences for five minutes.*
- Phases, to the *tenth* of a minute, . . } for each lunation.
- Perigee and Apogee for the nearest *hour*,

PLANETS, viz. Mercury, Venus, Mars, Jupiter, Saturn, Georgian.

- Heliocentric Longitude to *one* place, . . } for *every day* at noon.
- ——— Latitude, to *one* place, . . .
- *Logarithm of Radius vector, to seven places,*
- Geocentric ☊ in time, to *two* places, . .
- ——— Declination, to *one* place, . .
- Log. dist. from the Earth, to *seven* places,
- Mean time of transit, to the *tenth* of a minute,
- Horizontal parallax, to two places, } for every *fifth* day.
- *Polar semidiameter, to two places,*

PLANETS, viz. *Vesta, Juno, Pallas, Ceres.*

- *Heliocentric Longitude,* } *to the nearest minute,* } *for every fourth day at noon.*
- ——— *Latitude,*
- *Geocentric ☊ in time, to the tenth of a minute,*
- ——— *Declination, to the nearest minute,*
- *Radius vector, to four places, ...*
- *Log. dist. from the Earth, to four places, .*
- *Mean time of transit, to the tenth of a minute,*
- *Geocentric ☊ in time, to two places, . . .* } *for one month before and after opposition, at midnight.*
- ——— *Declination, to one place, . . .*
- *Radius vector, to five places, ...*
- *Log. dist. from the Earth, to five places, .*

The co-efficients *A*, *B*, C, D, for every day, at midnight.

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JUPITER'S SATELLITES
- Eclipses of { in mean and *sidereal* time, to *one* place.
  diagrams for shewing the place at that time.
- *Contact with the planet, in sidereal time,* } *to the nearest minute.*
  Contact of shadows with the planet, in do. }
- Configurations.

LUNAR DISTANCES { from the Sun and the nine principal fixed stars, and from *Venus*, *Mars*, *Jupiter*, and *Saturn*, } for every third hour, *with the proportional logarithms of the differences, annexed.*

Apparent obliquity of the ecliptic, to *two* places, . .
Parallax of the sun, to two places, ... } for every
Aberration of the sun, to two places, ... tenth day.
Equation of equinoctial points in longitude, to *two* places,
——————————— *in* Ⓡ, *to two places,* .
Mean longitude of Moon's node, to the tenth of a minute,

Mean obliquity of the ecliptic, for January 1st, } at the bottom of the page.
Mean daily motion of the moon's node, . . }

ECLIPSES. { Solar, *with the line of the moon's umbra, diagrams, &c.*
Lunar.

Predicted Occultations (visible at Greenwich) of planets and fixed stars to the sixth magnitude inclusive, in mean and sidereal time, to the nearest minute; with the angle from the vertex, and also from the most northern point of the moon's disc.

Elements for predicting such occultations of the *planets* and fixed stars to the fifth magnitude inclusive, as may be visible in any habitable part of the globe; *with the limits of latitude annexed.*

The apparent places of the stars on the days of occultation to be given, in both cases.

Apparent places of the fixed stars (100 *in number*) for their time of transit:
α and δ Ursæ Minoris, for *every* day;
the remainder for every tenth day, *with differences annexed;*
Mean places of the same at the beginnning of the year, in a separate list.

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A list of Moon-culminating Stars, continued within *four* days of new moon: the *apparent* Æ of the stars to *two* places, and the mean declination to the nearest minute. Also the

Moon's { Æ in time, of her bright limb, to *two* places, / *Variation in ditto for one hour of longitude,* / Sidereal time of semidiameter passing meridian, to two places, ... } for upper and *lower* culmination. / Declination, to nearest minute, for upper culmination.

A List of Phenomena, containing

- conjunctions (in Æ) of the planets with { the moon. / certain fixed stars. / each other. } with difference of declination to the nearest minute.
- time when the planets are { in Quadrature. / in Conjunction. / in Opposition. / in their Perihelion. / in their Aphelion. / *in their Nodes.* / stationary. / *at their greatest heliocentric Latitude.* / at their greatest Elongation (*with amount*).
- *time when the Sun is in* { *Perigee.* / *Apogee.*
- *time of the greatest brilliancy of Venus.*
- *time of the maximum and minimum of the light of variable stars.*
- *time of the maxima of the Moon's libration.*
- notice of { transits of Mercury. / *predicted Comets.* / any other remarkable phenomena.

Elements for finding { *the geocentric appearance of Saturn's ring.* / *the illuminated portions of the discs of Venus and Mars.*

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TABLES
- *for the correction of second differences, in Lunar distances.*
- *for determining the Latitude by the pole star, out of the meridian.*
- *of the Longitude and Latitude of the principal Observatories.*
- *of the time of high water at London Bridge.*
- *for finding the time of high water at the principal ports.*
- *of Errata discovered in logarithmic and other tables of repute.*

Notice of newly determined positions, magnetic variations, &c. &c.

Preface, to contain an account of *all* the Tables used in *every computation;* and a notice of any *Equations omitted,* or *new Corrections* applied.

Cycles, remarkable days, moveable feasts, law terms, &c., to be prefixed.

Table of Contents.

(Signed) J. SOUTH, *President.*

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XXII. *On Notation.* *By J. W. Lubbock, Esq., Member of the Society.*

Read December 11, 1829.

That part of the theory of mathematical notation which relates to symbols of operation, or functional and derivative characteristics, appears to have attracted some attention; but that part which relates to symbols of quantity has hitherto, I think, been entirely disregarded. If we examine the works of the greatest mathematicians, we find symbols chosen without any regard to those made use of by their predecessors, or even by themselves in other parts of the same work; thus increasing greatly to their readers the difficulty of understanding their meaning.

In the following remarks I have confined myself within narrow limits, wishing to call attention to those principles only which appear generally admitted. Nor have I discussed at length the theory of notation as regards language, which opens a much wider field of inquiry: there are, however, some inconsistencies which it may be worth while to notice, although they are so firmly rooted that any attempt to remove them would cause far greater evil than their continuance. Thus, terrestrial longitude and latitude, and celestial longitude and latitude, are angles measured in different planes; but terrestrial longitude and latitude, and right ascension and declination, are measured in the same planes.

The unity of right ascension should correspond to the unity of angular circumference; if, therefore, the day be taken as the unity of time, the circumference should be taken as the unity of angle: many reductions would thereby be saved in astronomical calculations. Whatever *unity*, however, be adopted, or *whatever quantity be the subject of measurement*, the denary division or scale presents such advantages, that it would be well worth while to undergo any temporary inconvenience in order to procure its final adoption. If accurate tables were published of the logarithms of the trigonometrical lines according to this division of the *degree*, it seems probable that it would soon be generally adopted. The inconvenience of this change would be much less than what attends the change of the *degree* from the $\frac{1}{360}$th to the $\frac{1}{400}$th of the circumference.

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Briggs did, in fact, publish tables of this kind for every hundredth of a degree; but these tables were superseded by the more accurate tables of Rheticus and Vieta, which were calculated to every 10 seconds. See Delambre, *Histoire de l'Astronomie*, vol. ii. p. 76.

There is one part of the subject of notation to which I will but just advert, because it would be impossible to treat it as it deserves within the limits which I have prescribed to myself; I mean the absence of a uniform system of references to equations which are of frequent recurrence. If we except a few theorems to which the name of their discoverer has been attached, such as Taylor's theorem, Lagrange's theorem, &c., it is difficult to refer to any formula without enuntiating it at full length. Thus, the well-known equations in the theory of rotatory motion,

$$\begin{aligned} C\mathrm{d}r + (B-A)\,pq\mathrm{d}t &= N\mathrm{d}t \\ B\mathrm{d}q + (A-C)\,rp\mathrm{d}t &= N'\mathrm{d}t \\ A\mathrm{d}p + (C-B)\,qr\mathrm{d}t &= N''\mathrm{d}t \end{aligned}$$

have the reference

(*b*) in the *Traité de Mécanique*, by M. Poisson.
(θ) in Professor Whewell's *Dynamics*.
(D) in the *Mécanique Céleste*.
(B) and (C) in the *Théorie Anal. du Système du Monde*.
(A) in the *Mécanique Analytique*.
and (II) in the *Astronomy* of Professor Littrow.

The equations to which I refer in these authors differ somewhat in form, but are the same in substance. Symmetry requires that P should be written for N'', Q for N', and R for N, in these equations.

M. Cauchy uses numerical references, which appear to me far preferable to letters for this purpose.

The construction of maps is intimately connected with the theory of notation; but with respect to this part of the subject I will only observe, that, whatever marks or system of projection be adopted, they should be distinctly stated and explained wherever doubt might arise, as well as the authorities from which the positions of the different points have been laid down.

Notation should be as simple, as distinct, as expressive, and, above all, as uniform, as possible; hence, when a system of notation has been proposed by any original author, it should not be changed without strong reasons. Ambiguity and diversity of language are the most fertile sources of error.

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I now, with great diffidence, submit for consideration the following rules; they must be viewed, as founded partly upon convenience and partly upon general practice, and liable, although, I hope, but rarely, to exceptions.

(1.) The letters $\int$, Σ, and d, which are commonly used as symbols of operation, are never to be used as symbols of quantity. Professor Babbage proposes that all letters which denote quantity should be printed in italics, and all which indicate operations should be printed in Roman characters: thus, fx denotes a quantity f multiplied by x; fx denotes some function of x and constants, and thus Lacroix and Arbogast use the Roman letter d as the sign of differentiation.

(2.) The letters of the Greek alphabet are generally to be used for angles. This principle seems already to pervade the works of mathematicians, although exceptions may be found.

(3.) Initial letters are generally to be used as symbols of a word written at full length, as t for *time*, r for *radius* vector, ζ for *zenith* distance, α for right *ascension*, ω for *obliquity* of the ecliptic, i for an *indeterminate* quantity, p for the length of the *pendulum*, b for the height of the *barometer*, &c. This rule is at variance with the use of δ for zenith *distance*, l for the *length* of the pendulum, h for the *height* of the barometer, &c.

The initial letters should be taken in preference from the Latin language, on account of difference of the initial letters in the living languages: thus Professor Littrow uses the letter β for the latitude of a star, from the German word *breite*, and ς for hour angle, from the German word *stunden-winkel*. English writers generally use w for *weight*, and French p (*poids*).

(4.) Letters should be chosen in notation so that the expressions containing them can be read and written easily: therefore the small letters (a, b, c, &c.) are preferable to the capital letters (A, B, C, &c.) or to the old English letters. This is of most consequence when they occur in long analytical calculations.

This objection applies to the mark $\mathfrak{R}$, often used to denote right ascension; to the mark $\mathfrak{N}$, used for the longitude of the ascending node; and to the letters A, B, C, used by MM. Laplace and Damoiseau for the co-efficients of the sines and cosines which are contained in the expressions for the parallax, the latitude, and the time, in terms of the longitude of the moon in the lunar theory.

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(5.) The letters x, y, z, are never to be used except to denote rectangular co-ordinates. With regard to polar co-ordinates, the practice has been so various that it is difficult to give any rule, except as regards the distance of any point from the origin, which should always be represented by the letter r. s is generally used for the arc of a curve; so that $ds^2 = dx^2 + dy^2 + dz^2$.

At variance with this rule, M. Fourier, *Théorie du Mouvement de la Chaleur dans les Corps Solides*, p. 228, uses x for the distance of any point from the origin, and z for its temperature; p. 235 of the same work he uses the letters x, y, z for the rectangular co-ordinates of any point, and v for its temperature. M. Damoiseau, in his *Lunar Theory*, uses the letters x, y, z in a different signification; but here there is not the same danger of confusion.

(6.) The use of the same letter with different meanings, where confusion might arise, is to be avoided, and the same quantity is never to be represented by different letters in the same work.

Professor Babbage says,* "We must adhere to one notation for one thing. It is particularly unphilosophical, and completely contrary to the whole spirit of symbolic reasoning, to employ the same signs for the representation of different operations; to do so is an error which should never be tolerated; not the most brilliant discoveries, nor the most illustrious name, can justify such an innovation."

In neglect of this principle, we find Laplace using the letter u both for the eccentric anomaly and for the reciprocal of the radius vector, so that

$$\frac{1}{u} = a\,(1 - e\,\cos\,u)$$

in which equation u has two different acceptations. Laplace also uses the letter u for the radius of a spherical shell, *Méc. Cél.* vol. i. p. 140, and for the quantity $e\,\cos\,(nt + \varepsilon - \varpi)$, vol. i. p. 259. Laplace uses v for declination in the theory of tides, although he constantly uses the same letter to denote velocity and longitude. In the article "Physical Astronomy," in the *Encyclopædia Metropolitana*, v is used to denote the velocity in the curve, the eccentric anomaly, and the square of the radius vector.

In order to retain the same letter for the same class of quantities, indices at foot must frequently be resorted to, which generally, in mathe-

* Article "Notation," *Edinburgh Encyclopædia.*

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matical notation, have the force of prefixes in common language; and although inconvenient to print, have the great advantage of rendering the notation expressive, and of diminishing the number of different letters or symbols required: thus, if p denote parallax and α right ascension, p_α may denote parallax (p) in right ascension (α); similarly, p_ζ may denote parallax in zenith distance ζ. These indices may be dropped when there is no danger of confusion: so p may be used indifferently for parallax in right ascension or in zenith distance, where both these quantities do not occur. If A be any given figure or area, its projection upon the plane (xy) may be called A_{xy} or A_z: the latter notation is adopted by Mr. Hamilton, in his work on *Analytical Geometry*. Altering the character of a letter may generally be considered the same as placing an index at foot; so, if r denote refraction in general, R may denote horizontal refraction; if p denote parallax in general, P may denote horizontal parallax. Here the capital letter denotes a maximum value: sometimes it is used in a different acceptation, as when M is put for Σm.

Roman characters, as x, y, z, may denote particular values of variables x, y, z. This notation is used by Lagrange in the *Mécanique Analytique*.

Generally, it is convenient to use the same letter, with different indices at foot, to denote quantities which are related: thus, if m be the mass of one planet, $m_,$ may be the mass of another. Sometimes, however, it is better to take consecutive letters in the alphabet; so a, b, c, may be used for the semiaxes of an ellipsoid; A, B, C, for the moments of inertia of a solid. A remarkable instance of want of symmetry in notation of this kind occurs in Woodhouse's *Astronomy*, vol. ii. p. 274, where we find the series $\mathrm{A} + \mathrm{B}\cos\omega + \Gamma\cos 2\omega + \&c.$

(7.) All indices are to be placed to the right of the letter to which they refer, and indices of situation at the foot of the letters to which they refer, in order that they may not be confounded with indices of evolution: hence the quantities $b_{\frac{1}{2}}^{(1)}$, $b_{\frac{1}{2}}^{(2)}$, &c. *Méc. Cél.* vol. i. p. 267, should rather be $b_{\frac{1}{2},1}$, $b_{\frac{1}{2},2}$, &c, and $\mathrm{A}^{(i)}$, A_i.

(8.) The value of any variable u corresponding to a particular value n of any variable t may be called u_n; but if u_n be used to denote this value of u, and x be any other variable also depending upon t, x_n should represent the value of x which corresponds to $t = n$.

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M. Cauchy (*Mémoire sur la Théorie des Ondes*) designates generally the co-ordinates of a fluid molecule by x, y, z; its velocities in the direction of the co-ordinate axes by u, v, w, at the time t; the initial values of u, v, w, or those which correspond to $t = o$, by u_o, v_o, w_o, and the initial values of x, y, z by a, b, c. Symmetry requires that the initial values of x, y, z should be denoted by x_o, y_o, z_o.

(9.) If u_1, u_2 . . . . . u_n be any particular values of the variable u, u represents the same quantity *generally*.

(10.) Numeral or literal indices are generally preferable as indices of order to dashes ($'$), but either to a combination of both, as when a^0, a, a' are used to denote three consecutive values of the quantity a, which notation is used by M. Legendre, *Nouvelles Méthodes pour la Détermination des Orbites des Comètes*. The acute accent ($'$) may be conveniently used to denote apparent; so, if α be the *true* right ascension of a star, α' may be its *apparent* right ascension. This notation is used by Professor Bessel, in *Encke's Ephemeris for* 1830; by Lagrange, *Mémoires sur les Eclipses sujettes aux Parallaxes;* by Professor Littrow; and by M. Schubert. M. Biot, on the contrary, uses Δ' for the *true* polar distance of a star, and Δ for its *apparent* polar distance, in his *Astronomy*, vol. i. p. 255. Other prosodiacal marks may be used in other cases; so $\bar{x}$, $\bar{y}$, $\bar{z}$, are frequently used to denote the co-ordinates of the centre of gravity of an assemblage M of particles (m), of which the co-ordinates are x, y, z. Clairaut uses the marks $\breve{}$ and $\grave{}$ in his *Lunar Theory*.

(11.) Symbols should not be multiplied unnecessarily. Thus, if r denote any quantity, its reciprocal should be called $\frac{1}{r}$, and not u; if δ be used to denote declination, polar distance should be $90^0 - \delta$; and if ζ be used to denote zenith distance, altitude should be $90^0 - \zeta$. If the inclination of the orbit to the ecliptic be called ι, the tangent of the inclination should be called $\tan \iota$, and not γ; if the latitude be called β, the tangent of the latitude should be called $\tan \beta$, and not s; nor is it necessary to have a symbol μ for $\cos \theta$.

I shall now exhibit synoptically the notation employed by some of the most distinguished astronomers for a few of the quantities which recur frequently. The construction of this and similar tables would

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be much facilitated if authors were consistent in their notation, and if they gave an index to the symbols they employ, the meaning of which is now sometimes only to be inferred from the context. The symbols in the table are extracted from the following works:

Mathematical Tracts, by Professor Airy.
Astronomical Tables and Formulæ, by Mr. Baily.
Fundamenta Astronomiæ, by Professor Bessel.
Traité Elémentaire d'Astronomie Physique, by Biot.
Astronomie Théorique et Pratique, by Delambre.
Astronomie Pratique, by Francœur.
Theoria Motûs Corporum Cœlestium, by Gauss.
Mécanique Analytique,
Mémoire sur les Eclipses sujettes aux Parallaxes, } by Lagrange.
Traité de Mécanique Céleste, by Laplace.
Theoretische und Practische Astronomie, by Professor Littrow.
Traité de Mécanique,
Mémoire sur les Inégalités Séculaires, } by Poisson.
Théorie Analytique du Système du Monde, by Pontécoulant.
Traité de Géodosie, by Puissant.
Traité d'Astronomie Théorique, by Professor Schubert.
Treatise on Dynamics, by Professor Whewell.
Treatise on Astronomy, by Woodhouse.

The first column contains the letters which I think it would be most desirable to adopt. I hope the time will soon arrive when each letter used as a mathematical symbol will generally have a conventional meaning; this is already the case with some marks, as $+$, $-$, $\times$, π, Æ, t, &c.

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		Airy.	Baily.	Bessel.	Biot.	Delambre.	Francœur.	Gauss.	Lagrange.	Laplace.	Littrow.	Poisson.	Pontécoulant.	Puissant.	Schubert.	Whewell.
Right ascension	α		Æ	α	α	Æ	Æ	α		ψ	α			Æ	α	
Declination	δ		D	δ	d	D	D	δ		v	δ			D	δ	
Azimuth	η		A		A		A								a	
Zenith distance	ζ		Z	Z	Z		Z				Z			N		
Hour angle	θ		P		P	P	P				s			P	γ	
Terrestrial latitude	φ	l	φ	φ	L	H	l		ϕ	ψ	ϕ		ψ		β	
Longitude of a star	λ		L		l	L	l	λ	a		λ			L	λ	
Latitude of a star	β		λ		λ	λ	λ	β		v				λ	β	
Longitude of a planet (heliocentric)*	λ				l	v	l	l		v	v	v	v			v
Latitude of a planet (heliocentric)	β				λ			l								
Longitude of a planet (geocentric)	λ				l			l		α			a		α	
Latitude of a planet (geocentric)	β				λ			l		β			b		β	
Eccentric anomaly	v		x		u	x		E	θ	u	u	u	u		u	u
Radius vector	r	r			r	V		r	r	r		r	r	r		r
Distance of a planet from the earth	r				r					ϱ			ϱ		ϱ	
Velocity	v									v	v	v	v		v	v
Time	t	t	t	t	t	t	t	t	t	t	t	t	t	t	t	t
Mean motion	nt									nt			nt			
Semi-major axis, or mean distance	a	a			a	a			a	a	a	a	a	a	a	a
Eccentricity	e	e	e		e	e	e	e	e	e	e	e	e	e	γ	e
Longitude of the perihelion	ϖ	B			ϖ	π		π	χ	ϖ	π	ω	ω	ϖ	ϖ	α
Longitude of the epoch	ε	β								ε	ε	ε	ε		ε	
Longitude of the node	ν	γ	Ω		N	Ω		Ω	h	I	k		C		J	
Inclination of the orbit to the ecliptic	ι					I		i	i	ϕ	φ					
Periodic time	T	T			T	T				T	T	T	T		$\odot$	
$\frac{r^2 d\lambda}{dt}$	h								D	h	B	h	k			h
Mass of primary + mass of secondary	μ	μ							g	μ			μ		μ	μ
Density	ϱ	ϱ			ϱ				Γ	ϱ	ϱ	ϱ	ϱ		δ	
Refraction	r		r	ϱ	r	r	r				ϱ				x	
Obliquity of the ecliptic	ω	I	ω		ω	ω	ω	ε	ω	θ	e	θ	θ	ω	ε	
Length of the pendulum	p	p	p		l			r	r	l						
Force of gravity	g				g				g		g	g	g	g	g	g
Ratio of circumference to diameter	π	π	π	π	π	π	π	π	π	π	π	π	π	π	π	π

* In cases where the heliocentric or geocentric longitude and latitude both occur, they can be distinguished by some convenient i

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I shall now present a few details which could not be conveniently inserted in the table.

Professor Encke uses the letters α, δ, λ, β, and ε, for right ascension, declination, longitude, latitude, and the obliquity of the ecliptic, in the *Berlin Ephemeris* for 1831.

Mr. Gompertz, in a paper on the aberration of light, in the 1st volume of the *Transactions of the Astronomical Society*, denotes the same quantities by the letters a, d, l, λ, and ω.

Mr. Herschel, in the introduction to the tables of precession, aberration, and nutation, in the same volume, denotes right ascension and declination by α and δ, the latitude of the place by L, and the obliquity of the ecliptic by ω.

Professor Schwerdt, No. 19 of the *Astronomische Nachrichten*, denotes the hour angle of a star by P, the polar distance by Δ, the zenith distance by Z, the co-latitude of the place by D, the azimuth of the star by A, and the angle at the star by S.

Professor Dirksen, in No. 23 of the same work, denotes the polar distance of a star by Δ, the altitude by h, the hour angle by t, and the latitude of the place by φ.

Professor Tettel, in No. 7 of the same work, denotes eccentricity by e, the longitude of the perihelion by ϖ, the radius vector by Δ, the obliquity of the ecliptic by ε, and the latitude of the place by φ.

I have suggested the letters α, δ, ζ, λ, and ω, conformably to § (2) and (3) in this notation.

$$\sin\beta = \cos\omega\cos\delta - \sin\omega\cos\delta\sin\alpha$$
$$\sin\delta = \cos\omega\sin\beta + \sin\omega\cos\beta\sin\lambda$$
$$\cos\beta\cos\lambda = \cos\delta\cos\alpha$$
$$\cos\beta\sin\lambda = \sin\omega\sin\delta + \cos\omega\cos\delta\sin\alpha$$
$$\cos\zeta = \cos\theta\cos\phi\cos\delta + \sin\phi\sin\delta$$

if Δ is the distance of the centre of the moon from a star (,)

$$\cos\Delta = \sin\zeta\sin\zeta_{,}\cos(\eta - \eta_{,}) + \cos\zeta\cos\zeta_{,}$$

In Woodhouse's *Trigonometry*, and in other works, A, B, C are used to denote the angles, and a, b, c the sides of a spherical triangle; so, if P be used to denote the hour angle of a star, p may denote its zenith distance. If, in the triangle ZPS, P denote the hour angle, by analogy, 180° − azimuth is Z, the angle at the star is S, the co-declination is z, and the co-latitude of the place s.

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The use of v for the longitude of a planet cannot, I think, be reconciled to any principle in notation: and as this letter is almost always used to denote velocity, I propose that λ be used in preference. u has been generally used to denote eccentric anomaly: in conformity to § (2), I have taken the Greek letter υ, which slight alteration can hardly, I think, be objected to.

Density should rather, perhaps, be denoted by δ, but the use of this letter for declination appears to be well established; and these quantities, declination and density, occur in the same equation in the theory of the tides.

M. Challis uses δ for density, and so, also, does M. Cauchy, in the *Mémoire sur la Théorie des Ondes;* but, in the *Exercices de Mathématiques*, 1828, p. 160, he uses the letter ϱ.

M. Damoiseau, in his *Lunar Theory*, has generally adhered to the notation of the *Mécanique Céleste;* but, at page 569, he uses R for the number of seconds in the sidereal revolution of the moon where Laplace uses T, and ζ for the space which the attraction of the earth would cause a body to describe in 1 second, for which Laplace uses ε.

Laplace uses the letter R to denote the quantity

$$m\left\{\frac{xx_{,}+yy_{,}+zz_{,}}{\sqrt{(x_{,}^2+y_{,}^2+z_{,}^2)^3}}-\frac{1}{\{(x-x_{,})^2+(y-y_{,})^2+(z-z_{,})^2\}^{\frac{1}{2}}}\right\}$$

M. de Pontécoulant uses $-\mathrm{R}$ to denote this quantity: a change of this kind makes great danger of confusion.

The letters a, b, c are frequently used to denote the cosines of the angles which a straight line makes with each of the co-ordinate axes; sometimes the letters α, β, γ are used in this signification, as by M. Poisson, *Mémoires de l'Académie*, 1830, by M. Cauchy in the *Exercices de Mathématiques*, and by Professor Hamilton, *Theory of Systems of Rays*, *Trans. Irish Acad.*

In forming the table, I have generally taken from each author, when several letters are used to denote the same quantity, that which appears to me preferable; it is impossible to point out the numerous inconsistencies which present themselves in mathematical works; but I shall be happy if this short paper induces attention to a subject which appears to me to have been too much neglected.

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XXIII. *On Barlow's New Telescopes. By J. J. Littrow.*

Read June 11, 1830.

Some time ago, Mr. Baily gave, in Professor Schumacher's *Astron. Nachr.* No. 127, an account of the great improvements which Mr. Barlow has made in the object-glasses for telescopes, filled with a fluid, a method which had been originally invented by Blair. By filling the second lens of the double object-glass with the well-known sulphuret of carbon, Mr. Barlow has contrived to diminish the length of the telescope, and at the same time to increase the magnifying power and the light, and thus to obtain two very essential advantages. His success is principally to be ascribed to the very great dispersive power of this fluid, which renders it possible to place the two object-glasses, which are, in the present construction, almost in contact, at a considerable distance from each other; and at the same time to make the second lens, that usually made of flint-glass, and now filled with sulphuret of carbon, much smaller than the other.

One of the principal obstacles that has hitherto stood in the way of improvement in our telescopes is, the small difference, in general, both of the refractive and the dispersive powers respectively belonging to the two sorts of glass, which, for want of better, are necessarily chosen for double object-glasses. Retaining the symbols used in my paper (*Mem. Ast. Soc.*, vol. iii. part ii. page 235) without change, and putting, for brevity, $P = \frac{n' - 1}{n - 1} \cdot \frac{dn}{dn'}$, we obtain, (see p. 243), for the length (L) of the telescope, this abbreviated expression, $L = \frac{1}{1 - P}$, where the thickness of the lens has been assumed = 0. The quantity P is, for all known diaphanous substances, a proper fraction, and, for crown and flint-glass, is contained between the two narrow limits of 0·5 and 0·7. The preceding equation shews, however, that the length of a telescope diminishes when P becomes smaller; but the quantity P cannot considerably decrease, unless the quantities n, n', dn, dn', undergo more considerable changes than those

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which take place for the two sorts of glass hitherto in use. It is therefore evident, that, in general, there are four ways of diminishing the length of a telescope, without injury to its other qualities: either, 1st, the refractive power (n) of crown-glass must be increased; or, 2nd, that of flint-glass (n') must be diminished; or, 3rd, the dispersive power dn of crown-glass must be diminished; or, 4th, lastly, that of flint-glass dn' must be increased. Whoever invents a new sort of glass, fulfilling any one of these conditions, will render a great service to practical optics, which would be still greater if this same glass should, at the same time, happen to fulfil two of the four conditions here enumerated. Mr. Barlow has invented, indeed, no new sort of glass; but he has pointed out a fluid fulfilling the fourth condition: for, according to Mr. Baily's account, "the index of this fluid is nearly the same as that of the best flint-glass, with a *dispersive power more than double*." In order to shew what influence the increase of the dispersive power* dn' of the second lens will have on the shortening of the telescope, let us assume, for the crown-glass, $n = 1{\cdot}53$, and for flint-glass, $n' = 1{\cdot}58$. For the dispersive power of the crown-glass we will assume $dn = 1$, and for that of the flint-glass we will successively assume $dn' = \frac{10}{9}, \frac{10}{8}, \frac{10}{7}, \frac{10}{6}, \frac{10}{5}$, and $\frac{10}{4}$. If we now take the focal length of the first lens of crown-glass, which was the unity assumed in the above equation, at two feet, that equation will give

Dispersive power of the flint-glass.	Length of the telescope.
$dn' = \frac{10}{9} = 1{\cdot}11$	132 feet.
$\frac{10}{8} = 1{\cdot}25$	16·05
$\frac{10}{7} = 1{\cdot}43$	8·54
$\frac{10}{6} = 1{\cdot}67$	5·82
$\frac{10}{5} = 2{\cdot}00$	4·42

* The reader will observe that the author does not affix to the phrase "dispersive power" the same meaning that optical writers in general do: what is ordinarily meant by the dispersive power of a medium is the fraction $\frac{dn}{n-1}$.

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Dispersive power of the flint-glass.		Length of the telescope.
$dn' = \frac{10}{4} = 2{\cdot}50$	.....	3·55 feet.
$\frac{10}{3} = 3{\cdot}33$	.....	2·98
$\frac{10}{2} = 5{\cdot}00$	.....	2·56 &c.

With a glass, therefore, for which $\frac{dn'}{dn} = \frac{10}{9}$, a telescope could not be made achromatic without being 132 feet long, while, by means of glass for which $\frac{dn'}{dn} = \frac{10}{4}$, it might be made achromatic with a length of $3\frac{1}{2}$ feet only. For $\frac{dn'}{dn} = \frac{100}{91} = 1{\cdot}099$, the length would even amount to 477 feet, &c. From this it becomes evident how important Mr. Barlow's invention is, and how desirable it is that the path which he has pointed out should be pursued with zeal and attention.

Not being a practical optician myself, I was at least desirous of becoming as fully acquainted with the theory of these new telescopes as my time and skill would permit; and I now beg to communicate what I have found, in the hope of doing thereby an agreeable service to artists. Indeed, for those object-glasses in which the two lenses are at a considerable distance from one another, the four curvatures of the two lenses must be most accurately determined and executed, in order to attain the best possible effect, as the smallest deviation from the curvature ascertained by theory, especially in the case of the second lens, is of the most injurious consequences; and, therefore, theory can much less be dispensed with for these telescopes than for those hitherto in common use.

I shall again apply the same indirect method which I have used in the paper above referred to (p. 248), because this method alone gives results strictly exact. As, however, the determination of the curvatures of the second lens is reduced, as is well known, to the resolution of a quadratic equation, so that, in fact, two solutions always exist; and as, besides, in our particular case, the two roots of the quadratic equation are near each other, the indirect method would be inconvenient, unless approximate values of the two last radii, r' and ϱ', had been previously obtained. It will, therefore, be necessary, in the first place, to give a simple approximate solution of the

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problem, and then to shew how, by a convenient indirect method, we can gradually approximate to the truth as closely as may be required.

Direct approximate Solution.

I designate, as before, the radii of the first lens, whose faces I assume equal, by r and ϱ; and as in my former paper, I assume $r = \varrho$, (p. 247.) Let the radii of the curvatures of the second lens be r' and ϱ', and the thickness of the first lens be d, that of the second $= d'$, and the distance of the centres of both $= \Delta$. If one of the faces of a lens becomes concave, its radius is negative. Again, we will assume the focal distance of the first lens as the unit of all dimensions, and $P = \frac{n'-1}{n-1} \cdot \frac{dn}{dn'}$. I shall not give the demonstration of the expressions which follow, because they would occupy too much space, and because they may be easily found by those readers who are acquainted with the subject; but I shall endeavour to give to them the form most convenient for actual calculation. The following direct approximate solution is, with the exception of some slight alterations which are here necessary, analogous to the one given by Euler, in his *Optics*, and will, therefore, the less require a demonstration for those who are acquainted with that celebrated work. This solution, however, requires a table of the six quantities, μ, ν, φ, σ, τ, ϑ, which Euler, indeed, has already given, but which, for the fluids or glasses here supposed, requires to be further extended. It is given at the end of this paper, and has been constructed from the following formulæ:—

$$\mu = \frac{n.(4n-1)}{8(n-1)^2(n+2)}, \qquad \nu = \frac{4(n-1)^2}{4n-1}$$

$$\varphi = \frac{4+n-2n^2}{2.(n+1)(n+2)} \qquad \sigma = \frac{n.(2n+1)}{2(n-1)(n+2)}$$

$$\tau = \frac{n.\sqrt{4n-1}}{2.(n-1)(n+2)} \qquad \sqrt{\vartheta - 1} = \frac{4(n^2-1)}{2n\sqrt{4n-1}}$$

The solution of our problem is now founded on the following expressions. In the first place, the two equal radii of the first lens are $r = \varrho = 2(n-1)$. Next, let the quantities p', a', and α' be found by these equations:—

$$p' = -\frac{(1-\Delta)^2}{P} \qquad a' = -(1-\Delta) \qquad \alpha' = \frac{(1-\Delta)^2}{1-P-\Delta}$$

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Taking from the table the values of μ, ϑ, for the first sort of glass, and those of μ', ν', for the second sort of glass, we then obtain the quantity ϑ' by this equation :

$$\vartheta' = -\frac{\mu\vartheta p'^3}{\mu' a'^4} - \frac{\nu' p'^2}{a\alpha'};$$

and hence immediately the two radii r' and ϱ' of the second lens by the equations

$$\frac{1}{r'} = \frac{\varphi'}{a'} + \frac{\sigma'}{\alpha'} \pm \frac{\tau'\sqrt{\vartheta'-1}}{p'} \quad \text{and} \quad \frac{1}{\varrho'} = \frac{\phi'}{\alpha'} + \frac{\sigma'}{a'} \pm \frac{\tau'\sqrt{\vartheta'-1}}{p'}$$

This solution, it will be seen, is very simple and convenient for calculation. In order to explain it by an example, let $n = 1{\cdot}53$, $n' = 1{\cdot}58$, $dn = 0{\cdot}006$, $dn' = 0{\cdot}036$; consequently, $\lambda = \frac{dn}{dn'} = \frac{1}{6}$, and the table will give

$\mu = 0{\cdot}9875$	$\vartheta = 1{\cdot}6001$
$\mu' = 0{\cdot}8724$	$\phi' = 0{\cdot}1414$
$\nu' = 0{\cdot}2529$	$\sigma' = 1{\cdot}5827$
	$\tau' = 0{\cdot}8775$

If we now assume, for example, $\Delta = 0{\cdot}63522$, in parts of the focal distance of the first lens, we have

$p' = -0{\cdot}73133$	$\alpha' = +0{\cdot}72787$
$a' = -0{\cdot}3648$	$\vartheta' = 40{\cdot}509$

Consequently, for determining r' and ϱ',

$$\frac{1}{r'} = -5{\cdot}75604 \text{ or } +9{\cdot}32956$$
$$\frac{1}{\varrho'} = +3{\cdot}39816 \text{ or } -11{\cdot}68744$$

We obtain, consequently, these values for the telescope,

$$\varrho = r = 2(n-1) = 1{\cdot}06$$

$$\left.\begin{matrix} r' = -0{\cdot}17378 \\ \varrho' = +0{\cdot}29427 \end{matrix}\right\} \text{ or } \left\{\begin{matrix} r' = +0{\cdot}10719 \\ \varrho' = -0{\cdot}08556 \end{matrix}\right.$$

where, for the second lens, the negative value of the radius indicates a concave surface of the lens.

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Let us assume, as a second example, $n = 1{\cdot}8$, $n' = 1{\cdot}3$, and $\lambda = \frac{dn}{dn'} = 0{\cdot}2$, and $\Delta = 0{\cdot}8$. These assumed values will give, by the preceding equations,

$$p' = -0{\cdot}53333 \qquad \alpha' = \ 0{\cdot}32000$$
$$a' = -0{\cdot}20000 \qquad \mathfrak{Y}' = 47{\cdot}69445$$

In like manner we have

$$r = \varrho = 2(n-1) = 1{\cdot}60$$

$$\left.\begin{aligned} r' &= -0{\cdot}06801 \\ \varrho' &= +1{\cdot}18304 \end{aligned}\right\} \text{ or, } \left\{\begin{aligned} r' &= +0{\cdot}05056 \\ \varrho' &= -0{\cdot}03842 \end{aligned}\right.$$

It is evidently very easy to find the dimensions of the lenses for any value of Δ. But the values of the radii thus found are only approximations to the truth; and we shall soon see what corrections they will still require.

Indirect accurate Solution.

We shall again follow the same path by which we proceeded in the place above referred to, (p. 248.) But as we now have to take into account the thickness d, of the first lens, (the thickness d' of the second lens may always be assumed $= 0$), and likewise the distance of the two lenses, which, in our case, may be very considerable, the process here alluded to must be, in some respects, modified. A little attention will shew that the whole problem is reduced to the following expressions.

With the given or known values of n, n', $\lambda = \frac{dn}{dn'}$, d, and Δ, we find, in the first place, the distance B′ of the point in which the mean central rays unite after the fourth refraction, by this expression

$$\frac{1}{B'} = \frac{1}{1-\Delta} - \frac{(n'-1)\lambda}{(n-1)(1-\Delta)^2}$$

$$+ \frac{n.(n-1)^2(1-\Delta) - (n'-1)[(n-1)^2\Delta + n^2 - 1]\lambda}{n^2 r^2 (1-\Delta)^3} \cdot d \quad \ldots\ldots\ldots\ldots \quad (1)$$

Next we have to deduce, from the first angle of incidence a, the quantities α, (A), x, b, β, and (B), (see p. 248), by means of these equations:

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$$\sin \alpha = \frac{1}{n} \sin a$$

$$(A) = a - \alpha$$

$$x = \frac{r \cdot \sin \alpha}{\sin (A)} + 2r - d$$

$$\sin b = \frac{x}{r} \sin (A)$$

$$\sin \beta = n \sin b$$

$$(B) = (A) + \beta - b$$

This is the first part of the calculation; and it is clear that it is independent of any previous hypothesis.

From the approximate value of r', found by the preceding direct solution, we now derive the value of ϱ' by this equation:

$$-\frac{1}{\varrho'} = \frac{1}{r'} + \frac{\lambda}{(n-1)(1-\Delta)^2} + \left\{ \frac{(n-1)^2 \Delta + n^2 - 1}{n^2 r^2 (1-\Delta)^3} \right\} \cdot \lambda d$$

The values of r' and ϱ' thus found will now give the quantities y, a', α', (A'), z, b', β', (B'), and B', by means of the following equations:

$$y = \frac{r \cdot \sin \beta}{\sin (B)} - r' - (r + \Delta) \qquad \sin a' = -\frac{y}{r'} \sin (B)$$

$$(A') = (B) + \alpha' - a' \qquad z = -\frac{r' \sin \alpha'}{\sin (A')} + (r' + \varrho')$$

$$\sin b' = -\frac{z \sin (A')}{\varrho'} \qquad \sin \beta' = n' \sin b'$$

$$(B') = (A') + b' - \beta' \qquad B' = -\frac{\varrho' \sin \beta'}{\sin (B')} - \varrho'$$

If this last value of B' agrees with the one found above from Equation (1), the calculation is finished; but if it differs considerably from it, the second part of the calculation is to be repeated, with a value of r' somewhat different from the former, until the true values of r' and ϱ' are found by the process explained in my former paper (p. 245).

We will now apply these formulæ to the first of the above given examples,

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in which we had $n = 1{\cdot}53, n = 1{\cdot}58$, $\lambda = \frac{1}{6}$, $\Delta = 0{\cdot}6352202$. If we assume d and $d' = 0$, and the first angle of incidence $a = 10^0$, we have, by the preceding equations,

From Equation (1) ..... $B' = 0{\cdot}7295597$

$\alpha = 6^\circ\ 31'\ 0'',7$	$(A) = 3^\circ\ 28'\ 59'',3$
$r = \varrho = 2(n-1) = 1{\cdot}06$	$b = 13\ 35\ 30\ ,9$
$\beta = 21^\circ\ 4'\ 22'',9$	$(B) = 10\ 57\ 51\ ,3$

Let now, as a first hypothesis, $r' = -0{\cdot}17$; we shall have $\frac{1}{\varrho'} = -2{\cdot}36326 - \frac{1}{r'}$, or $\varrho' = +0{\cdot}2842$, and with this value we obtain

$a' = 32^\circ\ 22'\ 40''$	$\alpha' = 19^\circ\ 48'\ 40''$
$(A') = -\ 1\ 36\ 40$	$b' = -11\ 2\ 30$
$\beta' = -17\ 36\ 50$	$(B') = 4\ 58\ 10$

$B' = 0{\cdot}70853$

But we had $B' = 0{\cdot}72956$

Difference $= -0{\cdot}02103$

In the same manner, as a second hypothesis, $r' = -0{\cdot}165$ gives $\varrho' = +0{\cdot}2704638$, and

$a' = 33^\circ\ 5'\ 33'',16$	$\alpha' = 20^\circ\ 12'\ 58'',67$
$(A') = -\ 1\ 54\ 43\ ,19$	$b' = -11\ 24\ 31\ ,40$
$\beta' = -18\ 12\ 43\ ,30$	$(B') = 4\ 53\ 28\ ,71$

and $B' = 0{\cdot}7208979$

But we had $B' = 0{\cdot}7295597$

Difference $-0{\cdot}0086618$

In this manner we shall find at last $r' = 0{\cdot}16188$ and $\varrho' = +0{\cdot}2621811$. It appears, then, that these last values of r' and ϱ', found by an accurate solution, differ considerably from those found above by a direct but only approximate solution.

In order to investigate whether these values of r' and ϱ' thus found do really bring together, after the fourth refraction, the mean central rays, and those incident near the edge of the glass under an angle of incidence $= 10^0$, we deduce, agreeably to the process explained in section iv. (p. 239), from the quantities $r = \varrho = 1{\cdot}06$, $r' = -0{\cdot}16188$, $\varrho' = +0{\cdot}2621811$, the following values:

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$\alpha' =$ 33° 33′ 46″,01	$a' =$ 20° 28′ 53″,47
$(A') =$ − 2 7 1 ,24	$b' =$ −11 38 55 ,62
$\beta' =$ −18 36 13 ,39	$(B') =$ 4 50 16 ,53

consequently, $B' = 0{\cdot}7295645$ for extreme rays.
$B' = 0{\cdot}7295597$ for central rays.

Difference..... 0·0000048

The spherical aberration is, consequently, perfectly remedied.

But the most important advantage of this construction is the diminished length of the telescope with the great aperture, which is very different from the construction hitherto used.

The preceding numbers refer to the focal distance of the first lens of crown-glass as unity; and we have, therefore, for the length of the telescope $L = B' + \Delta = 1{\cdot}36476$.

Diameter of aperture of first lens ..... $2x = 2L \tan (B') = 0{\cdot}16928\ L$
——————— second lens.... $2x' = 2(1 - \Delta)x = 0{\cdot}06175\ L$

If, for example, the length of the telescope $L = 2$ feet $= 24$ inches, we have $2x = 4{\cdot}062$ inches, and $2x' = 1{\cdot}482$ inches.

For $L = 4$ feet, we have $2x = 8{\cdot}12$, and $2x' = 2{\cdot}96$; so that a telescope of 4 feet, with these object-glasses, admits even of 8·12 inches aperture. Another advantage of this construction is, that the second lens is so small; in this case, only the third part of the first. Should it, therefore, be possible to obtain only small pieces of the flint-glass here required of proper purity, they will be sufficient even for larger telescopes; while the construction hitherto used required lenses of flint-glass as large as those of crown-glass, which created great difficulties, as the addition of lead was apt to cause striæ and veins, and it was, therefore, not so easy to obtain larger pieces of pure flint-glass. The second lens might be made still much smaller, by assuming a greater value of Δ.

Lastly, if we assume, as is usual, the length of the telescope L as the unity of all dimensions, we shall have to divide the preceding numbers by $L = 1{\cdot}36476$, and thus obtain

$$r = \varrho = 0{\cdot}7766935$$

$r' =$ −0·118614	$\varrho' =$ +0·192108
$2x =$ 0·16928	$2x' =$ 0·06175

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Let us now find the accurate solution of the second example above given. We have $n = 1{\cdot}8$, $n' = 1{\cdot}3$, $\lambda = 0{\cdot}2$, $\Delta = 0{\cdot}8$. If we assume, again, $d = d' = 0$, and the first angle of incidence $a = 3^0$, we find

$$r = \varrho = 1{\cdot}60$$

$\alpha = 1^\circ\,39'\,58'',11$	$(A) = 1^\circ\,20'\,1'',89$
$b = 4\ 20\ 15\ ,08$	$\beta = 7\ 49\ 27\ ,77$

$$(B) = 4^\circ\,49'\,14'',58$$

We may now assume, agreeably to the preceding direct solution, as a first hypothesis, $r' = +0{\cdot}05056$, and shall then find $\varrho' = -0{\cdot}0384198$, from which we further deduce

$a' = -13^\circ\,35'\,17'',97$	$\alpha' = -10^\circ\,24'\,43'',41$
$(A') = 7\ 59\ 49\ ,14$	$b' = 16\ 22\ 2\ ,97$
$\beta' = 21\ 29\ 23\ ,43$	$(B) = 2\ 52\ 28\ ,68$

$B' = 0{\cdot}3187116$ for rays near the edge.
$B' = 0{\cdot}3200000$ for the central rays.

Difference $-0{\cdot}0012884$

In like manner, $r' = +0{\cdot}049555$ will make $\varrho' = -0{\cdot}0378364$, and hence

$B' = 0{\cdot}3201470$ for rays near the edge.
$B' = 0{\cdot}3200000$ for the central rays.

Difference $+0{\cdot}0001470$

These two hypotheses combined will now give $r' = +0{\cdot}04965$, and $\varrho' = -0{\cdot}0378973$. If we do not carry on the approximation any further, we deduce, for the investigation of the telescope, from the last values of r' and ϱ', (conformably to p. 239, sect. iv.)

$a' = -13^\circ\,56'\ 0'',20$	$\alpha' = -10^\circ\,40'\,27'',49$
$(A') = 8\ 4\ 47\ ,29$	$b' = 16\ 38\ 11\ ,01$
$\beta' = 21\ 51\ 1\ ,83$	$(B') = 2\ 51\ 56\ ,47$

$B' = 0{\cdot}3199821$ for rays near the edge.
$B' = 0{\cdot}3200000$ for central rays.

Difference $-0{\cdot}0000179$

The spherical aberration of the lenses has, therefore, been sufficiently done away.

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The length of this second telescope is $L = \Delta + B'$, or $L = 1{\cdot}12$, in parts of the focal distance of the first lens. The diameter of the aperture of the first lens is $2x = 2L \tan(B') = 0{\cdot}1002\ L$, and that of the second lens $2x' = (1 - \Delta) \cdot 2x = 0{\cdot}0200\ L$. The aperture of the second lens is, consequently, only the fifth part of that of the first. For a telescope of 5 feet in length, the diameter of the aperture of the first lens is 6 inches, and that of the second only 1·2 inches.

From what precedes, it is sufficiently clear how much these telescopes, already so much improved by Mr. Barlow, are entitled to our attention, and of what consequence it would be to obtain even smaller pieces of pure glass, which would fulfil one, or, what would be still better, several of the above-mentioned conditions. If chemists and manufacturers of glass were properly applied to for the fabrication of such kinds of glass, we might perhaps most reasonably expect, from such a quarter, the greatest improvements in practical optics. Euler believed, in the beginning, that the two sorts of glass known by the names of crown and flint-glass differed too little from one another, both as to refractive and dispersive power, to found the achromatism of telescopes upon that difference; and, in analogy to the construction of the human eye, he was always for using fluids and glasses, because these two classes of bodies present greater differences in their refractive and dispersive powers respectively. When at last Dollond had exhibited his first achromatic telescope to the Royal Society in London, and when every body admired its excellence, Euler, even then, could not persuade himself that Dollond had produced this effect by the extremely small difference of the dispersive powers of the two sorts of glass; and he attributed the great success of Dollond, which he could no more call in question, to a fortunate combination of the curvatures. Even in the *Mémoires de l'Académie de Berlin* of 1762, (consequently five years after Dollond's first achromatic telescope), Euler maintained the singular opinion, that Dollond, favoured by similar fortunate circumstances, might have produced the same effect, even if all his lenses had been constructed from the same sort of glass, as all kinds of glass hitherto known differed too little from each other, in regard to their dispersive powers, to give rise to such great and important successes. It was not until the year 1764, when Euler received a letter from M. Zicher, Professor of Chemistry in Peters-

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burgh, in which he informed him, that, by the mere addition of lead, he had obtained pieces of glass having a dispersive power four times as great as the other kinds of glass, that Euler renounced his former opinions; and thenceforward, believing in the practical superiority of Dollond, the great theorist published those numerous and excellent memoirs in which he has succeeded in carrying the theory of these instruments to such a high degree of improvement. If we reflect, that the smallness of the difference of the two sorts of glass, with regard to their refractive and dispersive powers, had nearly rendered impossible the construction of achromatic telescopes; and that it was only owing to the perseverance of Dollond, who, in spite of Euler's contrary opinion, continued his experiments, that effects which had been considered as unattainable were actually realised,—we should certainly not be deterred by similar impediments from endeavouring to make another step in advance. Dollond had already the two kinds of glass which we now have, and our only endeavour has been to obtain similar glass, in large pieces, of great purity; so that, in fact, nothing new has been attempted since Dollond's time. But would it not be possible to manufacture other kinds of glass, having, for instance, the same dispersive power as sulphuret of carbon? From practical trials and experiments only can an answer to this question be derived; and as an affirmative answer would hold out the greatest improvements in practical optics, it becomes highly desirable that persons possessed of the means of instituting such inquiries should be induced to devote their attention to this highly-important object.

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TABLE.

n	μ	ν	ϕ	σ	τ	ϑ	n	μ	ν	ϕ	σ	τ	ϑ
1·30	2·2978	0·0857	0·9697	2·3636	1·3456	1·2683							
1·31	2·1827	0 0907	0·9150	2·3108	1·3144	1·2819	1·56	0·9151	0·2393	0·1737	1·6119	0·8956	1·6447
1·32	2·0773	0·0957	0·8637	2·2613	1·2852	1·2956	1·57	0·8932	0·2461	0·1573	1·5970	0·8864	1·6595
1·33	1·9805	0·1008	0·8155	2·2138	1·2578	1·3092	1·58	0·8724	0·2529	0·1414	1·5827	0·8775	1·6744
1·34	1·8914	0·1061	0·7700	2·1712	1·2320	1·3234	1·59	0·8525	0·2597	0·1259	1·5689	0·8689	1·6895
1·35	1·8093	0·1114	0·7271	2·1301	1·2076	1·3374	1·60	0·8333	0·2666	0·1111	1·5555	0·8607	1·7041
1·36	1·7333	0·1168	0·6865	2·0912	1·1846	1·3515	1·61	0·8127	0·2736	0·0967	1·5426	0·8526	1·7190
1·37	1·6629	0·1222	0·6481	2·0546	1·1628	1·3658	1·62	0·7974	0·2805	0·0827	1·5302	0·8448	1·7340
1·38	1·5975	0·1278	0·6116	2·0199	1·1421	1·3801	1·63	0·7806	0·2876	0·0691	1·5182	0·8373	1·7488
1·39	1·5334	0·1340	0·5771	1·9871	1·1225	1·3945	1·64	0·7644	0·2946	0·0562	1·5065	0·8300	1·7633
1·40	1·4758	0·1395	0·5441	1·9559	1·1039	1·4089	1·65	0·7455	0·3017	0·0432	1·4952	0·8229	1·7783
1·41	1·4267	0·1449	0·5121	1·9263	1·0887	1·4218	1·66	0·7405	0·3089	0·0308	1·4843	0·8160	1·7931
1·42	1·3769	0·1508	0·4829	1·8981	1·0693	1·4379	1·67	0·7197	0·3161	0·0187	1·4738	0·8094	1·8080
1·43	1·3303	0·1567	0·4543	1·8721	1·0532	1·4530	1·68	0·7059	0·3233	0·0070	1·4636	0·8028	1·8231
1·44	1·2865	0·1627	0·4271	1·8457	1·0378	1·4671	1·69	0·6926	0·3306	−0·0044	1·4536	0·7965	1·8377
1·45	1·2453	0·1687	0·4009	1·8213	1·0231	1·4819	1·70	0·6798	0·3379	−0·0154	1·4440	0·7904	1·8523
1·46	1·2065	0·1749	0·3760	1·7979	1·0091	1·4964	1·71	0·6674	0·3452	−0·0262	1·4347	0·7844	1·8672
1·47	1·1708	0·1810	0·3520	1·7756	0·9956	1·5106	1·72	0·6555	0·3526	−0·0366	1·4256	0·7786	1·8817
1·48	1·1352	0·1873	0·3290	1·7543	0·9823	1·5263	1·73	0·6440	0·3600	−0·0470	1·4168	0·7741	1·8939
1·49	1·1025	0·1936	0·3069	1·7339	0·9702	1·5408	1·74	0·6332	0·3675	−0·0569	1·4091	0·7674	1·9123
1·50	1·0714	0·2000	0·2858	1·7143	0·9583	1·5555	1·75	0·6222	0·3750	−0·0667	1·4000	0·7620	1·9262
1·51	1·0420	0·2065	0·2653	1·6956	0·9468	1·5705	1·76	0·6118	0·3825	−0·0761	1·3919	0·7568	1·9407
1·52	1·0140	0·2129	0·2456	1·6776	0·9358	1·5854	1·77	0·6018	0·3900	−0·0854	1·3841	0·7518	1·9552
1·53	0·9875	0·2194	0·2267	1·6601	0·9252	1·6001	1·78	0·5921	0·3976	−0·0944	1·3764	0·7467	1·9700
1·54	0·9622	0·2260	0·2083	1·6434	0·9149	1·6151	1·79	0·5827	0·4052	−0·1032	1·3691	0·7419	1·9844
1·55	0·9381	0·2326	0·1908	1·6274	0·9051	1·6299	1·80	0·5736	0·4129	−0·1118	1·3618	0·7372	1·9990

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XXIV. *On the Use of the Equatorial.* By M. KREIL.

Read June 11, 1830.

THE following remarks may serve as a continuation and practical application of the memoir on the equatorial by Professor LITTROW, in the *Mem. Ast. Soc.* Vol. II. Part I. p. 45. The observations here adduced were made with the instrument which was added last year to our observatory: its circles are 2·1 feet in diameter, and the telescope has a focal length of 2·6 feet, and an aperture of 2·4 inches.

If we denote the inclination of the circle of declination to the polar axis of the instrument by μ, and the inclination of the optical axis of the telescope to the plane of the circle of declination by ν, it will be seen, that if the first power only of these errors is taken into account, the preceding value of p will remain unchanged; while the value of s is to be increased, for the first error, by the quantity $\mu \cot p$, and for the second error, as in the case of the transit, by the quantity $\frac{\nu}{\sin p}$; so that the complete expressions, having due regard to all the six errors of the instrument, are as follow:

$$\left.\begin{aligned} s &= \sigma + \Delta\sigma + \lambda \sin(\varphi - s) \cot p + \mu \cot p + \nu \operatorname{cosec} p \\ p &= \pi + \Delta\pi + \lambda \cos(\varphi - s) \end{aligned}\right\} \text{IV.}$$

For determining the quantity ν, we have, for a star near the equator, (see KREIL's memoir in the *Annals of the Observatory of Vienna*, Vol. X.)

$$s = \sigma + \Delta\sigma + \nu \operatorname{cosec} p$$

and, if again observed near the meridian, and in a reversed position of the circle of declination,

$$s' = \sigma' + \Delta\sigma - \nu \operatorname{cosec} p$$

The difference of the two expressions gives

$$\nu = \frac{(s - \sigma) - (s' - \sigma')}{2} \sin p$$

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But t, t', being the sidereal times of the observations, and α the right ascension of the star, we have $s = t - \alpha$, and $s' = t' - \alpha$; consequently, also,

$$\nu = \frac{(t - \sigma) - (t' - \sigma')}{2} \sin p$$

This simple expression may be used without regard to refraction, or correction of the clock, and even without reduction to the meridian, provided the star be sufficiently near to the equator. It is even unnecessary that the position of the star should be known, as p is given with sufficient nearness by the instrument itself. Thus, on the 24th August I found

	Circle West.				Circle East.		
Time of the clock	17^h	42^m	$56^s,25$	....	17^h	48^m	$58^s,49$
σ	$178°$	$30'$	$50''$	....	$0°$	$1'$	$24''$
π	89	17	48				

Hence $\nu = +0'',75$ (in arc.)

In the same manner was found, on the 27th August,

	Circle West.				Circle East.		
Time of the clock	19^h	9^m	$59^s,28$	....	19^h	14^m	$36^s,02$
σ	$182°$	$4'$	$53''$	....	$2°$	$59'$	$5''$
π	90	30	36				

Hence $\nu = +0'',45$ (in arc.)

For determining the quantity μ, we obtain, by the first of the equations (IV.), if the same star is made to pass through the field of the telescope twice in quick succession, and in reversed positions of the circle,

$$s = \sigma + \Delta\sigma + \lambda \operatorname{cotan} p \sin(\varphi - s) + \mu \operatorname{cotan} p + \nu \operatorname{cosec} p$$
$$s' = \sigma' + \Delta\sigma + \lambda \,.\, \operatorname{cotan} p \,.\, \sin(\varphi - s) - \mu \,.\, \operatorname{cotan} p - \nu \operatorname{cosec} p$$

whence we derive

$$\mu \operatorname{cotan} p + \nu \operatorname{cosec} p = \frac{(s - s') - (\sigma - \sigma')}{2} = \frac{(t - t') - (\sigma - \sigma')}{2} \text{ let } = m$$

where t, t', are, as before, the times of the clock at the two observations. The value of m being thus known, and likewise (by I.) that of ν, we have

$$\mu = \frac{m \sin p - \nu}{\cos p}$$

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It is evident that, for determining μ, a star near the pole should be selected.

The following observations of the pole-star have been calculated on the supposition of $\nu = 0'',75$, and the polar distance of *Polaris* $= 1^{\circ}\ 36'\ 14''$.

	Circle.	Time of the Clock.	σ	Combination of Observations.	μ
		h m s	° ′ ″		″
I.	West	12 30 15,0	172 2 18	I. and II.	+1,86
II.	East	12 34 20,5	353 6 36		
III.	East	12 36 14,5	353 35 19	III. and IV.	+1,12
IV.	West	12 39 44,0	174 24 39		
V.	West	12 41 21,5	174 49 56	V. and VI.	+1,55
VI.	East	12 43 44,3	355 28 26		

As soon as μ and ν are known, it will be possible to determine the quantities λ and φ more accurately. Putting, for the first observation of a star, the quantity $\mu \operatorname{cotan} p + \nu \operatorname{cosec} p = n$, and for the second observation of the same star, $\mu \operatorname{cotan} p' + \nu \operatorname{cosec} p' = n'$, we obtain

$$\tan\left[\varphi - \tfrac{1}{2}(s' + s)\right] = \frac{-\Pi}{\Sigma} \cot p$$

$$\lambda = \frac{\frac{1}{2}\Pi}{\sin\left[\varphi - \frac{1}{2}(s' + s)\right] \sin\frac{s' - s}{2}} = \frac{-\frac{1}{2}\Sigma}{\cos\left[\varphi - \frac{1}{2}(s' + s)\right] \sin\left(\frac{s' - s}{2}\right)}$$

where

$$\Sigma = (s' - s) - (\sigma' - \sigma) - (n' - n)$$
$$\Pi = (p' - p) - (\pi' - \pi)$$

The quantities φ, λ, μ, and ν, being known, every single observation of a star will give directly the values of the two last errors, $\Delta\sigma$ and $\Delta\pi$, by means of the equations (IV.)

These quantities may likewise be determined directly in the following manner: If a star be observed before its culmination, in the hour angle $360 - \sigma$, and after its culmination, without reversing the declination circle, in the hour angle σ', where σ' is supposed nearly equal $360 - \sigma$, the first of the equations (IV.) will give the following expressions:

$$360 - s = 360 - \sigma + \Delta\sigma + \lambda \operatorname{cotan} p \sin\left[\varphi - (360 - s)\right] + \mu \operatorname{cotan} p + \nu \operatorname{cosec} p$$
$$s' = \sigma' + \Delta\sigma + \lambda \operatorname{cotan} p \sin(\varphi - s) - \mu \operatorname{cotan} p - \nu \operatorname{cosec} p$$

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The sum of these expressions gives

$$s' - s = \sigma' - \sigma + 2\Delta\sigma + \lambda \operatorname{cotan} p \left(\sin(\varphi + s) + \sin(\varphi - s)\right)$$

whence

$$\Delta\sigma = \frac{(s' - s) - (\sigma' - \sigma)}{2} - \lambda \operatorname{cotan} p \sin\varphi \,.\, \cos s$$

or, t' and t being the sidereal times, or times of the clock, corresponding to the observations,

$$\Delta\sigma = \frac{(t' - t) - (\sigma' - \sigma)}{2} - \lambda \operatorname{cotan} p \,.\, \sin\varphi \cos s$$

For a star near the equator, or likewise for a star observed on both sides of the meridian in hour angles nearly equal $\pm$ 90°, this equation assumes the following more simple form:

$$\Delta\sigma = \frac{(t' - t) - (\sigma' - \sigma)}{2}$$

In like manner, if the same star, or if two different stars in the hour angles 360 − s and s, have been so observed, that $\Delta\pi$ does not change its sign in the two observations, the second of the equations (IV.) gives these expressions:

$$p = \pi + \Delta\pi + \lambda \cos(\varphi + s)$$
$$p' = \pi' + \Delta\pi + \lambda \cos(\varphi - s)$$

whence we derive immediately

$$\Delta\pi = \frac{(p + p') - (\pi + \pi')}{2} - \lambda \cos\varphi \,.\, \cos s$$

If, therefore, s be sufficiently near 90°, we have

$$\Delta\pi = \frac{(p + p') - (\pi + \pi')}{2}$$

The quantity $\Delta\pi$ changing its sign, if the same star be observed twice in immediate succession, and in reversed positions of the circle, we have likewise

$$p = \pi + \Delta\pi + \lambda \cos(\varphi - s)$$
$$p = \pi' - \Delta\pi + \lambda \cos(\varphi - s)$$

hence

$$\Delta\pi = \frac{\pi' - \pi}{2}$$

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EXAMPLE. *α Canis minoris.*

	Sidereal time.				σ				Pos. of circle.
I.	7^h	21^m	$21^s,19$	.....	357°	21′	48″	.....	East.
II.	7	24	37,48	.....	178	10	50	.....	West.
III.	7	44	13,18	.....	183	4	39	.....	West.
IV.	7	46	58,30	.....	3	45	56	.....	East.

We obtain, by combining,

I. and III. ..... $\Delta\sigma = 0^s,30$ (in time)
II. and IV. ..... $\Delta\sigma = 0^s,24$

δ Ursæ minoris.

	Sidereal time				π				Pos. of circle.
I.	18^h	15^m	12^s	.....	176°	34′	54″	.....	West.
II.	18	19	21	.....	3	25	18	.....	East.
III.	18	22	59	.....	176	34	52	.....	West.
IV.	18	25	57	.....	3	25	20	.....	East.

Hence we obtain, by combining,

I. and II. ..... $\Delta\pi = 6″,0$
II. and III. ..... $\Delta\pi = 5″,0$
III. and IV. ..... $\Delta\pi = 6″,0$

We shall now shew, by an example, how the observations made with this instrument, for the purpose of determining the position of an unknown star from that of a known one, are to be calculated. With this view we select the following observations, made at Vienna on the 24th August, 1829.

	α Coronæ bor.				*2α Capricorni.*			
Sidereal time of obs.	$t = 17^h$	7^m	$27^s,49$	.....	$t' = 18^h$	36^m	$30^s,90$	
Read off	$\sigma = 24°$	59	34″,0	.....	$\sigma' = 336°$	59′	4″,0	
Read off	$\pi = 62$	41	0,0	.....	$\pi = 103$	1	16,0	

From previous determinations, we had found $\varphi = 291° 36′$, $\lambda = 9″,9$, $\mu = 1″,51$, and $\nu = 0″,75$. The apparent positions of these stars, the first of which we assume as known, and the second as unknown, are

Apparent right ascension	A = 15^h	27^m	$28^s,30$	....	A′ = 20^h	8^m	$36^s,99$
Apparent polar distance	P = 62°	42′	4″,34	....	P′ = 103°	3′	48″,39

For calculating the refraction, we have, for *α Coronæ*, by the abbreviated formulæ, $s = t - \text{Æ} = 24° 59′$, $\psi = 39° 1′$, $d\sigma = +20″,56$, $d\pi = +25″,00$.

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For 2α *Capricorni*, the accurate expressions give $s = 336^\circ\ 58'$, $\psi = 39^\circ\ 26'$, $w = 16^\circ\ 46'$, $z = 64^\circ\ 41'$; and the barometer being 27·40 inches (Paris), interior therm. $+14^\circ,0$, and exterior therm. $+14^\circ,0$ Reaumur, the refraction $r = 115'',8$, and hence $d\sigma' = -34'',30$, and $d\pi' = +110'',91$. We have, therefore,

σ free from refraction....	24°	59′	54″,56	.... σ' =	336°	58′	29″,70
$\lambda \sin(\varphi - s) - \text{cotan}\, p$ ..			−5 ,10	....			+1 ,63
μ cotan p			+0 ,75	....			−0 ,35
ν cosec p			+0 ,84	....			+0 ,77
s =	24	59	51 ,08	.... s' =	336	58	31 ,75
				s =	24	59	51 ,08
				$s' - s$ =	311	58	40 ,67
					20h	47m	54s,71

$= (t'-t) - (A'-A)$

We had $t' - t$ =	1	29	3 ,41
consequently, $A' - A$ =	4	41	8 ,70
A being given =	15	27	28 ,30
We obtain A′ which was required =	20	8	37 ,00 too great by $0^s,01$

In like manner, we have, for the polar distance,

π (corrected for refraction) =	62°	41′	25″,00	.... π' =	103°	3′	6″,91
$\lambda \cos(\varphi - s)$			−0 ,59	....			+6 ,96
p =	62	41	24 ,41	.... p' =	103	3	13 ,87
				p =	62	41	24 ,41
				$p' - p$ =	40	21	49 ,46 = P′ − P
				Given P =	62	42	4 ,34 = P
				P′ which was required =	103	3	53 ,80 too great by 5″,41

On the same day, the following observations were made:

α Herculis.				*2α Capricorni.*			
t =	17h	12m	1s,83 ..... t' =	18h	36m	30s,90
σ =	1°	17′	8″,0 ..... σ' =	336°	59′	4″,0
π =	75	22	56 ,0 ..... π' =	103	1	16 ,0

The refractions are, for α *Herculis*, $d\sigma = +1'',06$, $d\pi = +37'',89$; and for 2α *Capricorni*, as before, $d\sigma' = -34'',30$, and $d\pi' = +110'',91$. We have, therefore, after making the corrections for refraction,

σ =	1°	17′	9″,06 ..... σ' =	336°	58′	29″,70
π =	75	23	33 ,89 ..... π' =	103	3	6 ,91

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and, consequently, for right ascension we have

$\sigma' - \sigma =$	335°	41′	20″,64	
I. corrected for λ			+ 4 ,05	
II. ..... μ			− 0 ,70	
III. ..... ν			0 ,00	
$s' - s =$	335	41	23 ,95	$= (t' - t) - (A' - A)$
in time =	22h	22m	45s,59	
$t' - t =$	1	24	29 ,07	
$A' - A =$	3	1	43 ,48	
Given A =	17	6	53 ,39	
A′ (required)	20	8	36 ,87	too small by 0s,12

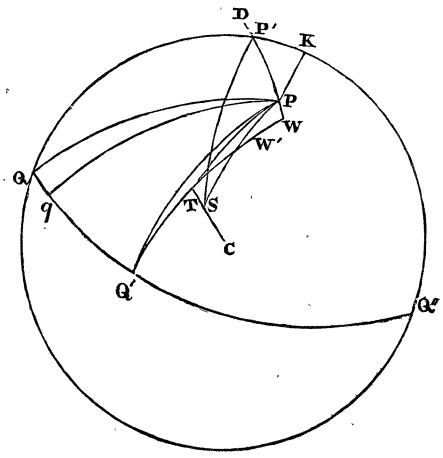
and, in like manner, we have, for the polar distance,

$\pi' - \pi =$	27°	39′	33″,02	
corr. for λ			+3 ,52	
P′ − P =	27	39	36 ,54	
Given P =	75	24	14 ,08	
P′ (required) =	103	3	50 ,62	too great by 2″,23

R. KREIL.

Addition to M. Kreil's Paper on the Use of the Equatorial. By Benjamin Gompertz, Esq. F.R.S. Member of the Society. (Read Nov. 12, 1830.)

As the reason for adopting the formulæ in the paper of the ingenious Professor Kreil may not appear evident to every reader, I offer, in consequence of the paper having been committed to me, the following explanation.



In a sphere referred to the heavens, described about the eye of the observer C as a centre, let P be the pole of the instrument, P′ the pole of the earth's diurnal motion, WQ′ the circle of declination of the instrument, conceived not to pass exactly through the pole of the instrument; S the place of the star, QQ′Q″ the equatorial circle of the instrument, conceived to be ac-

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curately perpendicular to the polar axis of the instrument, cutting the true meridian of the place QP′ in Q, and the circle of declination of the instrument in Q′; CS the line of collimation of the telescope. Draw the great circle ST a perpendicular to WQ′ cutting it in T, and let PW be a great circle described about Q′ as a pole cutting the circle of declination of the instrument in W; and the angles PWQ′, WPQ′ will be right angles. Produce the great circle PP′ indefinitely to D. Let W′ be a fixed point in the circle of declination of the instrument, from whence the division of the limb commences, and q a fixed point in the equatorial circle of the instrument, marking the zero of that circle; then, according to the notation of the paper $PP' = \lambda$, $\angle QP'P = \varphi$, $W'T = \pi$, WW' which is supposed small $= \Delta\pi$, $\angle\, q\, PQ' = \sigma$, $PS' = p$, $\angle QP'S = s$, $ST = \nu$, $PW = \mu$ a small quantity $= \angle PQ'W$; $\angle TPS =$ nearly ST . cosec of $PT = \nu$. cosec of π nearly, because ST is supposed small, and the $\angle STP$ nearly a right $\angle$; $\angle TPQ'$ = nearly $\frac{\text{sin of } QT}{\text{sin of } PT} \times \mu$, that is, because Q′T is the complement of PT very nearly, $\angle TPQ' = \mu$. cos of PT nearly $= \mu$. cot of π nearly; $\because \angle SPD = \angle DPq + \sigma + \nu$. cosec of $\pi + \mu$. cot of π. Moreover, in the spherical triangle SPP′ we have cos of $\frac{SP + SP'}{2}$: cos of $\frac{SP - SP'}{2}$: : cot of $\frac{\angle SPP' + \angle SP'P}{2}$ or tan of $\frac{\angle SP'D - \angle SPD}{2}$: tan of $\frac{PSP'}{2}$; and therefore, because PSP′ is small, and also because $\angle SP'D - \angle SPD$ is small, we have $\angle SP'D - \angle SPD$ = PSP′ × cos of SP nearly, as S′P differs but little from SP; and therefore, because $PSP' = PP' \times \frac{\text{sin of } SP'P}{\text{sin of } SP}$ nearly, $\angle SP'D - \angle SPD = PP'$ × sin of SPP′ × cot of SP; but $\angle SP'D = \angle DP'Q + s$; consequently $s = \angle SPD - \angle DP'Q + PP' \times$ sin of SPP′ . cot of SP = from above (by writing for the sin of SPP′ its near equal sin of $(\varphi - s)$, and for this its near equal sin of $\overline{\varphi - \sigma}$, $s = \sigma + \angle DPq - \angle DP'Q + \nu$. cosec of $\pi + \mu$. cot of $\pi + \lambda$. cot of π . sin of $\overline{\varphi - \sigma}$; where $\angle DPq - DP'Q$, or its equal $\angle QPq + \angle QPD - \angle QP'D$, is a constant quantity, and appears to be the quantity denoted in the paper by $\Delta\sigma$, this may be called the index error of the divisions of the equatorial circle, and is compounded of two distinct parts, the one the $\angle QPq$, common to the instrument in all positions of the polar axis, and the other $\angle QP'D - \angle QPD$, which varies as the positions of the polar axis of the instrument may vary in fixing the instrument, and is nothing if the polar axis of the instrument coincides with the axis of the

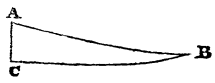
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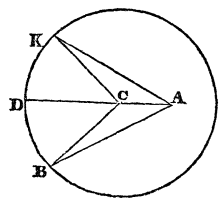
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world. Note.—We might, with the same degree of approximation, use ν . cos of p, and λ . cotan of p . sin of $\overline{\varphi - s}$, instead of ν . cos of π, and λ . cos of $\pi \times$ sin of $\overline{\varphi - \sigma}$, and then the formula would agree with the text; but the formula as I put it seems to be that which is required.

Moreover, PS is nearly equal to PT, nearly equal to $WT = \pi + \Delta\pi$; therefore, in the spherical triangle PSP′ having $PP' = \lambda$, a small quantity, we have $P'S - PS = PP' \times$ cos of SP′P, nearly $= \lambda$. cos of $\overline{\varphi - s}$; $\because p = \pi + \Delta\pi + \lambda$. cos of $\overline{\varphi - s}$; or $\pi + \Delta\pi + \lambda$ cos of $\overline{\varphi - \sigma}$ nearly. In these approximations small quantities of the second order are omitted.

Besides the errors enumerated above, the equatorial circle, which is there supposed to be accurately perpendicular to the polar axis of the instrument, may not be so fixed; and the axis of motion, which is intended to carry the telescope round the declination circle of the instrument, may not be accurately perpendicular to that circle, the consequence of which would be, that though the equatorial and declination circles may be both accurately divided, they will not accurately measure the angles indicated by the divisions; thus, if AB be the equatorial circle of the instrument, and BC the great circle which is perpendicular to the polar axis, AC a portion of the circle of declination intercepted between them, the divisions will indicate the arc AB, and the real arc required will be BC, and the error AB − BC, when the ∠ B is very small, is nearly $\frac{B^2}{4} \times$ sin of 2 AB; this, if only the first powers of all small quantities be required, may be neglected, and the same may be said with respect to the error, from a similar cause, in the declination circle; but besides these, each circle may have an error arising from eccentricity in the divisions; that is, arising from centre of the circle of the division not being the centre of motion.





Thus, if C be the centre of the divided circle BDK, and A the centre of the motion of the nonius AK, AB; K the zero point, and KAB be the angle to be measured, the angle KCB will be the angle read off, and the error will be ∠ KCB − ∠ KAB, or ∠ KCA + ∠ ABC; that is, nearly $\frac{AC}{AK} \times$ (sin of KD + sin of DB). These considerations will cause other quantities in the equation of corrections,

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and we shall now have $s = \sigma + \Delta'\sigma + \nu \cdot \cos \text{of} \pi + \mu \cdot \cot \text{of} \pi + \lambda \cdot \cot \text{of} \pi \cdot \sin \text{of} \overline{\varphi - \sigma} + \varepsilon' \cdot \sin \text{of} \overline{2\sigma - f} + \sin \text{of} \overline{\sigma - \alpha}$, and $p = \pi + \Delta'\pi - \lambda \cdot \cos \text{of} \overline{\varphi - \sigma} + \mu \cdot \sin \text{of} \overline{2\pi - h} + \tau \cdot \sin \text{of} \overline{\pi - \beta}$; where, in addition to the letters already defined, we have ε for $\frac{1}{4}$ square of the arc of inclination (to radius unity), of the circle which is perpendicular to the polar axis of the instrument to the equatorial circle of the instrument; K for $\frac{1}{4}$ the square of the arc of inclination (to the radius unity) of the circle which the telescope describes, when the declination circle is fixed, to the declination circle of the instrument; and I observe that the quantities of which ε and K are co-efficients may be omitted when the said inclinations are not of a greater order of smallness than the other small quantities ν, μ, &c.; but that it is, notwithstanding, till that point be ascertained, worth retaining them; $\frac{1}{2}f$, $\frac{1}{2}h$, constant quantities to be found, and are respectively the values of σ and π, when the said corrections vanish; or, in other words, they are respectively the values of σ and π at the points where the circles above named intersect; ϱ and τ the eccentricities to the radius unity of the divisions of the equatorial circle and declination circle of the instrument respectively; α and β are constant quantities to be found, the values respectively of σ and π, when the noniuses of the respective circles pass through the centres of the said circle; and lastly, the quantities $\Delta'\sigma$ and $\Delta'\pi$, which may be called compound index errors, are respectively $= \Delta\sigma + \varrho \cdot \sin \text{of} \alpha$, and $\Delta\pi + \tau \sin \text{of} \beta$.

B. G.

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XXV. *On the Method of determining the Declination of two Stars with one Mural Circle, by means of the sum and difference of their Altitudes.* By J. Pond, Esq. Astronomer Royal.

Read December 10, 1830.

In a former paper which I had the honour of presenting to this Society, I endeavoured to explain the peculiar mode of observation which I had been led to adopt with the two mural circles.

It must be evident to every one, that few astronomers will be sufficiently fortunate to have the means of employing a method which nothing but the powers of such a government as ours could enable them to adopt.

The use of single mural circles is, however, extending; and this circumstance may induce me, at some future period, to explain more fully than I have hitherto done the various systems of observation with a single instrument, with the advantages and disadvantages peculiar to each of them.

The single mural circle, without the aid of reflected observations, is, by my method of differences, a most powerful instrument. When circumstances permit recourse to be had to reflected observations, an objection has, I believe, been made to our manner of conducting them, that the instrument must be supposed to be invariable between the direct observation one day, and the corresponding reflected observation on the following, or perhaps many days after.

The intention of this communication is to shew that this invariability is by no means essential, but that steadiness, for an extremely short interval of time only, is requisite.

The process I recommend consists in determining the sum and difference of the altitudes of two stars; a method with which I have long been familiar, and have often ascertained its exactness; but I have not alluded to it in the Greenwich observations, because each of our instruments remains in general sufficiently steady not to stand in need of it.

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To illustrate this subject in a few words, and by the most simple case imaginable, let it be required to determine the altitudes of *Castor* and *Pollux*. Let the two stars be observed by direct vision on the same night. The following night, or as early as is practicable, let the one star be observed by direct vision, and the other by reflection. The first observation gives the *difference* of their altitudes; the second the *sum* of them. We have now all the data requisite for determining the respective altitudes of the two stars. In the interval between the observations, the instrument may have changed its index error by any quantity; but whatever be its magnitude, it is not of the least importance to investigate this; nor is the length of the interval between the observations of any consequence, since the equations which are applied are those which are due to the respective moments of observation. It is almost unnecessary to remark, that, in repeating the experiment, the process may be varied by obtaining the difference of the altitudes by reflected observations, and the sum by reversing the stars. It ought to be noticed, that none of the divisions which enter into the first determination can possibly occur in the second; so that the determination is as practically perfect as can be obtained by this instrument: moreover, it requires neither the investigation of index error nor of horizontal points.

An Example to elucidate the above Method.

Date.	Stars' Names.	Observed N.P.D. by Troughton's Circle.	Refraction.	Correction.	N.P.D. corrected for Equations.
1830. Mar. 27	Castor	57° 44′ 25″,8	+19″,98	−6″,62	57° 44′ 39″,16
	Pollux	61 33 45,3	+24,42	−8,01	61 34 1,71
			Diff. = Diff. of altitude =		3 49 22,55
29	Castor	57 44 24,0	+19,66	−6,53	57 44 37,13
	Pollux, R.	195 28 33,0	−24,04	+7,92	195 28 16,88
				Diff. = Sum of altitudes =	137 43 39,75
				Sum + Diff. =	141 33 2,30
				Altitude of Castor = $\frac{\text{Sum + Diff.}}{2}$ =	70 46 31,15
				Sum − Diff. =	133 54 17,20
				Altitude of Pollux = $\frac{\text{Sum − Diff.}}{2}$ =	66 57 8,60

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If we subtract the altitude of each star here obtained from the supplement of latitude, 128° 31′ 21″, we shall have their respective mean N.P.D. for the commencement of 1830, which we can compare with their N.P.D. as given in the catalogue of 720 stars lately published.

		Seconds by Cat.	Diff.
Castor, N.P.D.	= 128° 31′ 21″ − 70° 46′ 31″,15 = 57° 44′ 49″,85	49″,00	+0″,85
Pollux ———	= 128 31 21 − 66 57 8,60 = 61 34 12,40	13,20	−0,80

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XXVI. *Note on the Orbit of the Comet of* HALLEY. *By Mr.* LUBBOCK.

Read January 14, 1831.

I HAD last year the honour of presenting to the Astronomical Society a paper upon the determination of the orbit of a comet, taking as an example the comet of HALLEY, which is expected to return in 1835. I then gave elements of the orbit of this comet, which satisfied, within the probable limits of their errors, all the observations made by MESSIER in 1759. But the results of M. DAMOISEAU's calculations of the perturbations, contained in the twenty-fourth volume of the *Memoirs of the Academy of Turin*, were then unknown to me; and I have since found that the change in the major axis due to the action of the planets *Jupiter* and *Saturn* (calculated by M. DAMOISEAU) was so great as sensibly to affect the values of the other elements. The elements, therefore, which I gave, p. 42, being rendered useless from this circumstance, I have now obtained others from the same observations of MESSIER, adopting the value of the semimajor axis (18·0763) given by M. DE PONTÉCOULANT, *Théorie Analytique du Système du Monde*, vol. ii. p. 142, instead of that I made use of before. I consider these elements to be more accurate than any which have yet been given of this remarkable comet. I will not say that they are unsusceptible of further improvement; but I do not think that the advantage which remains to be gained is commensurate to the immense labour the attempt will require.

The semiaxis major being equal to	18·0763	
Eccentricity	·9676	
Perihelion passage, 1759, March, $13^h,333$, or	$3^h\ 19^m\ 24^s$	Mean time from midnight at Paris.
Inclination	17° 36′	
Longitude of ascending node	53 45	Referred to the mean equinox, 1759.
Longitude of the perihelion	303 3 20	Referred to the mean equinox, 1759.

The following Table shews how nearly these elements satisfy MESSIER's observations; and, with the *data* I have given, any of the calculated places can be easily verified.

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Mean Time at Paris from midnight.	Observed by Messier.		Calculated.		Eccentric Anomaly.	Time from perihelion passage.	Longitude of the sun.	Log. of sun's distance.
1759.	Longitude.	Latitude.	Longitude	Latitude.				
Jan. 22 19 0 0	353° 5′ 47″	4° 36′ 38″	353° 5′ 7″	4° 39′ 48″	14° 42′ 58″	h −1184,33	302° 34′ 58″	9·9931547
25 19 0 0	351 53 19	4 51 3	351 51 45	4 52 43	14 6 14	1112,33	305 37 52	9·9934390
28 18 30 0	350 46 31	5 3 50	350 43 9	5 5 8	13 28 12	1040,83	308 38 32	9·9935971
Feb. 4 18 40 0	348 18 2	5 31 16	348 14 42	5 32 13	11 51 54	− 872,66	315 45 32	9·9940981
April 2 4 36 36	326 55 26	4 3 32	326 56 34	4 5 20	7 20 22	+ 481,33	12 7 11	0·0003886
17 4 0 0	317 39 20	5 56 26	317 45 20	5 48 51	11 32 22	840,67	26 48 35	0·0021513
May 1 22 0 0	172 22 16	31 22 34	172 23 0	31 20 9	14 48 8	1194,67	41 9 7	0·0038021
18 10 0 0	157 52 30	15 54 44	157 50 45	15 52 32	17 46 7	1590,67	57 4 0	0·0053859
June 3 22 0 0	157 36 22	13 5 21	157 39 9	13 1 50	20 15 4	+1986,67	72 53 17	0·0064878

The observation of the 17th April is that which differs most from the calculated place.

Adding to these elements the *perturbations* given by M. de Pontécoulant, in the work before referred to, the elements which result for 1835 are as follow:

The semimajor axis	17·98355	
Eccentricity	·967348	
Perihelion passage, 1835, Oct. 31 ..	$4^h\ 47^m$	Mean time from midnight at Paris.
Inclination	17° 42′ 50″	
Longitude of ascending node	55 3 59	
Longitude of the perihelion	304 23 39	

This comet is one of those which approach near to the orbit of the earth. When in one of its nodes, it may be at a distance from the earth equal to a twentieth of the distance of the sun; but its mass is so small, that were it to come very much nearer, it would afford no just cause of alarm.

I have obtained these elements partly by repeated trials, and partly by means of the following equations, in which the logarithms of the co-efficients are given instead of the co-efficients themselves:

$$\left.\begin{aligned} \delta\lambda &= 6{\cdot}78997\,\delta e + {\cdot}06695\,\delta t + 9{\cdot}76061\,\delta\pi \\ \delta\beta &= 9{\cdot}41251\,\delta\nu + 9{\cdot}34390\,\delta\nu \end{aligned}\right\}\ \text{Jan. 22.}$$

$$\delta\lambda = 6{\cdot}58981\,\delta e + {\cdot}30578\,\delta t + 9{\cdot}27589\,\delta\pi \quad \text{April 2.}$$

$$\left.\begin{aligned} \delta\lambda &= -7{\cdot}64559\,\delta e - {\cdot}87467\,\delta t + {\cdot}61922\,\delta\pi \\ \delta\beta &= {\cdot}22985\,\delta\nu + {\cdot}89977\,\delta\nu \end{aligned}\right\}\ \text{May 1.}$$

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In which $\delta\lambda$ is the error of geocentric longitude
$\delta\beta$ ..... geocentric latitude
$\delta\pi$ ..... longitude of the perihelion
$\delta\nu$ ..... longitude of ascending node
$\delta\iota$ ..... inclination
} expressed in minutes of space.
δt ..... time of perihelion passage, expressed in hours.
δe ..... eccentricity.

The equations given above were obtained in the usual way, by finding the error $\delta\lambda'$ due to a hypothetical error of one of the elements $\delta e'$, and supposing that

$$\delta\lambda = \frac{\delta\lambda'}{\delta e'}\delta e + \frac{\delta\lambda'}{\delta t'}\delta t + \frac{\delta\lambda'}{\delta\pi'}\delta\pi$$

$$\delta\beta = \frac{\delta\beta'}{\delta\iota'}\delta\iota + \frac{\delta\beta'}{\delta\nu'}\delta\nu$$

In calculating the place of the comet, if t be the time from the perihelion passage, and v the eccentric anomaly, $t = c_1, v - c_2 \sin v$.

c_1 = the periodic time of the comet, expressed in the same unit as t, divided by 360°, expressed in the same unit as v; and since the periodic times of the planets are as the major axis of their orbits to the power of $\frac{3}{2}$,

= the periodic time of the earth, expressed in the same unit as t, divided by 360°, expressed in the same unit as v, multiplied by the semimajor axis of the comet to the power of $\frac{3}{2}$, the mean distance of the earth from the sun being, as usual, assumed for unity.

c_2 = the periodic time of the comet, expressed in the same unit as t, multiplied by the eccentricity, and divided by $2 \times 3{\cdot}14159$.

= the periodic time of the earth, expressed in the same unit as t, multiplied by the eccentricity and by the semiaxis major of the comet to the power of $\frac{3}{2}$, and divided by $2 \times 3{\cdot}14159$.

The periodic time of the earth = 365·2564 days; whence, for 1759, *the time being expressed in hours, and the eccentric anomaly in seconds,*

$$\log. c_1 = 9{\cdot}7158679$$
$$\log. c_2 = 5{\cdot}0159889$$

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For 1835, *the time being expressed in hours, and the eccentric anomaly in seconds,*

$$\log. c_1 = 9{\cdot}7125168$$
$$\log. c_2 = 5{\cdot}0125250$$

It is to be hoped that *ephemerides* of this comet will be given for 1835, calculated upon at least three different hypotheses, with respect to its perihelion passage, in order that astronomers may know the lines in which to sweep for it on different days, and that it may be detected as early as possible.

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XXVII. *Addition to the Note by Mr. Lubbock upon Halley's Comet.*

Read Jan. 14, 1831.

Since this note was written I have met with a very valuable memoir on the subject of this comet, by Mr. O. A. Rosenberger, contained in Nos. 180 and 181 of the *Astronomische Nachrichten.*

The author first obtained (by means of five observations of Messier, namely, on the 25th January, the 2nd February, the 7th April, and the 5th and 18th May, and assuming the semimajor axis given by M. Damoiseau,) the following approximate elements:

Semiaxis major	18·083275
Eccentricity	·96768269
Perihelion passage	March 12·56261
Longitude of ascending node	53° 47′ 56″,84
Distance of perihelion from node..	110 37 8 ,23
Inclination	162 21 51 ,35

Referred to the mean equinox, Jan. 1, 1759.

The author then calculated the effect produced upon the elements by the *perturbations* of all the larger planets, (*Mercury, Venus, Mars, Jupiter, Saturn, Uranus,* and the *Earth,*) for every ten days from the 1st January, 1759, until the end of May, (160 days.)

Having calculated the variations of the elements due to the *perturbations,* the author proceeded, with the proper elements corresponding to each day, to calculate an exact ephemeris of the comet, employing for this purpose Carlini's solar tables, with Professor Bessel's corrections.

The following Table shews the effect of the perturbations, or the variations in the place of the comet, due to the disturbing forces.

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Date.	ΔR.	Dec.
January 22	+ 0″,01	+0″,03
February 5	+ 0,13	+0,04
March 31	+ 0,60	−1,64
April 6	+ 1,20	−2,54
13	+ 2,40	−5,04
16	+ 3,25	−7,71
30	−19,65	+8,68
May 9	− 7,09	+1,83
19	− 5,13	+1,60
June 4	− 4,24	+1,65

The calculated places were then corrected for precession and nutation, and carefully compared with places of the comet deduced from the observations. The positions of the stars with which the comet was compared were taken, when it was possible, from the *Fundamenta Astronomiæ*, or Piazzi's catalogue. When these means were wanting, the *Histoire Céleste* and Bessel's *Zones* were resorted to. Many stars were determined on purpose for the author by Professor Bessel. In reducing the observations, parallax was attended to, and also the influence of refraction, *i. e.* the difference of refraction between the comet and star. The observations were corrected for refraction by means of the expressions given in the third volume of the *Astron. Nachr.* p. 386: it was generally unimportant. Finally, all the observations which could be depended upon of Messier, Maraldi, Cassini, Bradley, Hall, and Darquier, were combined and made use of by the method of least squares. The observations of Bradley which had not been published were communicated to the author by Dr. Rigaud.

The following are the results, to which the author has added a correction for each element corresponding to a slight change in the semiaxis major. It is unfortunate that the semiaxis major given by M. de Pontécoulant, *Théorie Analytique*, ($a = 18{\cdot}0763$),* was not made use of,

* In the value of a, given by M. Damoiseau ($a = 18{\cdot}083275$), the action of the earth appears to be neglected.

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as this must, I think, affect the accuracy of the elements given by M. Rosenberger; for I doubt whether equations such as those he has given for taking into account a change in the semiaxis major can be depended upon, unless the change be extremely small.

Semiaxis major..... $= 18{\cdot}083275 + \Delta a$
Eccentricity ..... $= {\cdot}96767572 + (\Delta a)\ {\cdot}0017766$
Perihelion passage..... March $13{\cdot}07093 + (\Delta a)\ {\cdot}04281$ M. T. from midnight at Paris.
Longitude of the ascending node $= 53^\circ\,47'\,46''{\cdot}88 - (\Delta a)\ 44''{\cdot}29$
Distance of perihelion from node $= 110\ 37\ 29\ {\cdot}55 + (\Delta a)\ 237''{\cdot}61$
Inclination of orbit ..... $= 162\ 21\ 43\ {\cdot}70 - (\Delta a)\ 41''{\cdot}90$

The author concludes by giving a table of the differences between Messier's observations and places of the comet (right ascension and declination), calculated with their elements: these differences are generally less than half a minute of space. It is much to be regretted that M. Rosenberger has not given a table of the corresponding places of the sun, and eccentric anomaly of the comet; for, without the aid of these quantities, the verification of these places of the comet is very laborious, if not impossible. I regret to find that the elements which he has given differ so widely from mine, particularly the eccentricity: and I am unable to account for this circumstance, unless it is owing to my having used Delambre's tables of the sun, while M. Rosenberger used Carlini's. The perturbations and the reductions made by M. Rosenberger of Messier's observations are not, I think, sufficient to account for the differences. With exception, however, of the eccentricity, although the differences are greater than I should have expected, they are of the order of the uncertainty which must exist in the calculation of the perturbations of the elements between 1759 and 1835, and therefore practically of little consequence.

According to M. de Pontécoulant, the semimajor axis of the comet in 1759 = 18·0763.

$$18{\cdot}0763 - 18{\cdot}083275 = \Delta a$$
$$= -{\cdot}006975$$

And hence, according to M. Rosenberger, the elements of the comet for 1759 are

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Eccentricity	= ·96766333	
Perihelion passage.....	March 13·07063	M. T. from midnight.
Longitude of ascending node ..	= 53° 47′ 47″,19	
Distance of perihelion from node	= 110 37 27 ,90	
Inclination.....	= 17 21 44	

With these elements, however, I calculated a place of the comet for May 1st, 1759, and the agreement with Messier's observation on that day was by no means satisfactory. This might arise from my not employing the same tables of the sun as M. Rosenberger.

ERRATA

IN MR. LUBBOCK'S PAPER ON THE DETERMINATION OF THE ORBIT OF A COMET, IN VOL. IV. PART I. OF THE MEMOIRS.

Page 45, line 17, *instead of* $-\frac{\mu t^2}{r^2}$, *read* $-\frac{\mu t^2}{r_2^2}$.

Page 45, line 18, *instead of* $-\frac{\mu t^2}{r^2}$, *read* $-\frac{\mu t^2}{r_2^2}$.

Page 46, line 16, *instead of* $4t\left\{\left\{\lambda_2 \sin(\odot_2-\alpha_3)\ \&c.\right\}\right\}$ *read* $4t\sqrt{\mu}\left\{\left\{\lambda_2 \sin(\odot_2-\alpha_3)\ \&c.\right\}\right\}$

Page 53, lines 9 and 10, *instead of* α_1, α_3, θ_1, θ_3, *read* α_1', α_3', θ_1', θ_3'.

Page 55, Latitude calculated Jan. 22, 19 hours, *instead of* 4° 37′ 58″, *read* 4° 39′ 35″. This error arose from taking SC′ instead of SC, in the Type of Calculation, No. 2.

Type of Calculation, No. 2, calculation of geocentric latitude, *read*

log. tan CSC′ =	9·0234184
log. SC′ =	0·0614300
	9·0848484
log. TC′ =	0·1736567
	8·9111917
nearest log. tan =	8·9110663

4° 39′ 35″ = CTC′ = geocentric latitude.

Type of Calculation, No. 2, *instead of* log. tan = 20° 11′,54, *read* log. tan 20° 11′ 54″.

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XXVIII. *Of the Fluctuations of the Atmosphere near the Earth's Surface; and of their Effects upon the Refraction at very low Altitudes. With an Appendix on the Dip of the Horizon.* By the late Mr. Henry Atkinson. Communicated by Mr. Riddle.

Read Nov. 12, 1830.

1. In the memoir on refraction which I had the honour of laying before the Society some time ago, the investigations respecting the *mean state* of the atmosphere, as it actually exists in nature, were very extensive; and it is hoped that the results were so accurate, that it will not be necessary to resume our inquiries into this department of the subject; but, in the course of these researches, it was clearly shewn that the lower parts of the atmosphere were frequently in very different states from what had been proved to be their mean state, and the effects of these fluctuations were so far inquired into as to shew clearly that the variations of the terrestrial refraction were almost entirely caused by them: it was further shewn to be probable, that both the horizontal refraction and the refraction at very low altitudes were greatly affected by these fluctuations. The inquiries into this part, however, were far from being so extensive as the importance of the subject seems to demand. I therefore propose to resume them in the present paper, and to shew that such fluctuations in the state of the atmosphere near to the surface of the earth produce much more important effects than have hitherto been ascribed to them. In the course of my researches into this department, I hope to be able to demonstrate,

1st. That the fluctuations in the state of the atmosphere near the surface of the earth are fully adequate to account for the very great variations which have been observed in the horizontal refraction, as well as in the refractions at very low altitudes.

2nd. That these fluctuations are not only sufficient to account for all

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the variations in the terrestrial refraction, but even for greater variations than any that have yet been observed.

3rd. That the variations in the dip of the horizon at sea are caused by the fluctuations of the atmosphere, and the former may be calculated when the latter are given.

4th. That, in levelling, these fluctuations change the direction of the line of sight; and therefore every change in the state of the air near the earth's surface requires a corresponding correction to be applied to the apparent level, to reduce it to the true level.

I. *Of the Fluctuations of the Atmosphere.*

2. By referring to Article 39, in my former paper, we shall there find it proved, in the most satisfactory manner, that there are occasionally very great deviations from the mean state of the atmosphere, and that such deviations occur at all seasons of the year. We see that, at some times, it requires a rise of only 60 feet to depress the temperature *one* degree, while at other times it takes 600 or 800 feet to produce the same effect. And again, on other occasions, we find that, instead of turning colder, the air actually turns warmer as we ascend in the lower parts of the atmosphere. Thus it appears, from the observations given in the article referred to, that, on one occasion, the air was warmer, by $4\frac{1}{2}$ degrees, at the height of $230\frac{1}{2}$ feet, than it was near the ground; and, at another time, it was no less than 6 degrees warmer at the height of 684 feet.

3. The changes, however, that are noticed in Article 39 are far from pointing out the extreme limits of such fluctuations: for Dr. Wells, in his *Essay on Dew*, p. 200, says, that "experiments by Mr. Pictet, Mr. Six, and I may add by myself, establish that, in exception to the common rule, the heat of the atmosphere, in clear and calm nights, *increases* with the distance from the earth. Agreeably to Mr. Six's experiments, the atmosphere, at the height of 220 feet, is often, upon such nights, 10 degrees warmer than it is at 7 feet from the ground."

Again, at p. 153, he seems to consider it as an established fact, that the temperature "of the air, 7 feet above the ground," in "clear and calm nights, may be regarded as half a degree warmer than the air at the height of 4 feet." But, below the height of 4 feet, the rate of change in the temperature of

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the air is generally, in clear and calm nights, still more rapid than between the heights of 4 and 7 feet; for, at such times, it is very common to find the air two, or even three or four degrees, warmer at the height of four feet than at one foot above the ground. These are facts that are now so generally known to scientific men, as to render it unnecessary to say more on the subject.

4. The examples just given are sufficient to prove that the deviations from the mean state of the atmosphere are sometimes very great on one side at least; and we shall now shew that they are not less considerable on the other side also.

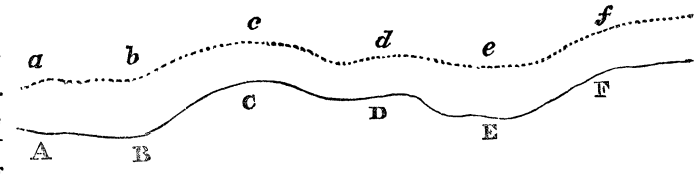
Humboldt relates, that when he was at San Fernando de Apure, he went, provided with thermometers, to the flat shores that border the river Apure, which are covered with white sand. "At two in the afternoon," says he, "I found the sand, wherever it was exposed to the sun, at 52°·5. The instrument, raised 18 inches above the sand, marked 42°·8, and at 6 feet, 38°·7. The temperature of the air, under the shade of a ceiba, was 36°·2. These observations were made during a dead calm. As soon as the wind began to blow, the temperature of the air rose 3°, yet we were not enveloped by a *wind of sand;* but the strata of air had been in contact with a soil more strongly heated, or through which *whirlwinds of sand* had passed." These numbers being centigrade degrees, when reduced to Fahrenheit's scale, we have the temperature of the sand 126°·5; of the air, at $1\frac{1}{2}$ feet from the ground, 109°, and at 6 feet $101^{\circ}\frac{2}{3}$; while the air in the shade was $97^{\circ}\frac{1}{6}$. From this it appears that the change of temperature, between the heights of $1\frac{1}{2}$ and 6 feet, was $7^{\circ}\frac{1}{3}$, or at the rate of 1° for every $7\frac{1}{3}$ inches. This undoubtedly is an extreme case; but it is plain, that, at different times and places, all intermediate degrees will occur. Thus, in the sandy deserts of Egypt, and, during the heats of summer, on the plains of Italy, of France, and of England, similar changes in the temperature of the air near the ground may be observed every year, differing only in degree. But, from whatever cause or causes such changes arise, it is found, from observation, that they are not confined to the heats of summer alone, but occur at all seasons of the year, though seldom to so great an extent as in the above example; and it is further observed, that this deviation from the ordinary rate of *change* of temperature is most rapid near the ground, and seldom continues to any great height: it seems

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probable that it rarely extends higher than a few hundred feet. We are thus fully authorised, by direct observations, to conclude, that in the mean state of the atmosphere, the air turns colder as we ascend, at the rate of 1° for about every 251 feet, at first; but that the deviations from this mean state are occasionally so great, that it sometimes turns 1° colder for every foot of height near the ground, while at other times it actually turns warmer at about the same rate, viz. 1° for every foot; such, and so great, are the *fluctuations* in the lower parts of the atmosphere.

5. Again: it must be particularly noted that this very rapid change in the temperature near the ground is not confined to plains and valleys, but is found, by observation, to take place almost to an equal extent, both on the tops and sides of the hills. For example, suppose A, B, C, D, E, &c. to represent a section through the irregular surface of the ground at any place; then it is found, from experiments which have been made in various situations, that the dotted line *a*, *b*, *c*, *d*, *e*, &c. passing through all the points where the temperature is any given number of degrees, say 5°, different from what it is at the ground at that place, is nearly parallel to the surface of the ground A, B, C, D, E, &c., though not exactly so.



Having thus pointed out the principal fluctuations which the atmosphere is liable to undergo near the ground, it now becomes our business to develope, as far as we are able, the effects which must be produced by such fluctuations.

Of the Effects upon the Horizontal Refraction, and Refractions at very low Altitudes.

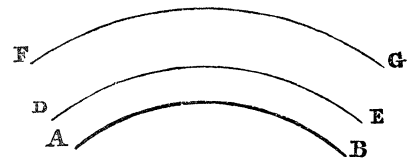
6. Although we have not a sufficient number of observations to enable us to determine with certainty the laws by which the deviations from the mean state of the atmosphere are governed; yet we may fairly conclude, from what we know, that these deviations are greatest near the ground, and that they do not extend to any great height in the atmosphere, probably very seldom above 1000 or 1200 feet, but more commonly not more than 500 or 600 feet. This, however, is a point which we have no means, at present, of ascertaining. All, therefore, that can now be done is to assume

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such different degrees of deviation from the mean state, as we have reason to believe, from observation, occur the most frequently; and after having calculated what the refraction is which corresponds with each different degree of deviation, we may then examine what effect would be produced by supposing a different arrangement in those parts of the atmosphere beyond our reach. An example will illustrate this.

Let AB represent a section of a part of the earth's surface passing through the centre C, extending to the top of the atmosphere, and intersecting the boundary between two parallel strata of the atmosphere in DE and FG, DE being 50, and FG 1125 feet, above the surface of the earth.



C.

It has already been observed, that there is little probability that any of these fluctuations or irregularities, arising from changes on or near the ground, will ever extend much beyond FG. It would hence appear, that there is very little probability that the refraction above this altitude will ever be affected by such changes or fluctuations in any material degree.

7. Again: as DE is only 50 feet high, and as we can almost always command the means of making observations, to this height at least, be the situation what it may, it is plain that we may consider the state of the air up to DE as known. It thus appears, that, above the height of 1125 feet, the atmosphere may, without fear of any error of consequence, be supposed to be always in its mean state, except in so far as it may be affected by the general changes in the barometer and thermometer; and below the height of 50 feet, the state of the air may always be got from direct observations. The only portion, therefore, respecting which there can be any degree of doubt is the stratum of 1075 feet in height, between DE and FG. Now, if it can be shewn that the variation in the refraction produced by the stratum of air of 50 feet next the ground is, in all cases, much greater than that which is produced by the stratum of 1075 feet in thickness between DE and FG, it must be obvious to every person, that our uncertainty respecting the horizontal refraction, and refractions at low altitudes, will be much diminished; and that this may be accomplished, we shall now endeavour to shew.

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8. Having already mentioned, that observations seem to indicate that it is highly improbable that the influence of the disturbing causes near the earth's surface ever extends beyond the height of 1125 feet, so as to produce any sensible effect upon the refraction; *I have, therefore, supposed the atmosphere to be always in its mean state, from the top down to this height.* So that, in the subsequent hypotheses respecting the arrangement of the atmosphere, it will be remembered, that, above the height of 1125 feet, they are all alike.

First Hypothesis.

We here suppose that the air is in such a state,

1st. That the temperature at 0 feet high is 40° Fahrenheit.

20	.....	41
50	.....	42
100	.....	43
200	.....	44

2nd. That above the height of 200 feet, up to that of 1125 feet, the *change in the density* is exactly proportioned to the *change in the height.*

3rd. That above the height of 1125 feet the atmosphere is in its mean state.

N. B. It will be observed, that there is no reason, arising from the nature of the subject, why the height of 1125 feet should be preferred to 1000, 1100, or 1200 feet. But as it is plain that it would make very little difference what number was taken within these limits; and as a part of the calculations had already been made, answering to the height of 1125 feet, in finding the mean refractions, it was thus fixed upon in preference to any other height, merely on account of the saving of labour which would attend its adoption. For a similar reason, the atmosphere below the height of 1125 feet has been divided into the same number of strata, and the thickness of each stratum taken, the same as in the calculations for finding the horizontal refraction in the mean state of the atmosphere.

In order to make the mode of calculation for any hypothesis respecting the state of the air near the ground as plain as possible, I shall give the computations for obtaining the numbers to be substituted in the general formulæ at greater length than before.

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According to this hypothesis, we have		Elasticity in mean state of atmosphere.	Density, or values of Δ.	Values of $\Delta-\Delta'$.	Log. of δ.	Values of a.
Height above the ground.	Temper.					
0	40°	1·0000000	1·022388			
6	40·3	·9997839	1·021489	·000899	—7·4009177	20892960
20	41	·9992796	1·019392	·002097	—7·7687564	20892966
50	42	·9981990	1·016038	·003354	—7·9727211	20892980
100	43	·9963980	1·011961	·004077	—6·0574987	20893010
200	44	·9927960	1·006073	·005888	—6·2171258	20893060
300	—	———	1·0020381	·0040349	—6·0529908	20893160
450	—	———	·9959857	·0060524	—6·2290856	20893260
600	—	———	·9899333	·0060524	—6·2290856	20893410
800	—	———	·9818635	·0080698	—6·3540208	20893560
1125	$45\frac{2}{3}$ nearly.	———	·9687500	·0131135	—6·5648767	20893760

No. of each stratum.	Height of each stratum.	Values of β.	Values of $\log. \frac{\beta}{a \cdot \tan \cdot 1''}$	Values of $\log. \frac{a\delta}{\beta}$	Values of $\log. \frac{h-a\delta}{(2a+h+a\delta)\tan 1''}$
1	6	3	—2·4715464	0·2437964	—3·5631136
2	14	7	—2·8395230	0·2436585	—3·9320679
3	30	15	—1·1705160	0·1166302	—2·7095489
4	50	25	—1·3923641	—1·9795597	—1·1108547
5	100	50	—1·6933931	—1·8381579	—1·5099967
6	100	50	—1·6933910	—1·6740250	—1·5264574
7	150	75	—1·8694802	—1·6740305	—1·7525442
8	150	75	—1·8694771	—1·6740336	—1·7525402
9	200	100	—1·9944127	—1·6740332	—1·8774753
10	325	162·5	0·2052619	—1·6740399	0·0883208

N.B. This notation is the same as that which was used in my former paper on refraction, and the requisite explanations may be seen at pages 140, 141, 144, and 147.

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Having thus obtained the logarithms of the co-efficients to be used in finding the values of $\frac{1}{2}v$, r, and $\frac{1}{2}w$, we have only to write the values of these co-efficients answering to the first stratum in the general formulæ, and we get the logarithmic formulæ of calculation for the first stratum; and by proceeding in a similar manner, we may write out the formulæ of calculation for the second and third strata, &c. up to the height of 1125 feet, as follows.

First Hypothesis. Part I.

1st. 6 feet.	$\left\{\begin{array}{l}\log.\frac{1}{2}v_1 = -2{\cdot}4715464 + \log.\tan(z_1 - \frac{1}{2}v_1)\\ \log.\frac{1}{2}w_1 = -3{\cdot}5631136 + \log.\tan(z_1 - \frac{1}{2}w_1)\end{array}\right.$	$\log. r_1 = 0{\cdot}2437964 + \log.\frac{1}{2}v_1$ $z_1 - w_1 = z_2$
2nd. 14 feet.	$\left\{\begin{array}{l}\log.\frac{1}{2}v_2 = -2{\cdot}8395230 + \log.\tan(z_2 - \frac{1}{2}v_2)\\ \log.\frac{1}{2}w_2 = -3{\cdot}9320679 + \log.\tan(z_2 - \frac{1}{2}w_2)\end{array}\right.$	$\log. r_2 = 0{\cdot}2436585 + \log.\frac{1}{2}v_2$ $z_2 - w_2 = z_3$
3rd. 30 feet.	$\left\{\begin{array}{l}\log.\frac{1}{2}v_3 = -1{\cdot}1705160 + \log.\tan(z_3 - \frac{1}{2}v_3)\\ \log.\frac{1}{2}w_3 = -2{\cdot}7095489 + \log.\tan(z_3 - \frac{1}{2}w_3)\end{array}\right.$	$\log. r_3 = 0{\cdot}1166302 + \log.\frac{1}{2}v_3$ $z_3 - w_3 = z_4$
4th. 50 feet.	$\left\{\begin{array}{l}\log.\frac{1}{2}v_4 = -1{\cdot}3923641 + \log.\tan(z_4 - \frac{1}{2}v_4)\\ \log.\frac{1}{2}w_4 = -1{\cdot}1108547 + \log.\tan(z_4 - \frac{1}{2}w_4)\end{array}\right.$	$\log. r_4 = -1{\cdot}9795597 + \log.\frac{1}{2}v_4$ $z_4 - w_4 = z_5$
5th. 100 feet.	$\left\{\begin{array}{l}\log.\frac{1}{2}v_5 = -1{\cdot}6933931 + \log.\tan(z_5 - \frac{1}{2}v_5)\\ \log.\frac{1}{2}w_5 = -1{\cdot}5099967 + \log.\tan(z_5 - \frac{1}{2}w_5)\end{array}\right.$	$\log. r_5 = -1{\cdot}8381579 + \log.\frac{1}{2}v_5$ $z_5 - w_5 = z_6$
6th. 100 feet.	$\left\{\begin{array}{l}\log.\frac{1}{2}v_6 = -1{\cdot}6933910 + \log.\tan(z_6 - \frac{1}{2}v_6)\\ \log.\frac{1}{2}w_6 = -1{\cdot}5264574 + \log.\tan(z_6 - \frac{1}{2}w_6)\end{array}\right.$	$\log. r_6 = -1{\cdot}6740250 + \log.\frac{1}{2}v_6$ $z_6 - w_6 = z_7$
7th. 150 feet.	$\left\{\begin{array}{l}\log.\frac{1}{2}v_7 = -1{\cdot}8694802 + \log.\tan(z_7 - \frac{1}{2}v_7)\\ \log.\frac{1}{2}w_7 = -1{\cdot}7525442 + \log.\tan(z_7 - \frac{1}{2}w_7)\end{array}\right.$	$\log. r_7 = -1{\cdot}6740305 + \log.\frac{1}{2}v_7$ $z_7 - w_7 = z_8$
8th. 150 feet.	$\left\{\begin{array}{l}\log.\frac{1}{2}v_8 = -1{\cdot}8694771 + \log.\tan(z_8 - \frac{1}{2}v_8)\\ \log.\frac{1}{2}w_8 = -1{\cdot}7525402 + \log.\tan(z_8 - \frac{1}{2}w_8)\end{array}\right.$	$\log. r_8 = -1{\cdot}6740336 + \log.\frac{1}{2}v_8$ $z_8 - w_8 = z_9$
9th. 200 feet.	$\left\{\begin{array}{l}\log.\frac{1}{2}v_9 = -1{\cdot}9944127 + \log.\tan(z_9 - \frac{1}{2}v_9)\\ \log.\frac{1}{2}w_9 = -1{\cdot}8774753 + \log.\tan(z_9 - \frac{1}{2}w_9)\end{array}\right.$	$\log. r_9 = -1{\cdot}6740332 + \log.\frac{1}{2}v_9$ $z_9 - w_9 = z_{10}$
10th. 325 feet.	$\left\{\begin{array}{l}\log.\frac{1}{2}v_{10} = 0{\cdot}2052619 + \log.\tan(z_{10} - \frac{1}{2}v_{10})\\ \log.\frac{1}{2}w_{10} = 0{\cdot}0883208 + \log.\tan(z_{10} - \frac{1}{2}w_{10})\end{array}\right.$	$\log. r_{10} = -1{\cdot}6740399 + \log.\frac{1}{2}v_{10}$ $z_{10} - w_{10} = z_{11}$

If we now make the calculations, according to the above formulæ, for the horizontal refraction, z being 90^0, we obtain the successive values of $\frac{1}{2}v$, r, $\frac{1}{2}w$, and z, as in the following Table.

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No. of each stratum.	Values of $\frac{1}{2}v$.	Values of r.	Values of $\frac{1}{2}w$.	Successive zenith distances, or values of z.
1	78″,161	137″,021	27″,4666	89° 59′ 5″,067
2	95,044	166,565	22,717	89 58 19,633
3	131,650	172,207	64,2104	89 56 11,212
4	138,577	132,206	84,8807	89 53 21,451
5	176,926	121,885	127,001	89 49 7,449
6	130,092	61,415	92,985	89 46 1,479
7	153,890	72,651	121,527	89 41 58,425
8	126,424	59,685	98,839	89 38 40,747
9	143,155	67,583	111,826	89 34 57,095
10	194,891	92,009	152,681	89 29 51,733

Adding all these values of r together, we get 1083″,227 for the whole refraction, up to the height of 1125 feet; and the last value of z shews that the zenith distance at that height is 89° 29′ 51″,733.

In calculating the horizontal refraction to the mean state of the atmosphere, it was found that the zenith distance, at the height of 1125 feet, was 89° 27′ 21″,14, and that the whole refraction above the same height was 26′ 45″,046.

Now, in the present hypothesis, the atmosphere, above the height of 1125 feet, is in its mean state. The refraction above this height would therefore have been exactly 26′ 45″,046, had the commencing zenith distance been 89° 27′ 21″,14; but as the commencing zenith distance is really 2′ 30″,593 more, it is hence evident that there must be a correction applied, on account of this small difference, as is done below.

To zenith distance 89° 27′ 21″,14 the refraction is 1605″,046; its log. = 3·20549
Correction for 2′ 30″,593 (diff. for 10′ being 2310) = 589

The number answering to the sum is 1626″,96; its log. = 3·21138

So that the refraction, *above* the height of 1125 feet, is, in this hypothesis, 1626″,96
Refraction *below* this height, as shewn above, is..... 1083 ,227

2710 ,187

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It thus appears, that if the temperature of the atmosphere were to vary, as is supposed in this hypothesis, with the barometer at 29·6 inches, and thermometer at 40° Fahrenheit at the ground, the whole horizontal refraction would be 45′ 10″,187. But tables of refraction are almost all calculated to 50° Fahrenheit. The refraction just found must therefore be reduced to what it would have been had the thermometer been 50°. The following are the calculations:

Whole refraction, therm. 40°	= 2710″,187
Correction for 10° from Table VI. (in my memoir)	29 ,36
	2680 ,827 ; its log. = 3·4282687
Correction for 10° from Table V. =	·0096157
Refraction, the therm. being 50°, is 2622″,1 ; its log. =	3·4186530

Hence, if the real state of the atmosphere should ever correspond with that state which is assumed in our present hypothesis, the horizontal refraction answering to barom. 29·6 inches and therm. 50°, would be 43′ 42″,1,

Having shewn that the horizontal refraction, in this state of the atmosphere, would be no less than 10′ 46″,4 greater than the mean horizontal refraction, we shall now proceed to shew that when the atmosphere, above the height of 1125, and below that of 50 feet, remains unaltered, the arrangement of the air in the intervening space of 1075 feet, always produces a much less effect upon the amount of the horizontal refraction than the 50 feet next the ground. For this purpose, I shall, in the following hypothesis, change the arrangement of the temperatures in this space of 1075 feet to the utmost verge that observations will warrant, in order that we may get the greatest change which this part of the atmosphere can produce.

Second Hypothesis.

9. We here suppose,

1st. That up to the height of 50 feet the temperature gets warmer and warmer as we ascend, the same as in the first hypothesis.

2nd. That above this height, up to that of 300 feet, a sudden change takes place, and the air gets colder, as follows:

The temperature at 100 feet high is 41° Fahrenheit.

200 40

300 40

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3rd. That above 300 feet, up to 1125, another sudden change takes place, and the air grows warmer as we ascend, the temperature varying in such a manner that the change in the density of the air is exactly proportional to the change in the height.

4th. That the atmosphere is in its mean state above the height of 1125 feet, as before.

N.B. It will here be observed, that this is designedly made an extreme case. The transitions are so sudden and so great, that such as they are can hardly be supposed to take place in nature. So great, indeed, is the change just above 50 feet, that the path of a ray of light through the fourth section from the ground is actually convex towards the earth, from 100 feet down to 50 feet of altitude, the value of r_4 being $-13''{,}425$. Besides, the temperatures are so assumed, that in both the fifth and sixth sections the refractions are very small; so that the greatest portion of the refraction which takes place in passing through the space of 1070 feet has thus been thrown towards the upper part of it, where the zenith distance is the least; and consequently the refraction due to any given difference of density is the least. The horizontal refraction, according to this hypothesis, will therefore be less than that of the first hypothesis to a greater extent than can probably ever take place in nature, when the temperature varies at the same rate for the first 50 feet of altitude.

On the contrary, if, instead of making the temperature vary gradually, as in the first hypothesis, we had supposed it to continue to turn warmer, up to the height of 300 feet, at the same rate as during the first 50 feet from the ground, a greater horizontal refraction would have been obtained than that due to the first hypothesis, or $43'\ 42''{,}1$; for the principal part of the refraction would, in this case, take place near to the bottom of the space of 1075 feet, where the zenith distance is the greatest, and consequently the refraction greatest.*

* [The completion of this paper was unfortunately prevented by the death of the author.—*Sec.*]

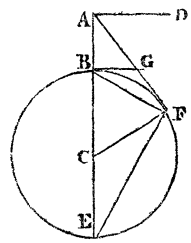
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Appendix. On the Dip of the Horizon.

Having in a former paper investigated the laws of celestial and terrestrial refractions, from elementary principles, and given tables of both, those for terrestrial refraction embracing all states of the atmosphere, we are prepared to meet the difficulties attending the fluctuations of the dip at sea.

1. Let AB represent the height of the eye above BF the surface of the sea, C the centre of the earth, and AD the level line passing through A; then, disregarding refraction, the angle DAF, between AD and AF, drawn from A to touch the surface of the sea at F, is the dip.

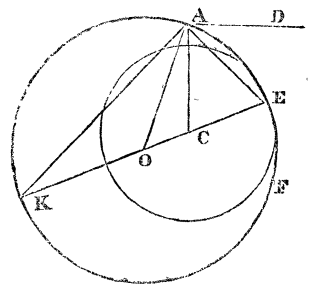


Produce AC to E, draw BG a tangent at B, to meet AF in G, and join EF and FB. Then it is obvious that ACF = FAD, and BEF, the half of ACF, is equal to GFB or GBF, or each of these angles is half the dip. Now, the triangles ABF and AFE being similar, we have $AB : AE :: AB^2 : AF^2 : \text{rad}^2 : \tan^2 \frac{1}{2}\,\text{dip}$. Or, putting $CB = r$, $AB = h$, and the dip $= x$, and rad $= 1$, we have $h : 2r + h :: 1 : \tan^2 \frac{x}{2}$, where $\tan \frac{x}{2} = \sqrt{\frac{h}{2r+h}}$.

But $\frac{x}{2}$ being, in all practical cases, a very small angle, we may consider $\tan \frac{x}{2}$ as equal to $\frac{x}{2} \tan 1''$; and h, in the factor $2r + h$, being also, in all practical cases, too small with respect to $2r$ to be worth regarding, the above expression may be reduced to the following.

$$x = \frac{2}{\tan 1'' \sqrt{2r}} \cdot \sqrt{h} = 63'',81757 \sqrt{h}$$

2. To estimate the effect of refraction on the dip, I have shewn, in my former paper, that the small portion of the curve AEF, described by a ray of light in the problem under consideration, does not sensibly differ from a circular arc. If E represent the point at which the curve touches the surface of the sea, it will represent a point on the boundary



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of the visible horizon; and if O be the centre of the circle which most nearly coincides with the portion of the curve between A and E, then EO is the radius of curvature at E; and therefore E, C, and O, are in one straight line. Complete this circle of curvature, and let EK be its diameter, and draw the straight lines AE, AO, and AK; then it is plain that the angle at A or E, included between the arch AE and its chord, or between the tangent at A and its chord, or the angle AKE in the alternate segment, is the terrestrial refraction. And as AE may be considered as indefinitely small with respect to EC, we have EK : EC :: ACE : AKE :: included arc : terrestrial refraction.

Now, if the *ratio* of the *included arc* to the terrestrial refraction, taken from the table of terrestrial refraction, be that of n to 1, the above proportion becomes EK : EC :: n : 1, or EK = n . EC; therefore, OE = $\frac{n}{2}$ EC, and OC = $\left(\frac{n-2}{2}\right)$ EC. Or, resuming the notation in Article 1, we have OA = $\frac{nr}{2}$, and OC = $\frac{n-2}{2}.r$, and AC = $r + h$.

The dip being the angle DAF, contained between the level line AD and the curve AEF, and DAF being equal to OAC, we have, in the triangle ACO, all the sides given to find the angle OAC, the required dip.

$$\sin \mathrm{OAC} = \frac{4}{\overline{r+h}\,.\,nr} \cdot \sqrt{\left\{\frac{nr+h}{2} \times \left(r+\frac{h}{2}\right) \times \left(\frac{n-2}{2}.r - \frac{h}{2}\right)\frac{h}{2}\right\}}$$

$$= \sqrt{\left\{2 \times \frac{nr+h}{(nr)^2} \times \frac{r+\frac{h}{2}}{(r+h)^2} \times \left(\overline{n-2}.r-h\right) \times h\right\}}$$

$$= \sqrt{\left\{\frac{2}{nr\,.\,\overline{r+h}} \times \left(1+\frac{h}{nr}\right) \times \left(1-\frac{h}{2\,.\,\overline{r+h}}\right) \times \left(\overline{n-2}\,.\,r-h\right) \times h\right\}}$$

Now, considering, as we have done above, that OAC, the dip, is in all cases a very small angle, and that h is also very small with respect to r, the above formulæ give

$$\sin x, \text{ the dip} = \sqrt{\frac{2}{r} \cdot \frac{n-2}{n} \cdot h}$$

$$\text{Or } x = \frac{1}{\sin 1''} \sqrt{\frac{2}{r} \cdot \frac{n-2}{n} \cdot h} = 63'',8175 \,.\, \sqrt{\frac{n-2}{n}} \,.\, h$$

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3. But it must be observed, that these formulæ apply only when n is a positive number, and greater than 2. When $n = 2$, the curvature of the ray of light is equal to that of the sea; and, consequently, the dip, in this case, will be nothing, and the surface of the sea will be visible as far as the eye can distinguish objects. Hence, as the distance increases, the appearance of the water and of the sky will become more and more blended, till it will be impossible to perceive any line of demarcation. This will also be the case when n is less than 2; for then the curvature of the rays of light will be greater than that of the sea. Hence, the water will be within the limit of view as far as the eye can reach, beyond the boundary of distinct vision; and consequently, in such cases, there can be no visible horizon.

In the case in which a ray of light reaching the eye is concave to the earth, we may deduce, by processes perfectly analogous to the above, the following expression for the dip:

$$x = 63'',8175 \sqrt{\frac{n+2}{n} \cdot h}$$

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XXIX. *On the Computation of observed Occultations.* By THOMAS MACLEAR, *Esq., Member of the Society.*

Read January 14, 1831.

THE following method of calculating the longitude of a place from an observed occultation of a fixed star by the moon, by finding what has been technically called "the point of occultation," is particularly applicable to the more numerous class of cases, where the determination must depend on the tabulated places of the moon and star. And when correspondent observations can be obtained, the direct comparison of the moon's right ascension resulting from the calculation for both stations, with the time of observation at each, gives the difference of longitudes.

It generally happens, in the numerical solution of differential equations, that the quantity sought is involved in the formula that expresses its value. In the present case, a quantity is so circumstanced; but it can be conveniently eliminated by approximation. On the other hand, there is the paramount advantage, that neither altitudes, nor auxiliary or parallactic angles, enter into the calculation, by which much labour and a source of error are avoided.

The theory of the following investigation is founded on the consideration that the star is affected by parallax, equal to that of the moon at a given altitude; and it is required to find an imaginary point in the heavens, having the same relation to the apparent place of the star that the moon's true place bears to her apparent. It is therefore obvious, that at the instant a ray of light proceeding from the star becomes a tangent to the moon's limb, and strikes the eye of the observer, the point of contact with the moon would be seen from the earth's centre projected in the heavens, in contact also with the true limb of that luminary, if it were not a spherical body.

Fig. 1. Let C represent the earth's centre, Z the position of an observer on the surface, M the moon, MC her true distance from the earth. The

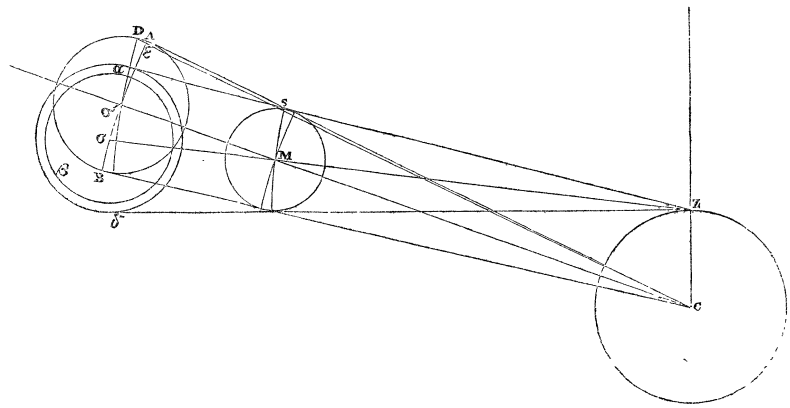
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diameter, as seen from Z, projected in the heavens, is $\alpha\delta$; and from C, is AB = $\alpha\beta$; and $\beta\delta'$ is the augmentation.

Let Zα represent a ray of light proceeding from the star, in apparent contact with the moon's limb; then, according to the theory, ZsC = D$s\alpha$ is the parallax in altitude of the point of occultation D, σ' the moon's true centre, and Aσ' her semidiameter, as seen from the centre of the earth.

Fig. 1.



It appears from the figure, that the portion of the diameter overlapping the point of occultation D is equal to the versed sine of the parallax to the semidiameter as radius, or cos. parallax × moon's semidiameter σ'D = $\varepsilon\sigma'$ the semidiameter in contact with the point of occultation D, and which should be employed in finding the centre σ'.

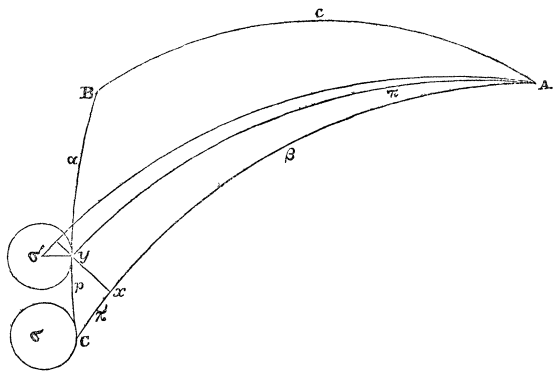
This negative correction Aε rarely exceeds one-tenth of a second in space, and may therefore be generally neglected.

Fig. 2. Suppose A the pole of the equator, B the zenith, C the apparent place of a fixed star in contact with the moon σ, at the instant of immersion; then AB = c, is the colatitude of the place of observation; AC = β, the polar distance of the star; BC its apparent zenith distance; By = α, the zenith distance of the point of occultation y, and Ay = b, its polar distance. BAC = A, the star's horary angle, σC the moon's apparent, and $\sigma'y$ her geocentric semidiameter. Cy = p, the parallax in altitude, yAC = π, the parallax in right ascension, and AC ~ Ay (making Ax = Ay) = xC = π', the parallax in declination; σ'Ay the difference between the right ascension of the point of occultation and the moon's centre.

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Fig. 2.



The resulting formulæ, from the following investigation of fig. 2, is similar to Cagnoli's, excepting in the change, arising from the apparent place of the object being the given quantity.

From the principles of spherical trigonometry, we have

$$\frac{\sin C}{\sin b} = \frac{\sin \pi}{\sin p} \quad \text{and} \quad \frac{\sin A}{\sin BC} = \frac{\sin C}{\sin c} \ \&c. \ \ldots\ldots\ldots \ (1)$$

$$\therefore \sin \pi = \frac{\sin A \,.\, \sin c \,.\, \sin p}{\sin BC \,\sin b} = \frac{\sin H \,.\, \sin c \,.\, \sin A}{\sin (\beta - \pi')}$$

(because $\sin p = \sin BC \sin H$, H being the horizontal parallax)

$$= \frac{\text{sin hor. par.} \times \text{cos lat.} \times \sin * \text{ app. horary angle}}{\cos (* \text{ declin.} + \text{par. in declin.})}$$

or, by proportional logarithms,

$$p.l.\,\pi = p.l.\,H + l.\sec \text{lat.} + l.\operatorname{cosec} * \text{ app. hor. angle} + l.\cos (* \text{ dec.} + \text{par. in dec.})$$

Again,
$$\cos B = \frac{\cos b - \cos \alpha \cos c}{\sin \alpha \sin c} = \frac{\cos \beta - \cos BC \cos c}{\sin BC \sin c}$$

$$\cos b \sin BC - \cos \beta \sin \alpha = \cos c \,(\cos \alpha \sin BC - \sin \alpha \cos BC) = \cos c \sin (BC - \alpha)$$

$$= \cos c \sin p = \cos c \sin H \sin BC$$

Divide by
$$\cos \beta \sin \alpha = \sin BC \cos b - \sin H \cos c \,.\, \sin BC$$

$$\sin \beta \sin \alpha = \frac{\sin A - \pi \sin BC \sin b}{\sin A} \ \ldots\ldots \text{ from (1)}$$

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and we obtain

$$\frac{\cot\beta \sin \overline{A-\pi}}{\sin A} = \cot b - \frac{\sin H \cos c}{\sin b}; \text{ but } \cot b = \cot\beta - \frac{\sin \overline{b-\beta}}{\sin b \sin\beta}$$

Hence

$$\frac{\sin \overline{b-\beta}}{\sin b \sin\beta} = \cot\beta \left(\frac{\sin A - \sin \overline{A-\pi}}{\sin A}\right) - \frac{\sin H \cos c}{\sin b}$$

$$= \cot\beta \left(\frac{2 \sin \frac{\pi}{2} \cos \overline{A-\frac{\pi}{2}}}{\sin A}\right) - \frac{\sin H \cos c}{\sin b}$$

$$= \frac{\cot\beta \sin\pi \cos \overline{A-\frac{\pi}{2}}}{\sin A \cos\frac{\pi}{2}} - \frac{\sin H \cos c}{\sin b}$$

$$= \frac{\cot\beta \sin H \sin c \cos \overline{A-\frac{\pi}{2}}}{\cos\frac{\pi}{2} . \sin b} - \frac{\sin H \cos c}{\sin b}$$

$$\therefore \text{par. in declin.} = \sin \overline{\beta - b} = \sin H \cos c \sin\beta - \frac{\sin H \sin c \cos\beta \cos \overline{A-\frac{\pi}{2}}}{\cos\frac{\pi}{2}}$$

$$= \sin \text{hor. par.} \sin \text{lat.} \cos * \text{dec.} - \frac{\sin \text{hor. par.} \cos \text{lat.} \sin * \text{dec.} \cos (* \text{ hor. } \angle - \frac{1}{2} \text{ par. } \mathcal{A}R)}{\cos (\frac{1}{2} \text{ par. in } \mathcal{A}R)}$$

The parallax in right ascension enters into the second term of the parallax in declination, (which cannot be avoided without increasing the equation,) and the latter cannot be computed without a knowledge of the former. This obstacle to a direct calculation is easily surmounted by substituting the star's declination, increased by a few minutes if north, or diminished if south; thus anticipating the declination of the point of occultation in the second formula, by which the parallax in right ascension becomes known sufficiently near for the computation of the second term of the parallax in declination. But the star's declination will answer in most cases, as is obvious on inspecting the examples.

In order that the process may not be ambiguous or difficult for general adoption, the following practical rules are given, which render a reference to the equations unnecessary.

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RULES.

1. Correct the mean place of the star for aberration, precession, &c. by the tables of the Astronomical Society, unless it be one of those whose apparent places are given for every ten days in the *Nautical Almanac*.

2. Add the sun's apparent right ascension to the apparent time, or the sun's mean right ascension to the mean time of observation, making allowance for the assumed longitude, the sum is the sidereal time, from which subtract the star's right ascension, the remainder, if less than twelve hours, is the star's horary angle; or, if greater than twelve hours, the complement to twenty-four is the horary angle, which convert into degrees, minutes, &c.

3. To the apparent time of observation add the estimated longitude if west, or subtract it if east, the result will be the estimated Greenwich time, to which compute, from the *Nautical Almanac*, the moon's declination, equatorial semidiameter, and horizontal equatorial parallax; likewise, the moon's right ascension to a near epoch before and after, so that the interval may be ten minutes.

4. Subtract the angle of the vertical (taken from Table, p. 544) from the latitude of the place of observation, the remainder is the reduced latitude. Also, add the log. of the earth's radius to the log. or log. sin (whichever is chosen) of the equatorial parallax; the sum is the log. of the reduced horizontal parallax. Or add the number from the column "prop. log." in the same Table, (if prop. log. be employed), to the prop. log. of the equatorial parallax.

Computation by Common Logarithms.

5. To the log. or log. sin. of the reduced horizontal parallax, add the log. cos. of the reduced latitude, and the log. sin. of the star's horary angle; call the sum constant log., to which add the log. secant of the star's declination; the natural number of the sum is the approximate parallax in right ascension.

6. To the log. or log. sin. of the reduced horizontal parallax, add the log. sin. of the reduced latitude, and the log. cos. of the star's declination; the natural number of the sum is the first term of the parallax in declination.

7. To the log. or log. sin. of the reduced horizontal parallax, add the log. cos. of the reduced latitude, the log. sin. of the star's declination, and

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the log. cos. of the star's horary angle, previously diminished by one-half the approximate parallax in right ascension; the natural number of the sum is the second term of the parallax in declination.

Remark. $\frac{1}{2}$ par. in $\mathcal{R}$ is generally insensible; but when employed, its log. cos. should be subtracted from the log. last found, previously to finding the natural number.

In Northern Latitudes.

8. If the star's declination be north, and the horary angle be $\left\{\begin{matrix}\text{less}\\\text{greater}\end{matrix}\right\}$ than 90°, the $\left\{\begin{matrix}\text{difference}\\\text{sum}\end{matrix}\right\}$, or if its declination be south, and the horary angle be $\left\{\begin{matrix}\text{less}\\\text{greater}\end{matrix}\right\}$ than 90°, the $\left\{\begin{matrix}\text{sum}\\\text{difference}\end{matrix}\right\}$ of the first and second terms is the parallax in declination. Or, generally, if the star's distance from the elevated pole, and its horary angle, be one less, and the other greater, than 90°, the parallax in declination will be the sum; but if both be less or greater than 90°, the difference is that quantity.

Those who are well acquainted with the rules of algebraic addition and subtraction, and the laws of trigonometrical signs, will not experience any difficulty on this subject.

In south latitudes the same rules prevail relative to the elevated pole.

9. Add the parallax in declination to the declination of the star, if the latter be north, or subtract it if south, (or, which is a more comprehensive rule, apply the parallax to the declination of the star in such a manner as will bring it nearer to the elevated pole); the sum or difference is the declination of the point of occultation, the log. secant of which, added to constant log., gives the log. of the parallax in right ascension.

When the horary angle is $\left\{\begin{matrix}\text{west}\\\text{east}\end{matrix}\right\}$ the $\left\{\begin{matrix}\text{sum}\\\text{difference}\end{matrix}\right\}$ of the parallax in right ascension, and the right ascension of the star, will be the right ascension of the point of occultation.

10. Compare the declination of the moon with the declination of the point of occultation, and subtract the lesser from the greater; the remainder is the difference of declination. To the log. of the sum of the moon's horizontal semidiameter, and the difference of declination, add the log. of their difference and twice the log. secant of the declination of the point of occultation; one half of the sum is the log. of the difference in right ascension between the point of occultation and the moon's

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centre, which, $\left\{\begin{matrix}\text{subtracted}\\\text{added}\end{matrix}\right\}$, if the observation be an $\left\{\begin{matrix}\text{immersion}\\\text{emersion}\end{matrix}\right\}$, from or to the right ascension of the point of occultation, gives the right ascension of the moon's centre.

11. Subtract the moon's right ascension, taken from the *Nautical Almanac* for the earlier epoch, from the right ascension of the moon's centre resulting from the calculation, and to the log. of the remainder add the log. of ten minutes and the ar. complement of the log. of the moon's motion during ten minutes; the sum is the log. of a quantity in time, which, added to the first epoch, gives the time at Greenwich. The difference between this and the time of observation is the longitude, east or west, as the latter is greater or less than the former.

Computation by Proportional Logarithms.

12. [See Rules 1, 2, 3, 4.] To the proportional log. of the moon's reduced horizontal parallax, add the log. secant of the reduced latitude, and the log. cosecant of the star's horary angle; call the sum constant log., to which add the log. cos. of the star's declination; the sum is the proportional log. of the approximate parallax in right ascension.

13. To the proportional log. of the moon's reduced horizontal parallax, add the log. cosecant of the reduced latitude, and the log. secant of the star's declination; the sum is the proportional log. of the first term of the parallax in declination.

14. To the proportional log. of the moon's reduced horizontal parallax, add the log. secant of the reduced latitude, the log. cosecant of the star's declination, and the log. secant of the moon's horary angle, previously diminished by one-half the approximate parallax in right ascension; the sum is the prop. log. of the second term of the parallax in declination.

15. [See Rule 8, and the first and last part of Rule 9.] To the log. cosine of the declination of the point of occultation, add the constant log.; the sum is the proportional log. of the parallax in right ascension.

16. [See first part of Rule 10.] To the proportional log. of the sum of the moon's horizontal semidiameter and difference of declination, add the proportional log. of their difference, and twice the log. cos. of the declination of the point of occultation; the sum, divided by two, is the proportional log. of the difference in right ascension between the point of occultation and the moon's centre. [See the latter part of Rule 10.]

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17. [See the first part of Rule 11.] To the proportional log. of the difference between the right ascension of the moon's centre and her right ascension for the first epoch, add the proportional log. of ten minutes, and the ar. complement of her motion in right ascension during ten minutes; the sum is the proportional log. of a quantity to be added to the first epoch. [See last part of Rule 11.)

Remarks. I may observe, relative to Rule 10, that when the difference of declination exceeds ten minutes, the secant of *half the sum of the declinations of the moon and point of occultation* will be more accurate. It is in this case that an erroneous assumption of the earth's compression, or of the elements, has an influence on the result of the computation, because the direction of the orbit may be nearly parallel to the equator.

When the computed, varies much from the assumed, longitude, the former should be applied to the apparent time of observation, and the moon's declination, &c. (see Rules 3, 10, 11, &c.) re-calculated for the time thus corrected; an operation that must be repeated, until the final assumed longitude agrees with that resulting from calculation. It is obvious, that if the observation was noted in sidereal time, the parallaxes need not be re-calculated, in any case, however great the discrepancy between the estimated and computed longitudes; but if in apparent or mean time, the whole operation should undergo revision. However, the method generally admits of a rapid convergence to the true longitude.

When the estimated longitude is uncertain to ten or fifteen minutes in time, the interval between the first and second epochs should be one hour.

Example by Proportional Logarithms.

1830. Feb. 5. Captain Smyth witnessed the immersion of 1 *Cancri*, from his observatory at Bedford, at $9^h\ 19^m\ 58^s,19$ sidereal time $= 12^h\ 3^m\ 2^s,35$ apparent time. The estimated longitude is $1^m\ 51^s$ west. Therefore, we find for $12^h\ 4^m\ 53^s,35$ the estimated Greenwich time,

By *Rule* 1. 1 *Cancri*, A.S.C. 970. App. $\mathcal{R}$ $7^h\ 47^m\ 20^s,968$. Declin. $+\ 16°\ 14'\ 6'',598$.

Rule 2. Star's horary angle west, $23°\ 9'\ 18'',33$.

Rule 3. Moon's declin. $= 16°\ 53'\ 35'',03$. Semidiam. $= 15'\ 17'',81$. Hor. equat. par. $= 56'\ 8'',1$, and its prop. log. $= 5061$.

Moon's $\mathcal{R}$, at $12^h = 116°\ 47'\ 1''$; at $12^h\ 10^m = 116°\ 52'\ 32'',98$. Prop. log. corr. of hor. par. $= 9$.

Rule 4. Assumed lat. of observatory $= 52°\ 8'\ 20''$. Angle of the vertical $= 11'\ 8''$.
$\therefore$ red. lat. $= 51°\ 57'\ 12''$.

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Red. hor. par. ..... p. l. 0·5070
Red. lat. ..... cosec 0·1037
Star's declin. ..... sec 0·0177

First term par. in declin. ..... p. l. 0·6284 = 44′ 21″

Red. hor. par. ..... p. l. 0·5070
Red. lat. ..... sec 0·2102
Star's declin. ..... cosec 0·5535

$23° 9′ 18″ - \frac{14′ 12″}{2} = 23° 2′ 12″$ sec 0·0361

Second term of par. in dec. .... p. l. 1·3068 = 8 52,8

Par. in declin. 33 28,2
Star's declin. 16 14 6,6

Declin. of point of occult. ..... 16 47 34,8 ..... 2 log. cos 9·9621
Moon's declin. 16 53 35,0

Diff. declin. ..... 6 0,2 } 21′ 18″ .. p. l. 0·9269
Moon's hor. semidiameter ..... 15 17,8 } 9 17,6.. p. l. 1·2871

2) 2·1761

Diff. in $\mathcal{R}$ between point of occult. and moon's centre 14 41,8.. p. l. 1·0881

Red. hor. par. ..... p. l. 0·5070
Red. lat. ..... sec 0·2102
Star's horary angle ..... cosec 0·4053
Star's dec. + 30′ = 16° 44′ 6″ cos 9·9812
} constant log. 1·1225

Approx. par. in $\mathcal{R}$ ..... p. l. 1·1037 = 14′ 11″
Constant log. ..... 1·1225
Declin. point of occult. 16° 47′ 34,8 cos 9·9811

Corr. par. in $\mathcal{R}$ ..... p. l. 1·1036 = 14′ 10″,8
Star's $\mathcal{R}$ ..... 116 50 14 ,52

$\mathcal{R}$ of point of occult. ..... 117 4 25 ,32
Diff. $\mathcal{R}$ point of occult. and moon's centre .. 14 41 ,8

1·8225 = p. l. diff. ..... 2′ 42″,52
8·4877 = ar. co. p. l. diff. 5 31 ,98
1·2553 = p. l. 10^m
1·5655 = p. l. .... 4^m 53^s,7

116 49 43 ,52 $\mathcal{R}$ of moon's centre
116 47 1 Moon's $\mathcal{R}$ at 12^h
116 52 32 ,98 Moon's $\mathcal{R}$ at 12^h 10^m

12^h

Time at Greenwich ..... 12 4 53 ,7
Time at Bedford ..... 12 3 2 ,35

Longitude of Bedford .... 1 51 ,35

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Example by log. sines. Case, as before, depending on the Tables.

Oct. 15, 1829. The immersion of *Aldebaran* was observed at Biggleswade, at $22^h\ 49^m\ 3^s,5$ sidereal time $= 9^h\ 26^m\ 47^s,487$ apparent time. Estimated longitude west $1^m\ 3^s$. Therefore, estimated Greenwich time $= 9^h\ 27^m\ 50^s,487$.

By *Rule* 1. From the *Nautical Almanac*, star's ☊ is $4^h\ 26^m\ 10^s,79 = 66°\ 32'\ 41'',85$. Declin. $= +16°\ 9'\ 30'',64$.

Rule 2. Star's horary angle east, $84°\ 16'\ 49'',35$.

Rule 3. Moon's declin. $= 16°\ 38'\ 33'',577$. Semidiam. $= 16'\ 4'',69$. Hor. par. $= 58'\ 59'',92$ Moon's ☊, at $9^h\ 20^m = 65°\ 42'\ 42'',478$; at $9^h\ 30^m = 65°\ 48'\ 45'',82$. Log. of rad. $= 9{\cdot}9991008$; compress. $\frac{1}{300}$.

Rule 4. Assumed lat. of Biggleswade $= 52°\ 5'\ 24''$ N. Angle of the vertical $11'\ 8''$. therefore, red. lat. $= 51°\ 54'\ 16''$ N.

Red. hor. par.	sin 8·2336474	
Red. lat.	sin 9·8959653	
Star's declin.	cos 9·9824953	
First term par. in declin.....	sin 8·1121080	$= 44'\ 30'',2$
Red. hor. par.	sin 8·2336474	
Lat.	cos 9·7902674	
Star's declin.	sin 9·4445061	
$84°\ 16'\ 49'' - \frac{37'\ 46''}{2} = 83°\ 57'\ 56''$	cos 9·0217115	
Second term par. in declin.....	sin 6·4901324	$= 1\ \ 3,7$

Par. in declin.....		$43\ 26,4$	
Star's declin.	$16\ \ 9\ 30,6$		
Declin. of point of occult.....	$16\ 52\ 57,0$	..... 2 log, sec. 0·0382648	
Moon's declin.	$16\ 38\ 33,5$		
Diff. of declin.	$14\ 23,5$	$30'\ 28'',2$	log. = 3·2620240
Moon's hor. semidiam.	$16\ \ 4,6$	$1\ 41\ ,2$	log. = 2·0050924
			2) 5·3053812
Diff. in ☊ between point of occult. and moon's centre		$= 7'\ 29'',46$	= 2·6526906

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Red. hor. par.	sin 8·2336474	} const. log. = 8·0217473	
Red lat.	cos 9·7902674		
Star's horary angle	sin 9·9978325		
Star's dec. + 44′ = 16° 53′ 30″	sec 0·0191343		
Approx. par. Æ =	sin 8·0408816	= 37′ 46″	
Const. log.	8·0217473		
Dec. point of occult. = 16° 52′ 57″	sec 0·0191324		
Corr. par. in Æ =	sin 8·0408797	= 37 46,28	
Star's Æ		66 32 41,85	
Æ of point of occult.		65 54 55,57	
Diff. in Æ between point of occult. and moon's centre		7 29,46	
		65 47 26,11	Æ of moon's centre.
2·4527553 = log. diff.	4′ 43″,632	65 42 42,47	☽'s Æ at 9h 20m
7·4396844 = ar. co. log. diff.....	6 3 ,342	65 48 45,82	☽'s Æ at 9h 30m
2·7781513 = log. of 10m			
2·6705910 = log.		7m 48s,37	
		9h 20	
Time at Greenwich		9 27 48 ,37	
Time at Biggleswade		9 26 47 ,48	
Longitude of Biggleswade =		1 0 ,88	

The same Occultation, by a correspondent Observation.

The above phenomenon was witnessed at the Royal Observatory, Greenwich, at 22h 48m 27s,74 sidereal time = 9h 26m 11s,982 apparent time.

By exactly a similar process to the preceding, we have

Moon's Æ at Greenwich.....	65° 46′ 26″,3	at	9h 26m 11s,982	
Moon's Æ at Biggleswade	65 47 26 ,11	at	9 26 47 ,487	
log. 1·7767738	−0 59 ,81		−0 35 ,505	
log. 10m = 2·7781513				
ar. co. log. 6′ 3″,342 = 7·4396844				
1·9946095 log.			−1 38 ,776	
			Long. of Bigg. = 1 3 ,271	

The logarithms have been carried to seven places of figures, which is not absolutely necessary; five places would have been sufficient, and common log. might have been substituted for the log. sin. of the horizontal parallax.

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Example.

In this example, I suppose the longitude uncertain to *an hour*, (a circumstance that can rarely happen), in order that the quick convergence to the true longitude may be seen.

When the apparent time of observation depends on a knowledge of the longitude, as far as the sun's right ascension and declination are involved, it should be corrected when the longitude has been computed, &c.

1825. Jan. 3. The immersion of η *Geminorum* was observed at Port Bowen by Lieut. Foster, at $6^h\,9^m\,17^s$ apparent time. (See Addend. *Nautical Almanac*, 1830; the example by Mr. Henderson.)

η *Gemin.* A.S.C., No. 775. App. $\mathcal{R} = 6^h\,4^m\,21^s,27 = 91°\,5'\,19'',05$. Dec. $= +22°\,32'\,54'',07$.

Apparent time, $6^h\,9^m\,17^s$; estimated long. about 5^h. We find for 11^h Greenwich time,

Sun's $\mathcal{R} = 18^h\,58^m\,9^s,3$. Sid. time $= 1^h\,7^m\,26^s,3$. Hor. ang. east $= 4^h\,56^m\,55^s = 74°\,13'\,45'$.

Moon's $\mathcal{R}$ at $11^h = 89°\,49'\,0'',6$. Declin. $= 23°\,30'\,33''$. P. l. hor. par. $= 4850$.

——— at $12^h = 90\;27\;19$ ——— $= 23\;27\;17$ ——— $= 4848$.

Latitude Port Bowen, 73° 13′ 40″. Angle of the vertical, 6′ 12″. Red lat. 73° 7′ 28″. Red. hor. par. 13.

Red. hor. par.	p. l. 0·4863	
Lat. 73° 7′ 28″.....	cosec 0·0191	
Star's declin. 22° 32′ 54″..	sec 0·0345	
First term of par. in declin.	p. l. 0·5399	= 51′ 55″,5
	p. l. 0·4863	
Lat.	sec 0·5371	
Star's declin.....	cosec 0·4162	
$74°\,14' - \frac{18'}{2} = 74°\,5'$ ...	sec 0·5618	
	p. l. 2·0014	= 1 48

Par. in declin.....	= 50 7,5		
Star's declin.	22 32 54,		
Dec. of point of occult. =	23 23 1,5	.. 2 log. cos 19·9256	
Moon's declin.....	23 30 33		
Diff. declin.....	7 31,5	23′ 35″	p. l. 0·8827
Moon's equat. semidiam...	16 3,5	8 32	p. l. 0·3242
			2) 2·1325

Difference $\mathcal{R}$ between point of occult. and moon's centre 15′ 27″ p. l. 1·0662

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Red. hor. par. ..... p. l. 0·4863
Lat. 73° 7′ 28″..... sec 0·5371 } const. 1·0400
Star's hor. ang. 74′ 13″ .. cosec 0·0166
Star's dec. + 40′ = 23′ 13″ cos 9·9633

Approx. par. in $\mathcal{R}$ ..... p. l. 1·0033 = 17′ 52″

Const. p. l. 1·0400
Dec. point of occult. 23° 23′ 1″,5.... cos 9·9628

Par. in $\mathcal{R}$ = p. l. 1·0028 = 17′ 53″

Star's $\mathcal{R}$ ..... = 91 5 19

$\mathcal{R}$ of point of occult..... = 90 47 26
Difference $\mathcal{R}$ between point of occult. and moon's centre = 15 27

0·6221 = p. l. diff.	42′ 58″,4	90 31 59	$\mathcal{R}$ of moon's centre
9·3279 = ar. co. p. l. diff...	38 18 ,4	89 49 0,6	Moon's $\mathcal{R}$ at 11^h
0·4771 = p. l. one hour		90 27 19,0	Moon's $\mathcal{R}$ at 12^h
0·4271 = p. l.		1^h 7^m 19^s	
		11	

Time at Greenwich of obs. at Port Bowen = 12 7 19
Time at Port Bowen ..... = 6 9 17

Long. of Port Bowen, from first approx. = 5 58 2

It appears that the longitude has been assumed in defect more than one hour. Therefore, to 12^h 7^m 19^s re-calculating the moon's declination, parallax, &c.; also, the sidereal time to the sun's variation in one hour, &c.; and proceeding as before, we obtain,

	h	m	s
Time at Greenwich	12	4	52,5
Time at Port Bowen	6	9	17
Long. of Port Bowen	5	55	35,5

It is obviously unnecessary to repeat the calculation *in detail*, as above, where there are so many constants.

Another approximation might perhaps alter this result a second or two.

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Table for reducing the Latitude to the Geocentric Latitude, and the Earth's Equatorial Diameter to the Diameter at a given Latitude. Compression $\frac{1}{300}$.

Latitude	Angle of the vertical.	Log. of the earth's radius.	Prop. log.
1°	0′ 24″	9·9999996	0
4	1 36	9·9999930	0
7	2 46	9·9999787	1
10	3 55	9·9999567	1
13	5 1	9·9999273	1
16	6 4	9·9998908	1
19	7 3	9·9998477	1
22	7 57	9·9997983	2
25	8 46	9·9997431	2
28	9 30	9·9996829	3
31	10 7	9·9996182	3
34	10 38	9·9995497	4
37	11 1	9·9994782	5
40	11 18	9·9994044	5
43	11 27	9·9993291	6
46	11 28	9·9992532	7
49	11 22	9·9991776	8
52	11 9	9·9991030	8
55	10 48	9·9990302	9
58	10 20	9·9989601	10
61	9 45	9·9988934	11
64	9 4	9·9988308	11
67	8 17	9·9987732	12
70	7 24	9·9987211	12
73	6 26	9·9986750	13
76	5 24	9·9986356	13
79	4 19	9·9986031	13
82	3 10	9·9985782	14
85	2 0	9·9985610	14
88	0 48	9·9985517	14

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XXX. *Account of a private Observatory, recently erected at Bedford. By Captain W. H. Smyth, R.N., Foreign Secretary to the Society.*

Read December 10, 1830.

Being now in the possession of a transit instrument and clock, which have been some time preparing for me, I beg to return those belonging to the Astronomical Society; and I have to present my sincere thanks for the liberal manner in which the loan was conferred, as being both grateful to my feelings, and highly illustrative of the earnest and honourable zeal with which the Society ever encourages the efforts of individuals, in the cause of science. In rendering this acknowledgment, I embrace the opportunity of submitting a few details respecting the means now in my power for forwarding the views of our association; because it may be satisfactory to many of its members to be acquainted with the nature and degree of confidence assignable to such observations as I may, from time to time, transmit to them.

Having duly weighed my object in erecting an observatory, I drew a plan on as small and economical a scale as was consistent with the required efficiency. Aware of the advantages of site and insulation, in guarding against local effects and corpuscular attractions, I caused a deep foundation to be placed on a hard bed of gravel, in the middle of my garden, and raised thereon a nine-inch brick wall, which was lathed and plastered over stout oak battens. The edifice stands at a convenient distance from high roads, and commands the passage of *Fomalhaut* to the south, and the lower transit of *Capella* to the north, well clear of trees, houses, or other obstructions.

The outer, or meridian room, is 17 feet in length, 12 in breadth, and 10 in height, having a flat roof, covered with sheet-lead. On a stone pedestal, in the centre of the south wall, stands the clock, enclosed in a strong mahogany case, and bracketted to substantial oak supports. The escapement is Graham's dead-beat; and in order that no irregularity should be given to the maintaining force by friction, the wheel-work is

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constructed with singular care. It has a screw adjustment for setting it in beat, and cross levels for watching the state of the same. The pendulum is mercurial; it consists of a round steel rod suspended by a spring, which passes through the quick-silver into a screw socket near the bottom of the inside of the cylinder; thus giving the means of the usual adjustment for length. The cistern is of brass, coated inside, and closed with a graduated circle with fixing-screws. The steel rod is covered with a brass tube; so that it is not more exposed to any accidental changes of heat or cold, than the mercury itself, with which it is in constant contact, and therefore in mutual communication of temperature. The cylinder is terminated by a steel point, which indicates the arc of vibration by a neat fixed scale. Upon the clock stands a small and sensitive inverted pendulum, called "Hardy's Noddy," enclosed in a glass bell, on a frame with three adjusting screws; its object is to discover whether the pendulum imparts any motion to its supports.

Opposite to the clock is the entrance, sheltered from sudden currents of air by a porch with a spring door. The spaces on the right and left are bisected by slits, 18 inches wide, which reach down through the north and south walls to the level of the circle and transit telescopes, each of which respectively occupies one. The vertical portion of the slits is closed by glazed windows, with shutters inside to exclude the solar rays; and the continuous portions across the roof are fitted with wooden flaps, covered with copper, and counterpoised by weights hanging in cells outside the east and west walls. The floor is supported on oak joists, forming square frames around the circle, transit, and clock bases, so that the planks are firm, yet entirely detached from the piers, and therefore communicate no tremors to them; whilst a free circulation of air is secured beneath, by means of small iron gratings. The whole of the piers are raised on solid masonry, from a compact bed of gravel, and their immobility has been well proved.

The transit instrument is an excellent specimen of the skill of Mr. Thomas Jones, of Charing Cross, and has been constructed expressly to meet my wishes. It consists of a telescope of $3\frac{1}{2}$ feet focal length, furnished with a very superior object-glass, whose aperture is 3·25 inches: this is supported by broad cones, forming an axis of 28 inches in length, the pivots of which I have submitted to a rigorous trial as to their cylindrical accuracy, by levelling the axis in every position, with the illuminated end

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alternately east and west, and I cannot detect any appreciable disparity. They rest on covered Y's, offering a surface of polished Brazilian pebble, an inch in bearing, and which (owing to their bases being hemispherical, and working in corresponding sockets) hold their proportionate weight, as well as insure the axes of the pivots being always strictly in the same right line. The Y's are placed on improved cheeks, whose azimuthal and vertical motions are effectually secured from dust and injury, and leave the shoulders of the pivots just sufficient room for moving without friction: they are morticed upon two piers of Portland stone, 5 feet 7 inches above the floor, and which, with their bases, weigh a ton each. The axis contains a contrivance for regulating the light on the lines, by means of a milled head on the telescope tube; and there is, moreover, a rack-screen to the lamp, for the same purpose. In the ocular focus are five principal vertical wires, besides two for the pole-star, crossed by a horizontal one; with a slide and divided scale, for bringing the axes of the eye-tubes exactly over the respective wires, and thereby destroying parallax. This part is also fitted with a simple means of nicely adjusting to the solar focus, and of changing the piece bearing the spider-webs, in case of accident. For setting the telescope, the eye-end is furnished with two circles of 6 inches diameter, divided on silver, with levels, shewing altitudes and zenith distances. Finally, there are four eye-pieces, magnifying 33, 60, 80, and 120 times; and the object-end has a cap pierced with three apertures, constantly attached to, and balanced with the instrument. The level for securing horizontality is a *rider*, of excellent workmanship: it is suspended by the centre, in its long brass frame and cell, instead of by the ends, as usual, owing to which it is free from contact, and safe from alterations in the ground curve: it shews seconds, and is accompanied by a small bubble, at right angles, with a screw-counterpoise and pillars, whereby the level may be reversed, end for end, with great facility, with regard to similar positions, and it stands the utmost scrutiny.

Corresponding to this instrument I have placed so useful and convenient a check, in a near meridian mark, that I cannot but strongly recommend its general adoption, as affording the means, by illumination at night, of verifying the transit's position at the times of observation, besides its being free, in daylight, from the tremulous action arising from the solar rays. Such a mark was formerly objected to, because it was thought necessary that the focal length of the telescope should be adjustable to it—a condition inconsistent with that

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permanency of position in the axis of vision to the axis of motion, so essential in a meridional instrument, because any lateral motion between the Y's would put the mark apparently out of the meridian. To obviate this defect, and obtain the advantage of a mark in my own power, I applied to Mr. Robinson, of Devonshire Street, to construct one for me, of which this is the description. A plate of brass, about $\frac{4}{10}$ of an inch in thickness, 5 inches long and 3 wide, is fastened, by four screws passing through its corners, to a stone, into which four brass sockets had been previously fixed, by melted lead, to receive them. On this plate there slides another of the same thickness, $3\frac{1}{2}$ inches long by $1\frac{1}{2}$ broad, attached to the former by dove-tailed side pieces, and adjustable by two long screws pressing against its ends. In the sliding-plate are also four long openings, to admit four capstan-headed screws, by means of which the sliding-plate is to be firmly screwed to the fixed one, after the mark is adjusted to the meridian, when, to prevent disturbance, the end screws are withdrawn altogether. On the sliding-plate is soldered a square piece of silver, bearing a well-defined black cross as a mark for the meridian. But as this scarcely affords sufficient length for examining the instrumental collimation, I applied a small circle of silver, $\frac{1}{6}$ of an inch in diameter, with a black dot in its centre, to the top of the fixed brass plate, movable laterally by two slender screws, which may also be taken out when the dot is once vertical with the bisection of the cross below it; and this I find to answer admirably. The stone to which the mark is fixed is morticed into a low pier, to guard against lateral action, and the whole has a firm foundation sunk into the gravel: earnest attention must be paid to this, as a motion of about $\frac{3}{1000}$ of an inch, with fifty feet radius, is equivalent to one second. The remaining and important part of this arrangement is a four-inch lens, ground by Tulley for a focal length of $49\frac{1}{2}$ feet, which is exactly its distance from the diaphragm: this is encircled by a brass rim, and attached by screws to a plate of cast-iron, which is let into the south wall, close under the window, in a line with the transit instrument. It is evident that the rays of light from the meridian mark become parallel after passing through the lens, and that the diaphragm can therefore be viewed through a telescope adjusted to solar focus. Another consequence of the rays being rendered thus parallel is, that no parallel motion of the transit axis would cause a change in the place of the image seen; so that the meridian is a line drawn from the diaphragm through the axis of the

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lens; and provided these two points remain rigidly permanent, they offer every advantage of a distant meridian mark. After all, the latter one can still be used, when obtainable, as a check to the near one.

Under the western slit of the meridian-room stands the beautiful Lee Circle, belonging to the Society. It was made by that distinguished artist, our venerable Troughton, in 1793, and is by far the most perfect specimen of simplicity in design, united to comprehensiveness of object, that I have yet met with amongst graduated instruments of similar dimensions; I therefore regret to add, that it not only evinces marks of premature age, but also of former neglect, and even ill-treatment. It is two feet in diameter, with a telescope of 30 inches focal length. The divisions are by dots on gold, to every five minutes, and to ten minutes by lines on the brass limb, the latter serving for rough reading by an ingeniously-contrived vernier, and the former being subdivided to seconds by two horizontal microscopes. It is furnished with two spirit-levels at right angles: the long one is fixed to the arms bearing the microscopes, while the other rides across the radii of the circle; and there is a capital plumb-line, with a ghost apparatus. The whole stands on a massy stone pier, of nearly two tons weight, imbedded in masonry which descends into the firm substratum of gravel. Owing to this advantage, the adjustments are retained with singular constancy; and the instrument being breast-high from the floor, affords the observer every convenience of position. To add to its power, I have placed a horizontal floating collimator in the south wall, as a fixed point; and immediately above the circle, two horizontal beams, stretching across the observatory, bear a large vertical collimator, which slides by four friction-rollers on an iron rail-way, when required to be removed out of the zenith. These additions were made for me by Mr. Robinson, under Captain Kater's personal inspection.

Four steps to a door-way in the western wall lead into a circular room, fifteen feet in diameter, containing the polar axis to which my large refractor is attached, forming what I term rather a telescope mounted equatorially, than an equatorial instrument, though the mechanical arrangement is so simple and effective, as to reflect much credit on Mr. G. Dollond. Aware of the *swagging* which all rotatory roofs must be liable to when placed, as usual, in the centre of a square room, I determined on adopting a circular one, because it was evident that the wall would offer points of support on all its

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bearings, and enable me to have a dome of more than ordinary dimensions. The wall is capped with an iron channel, containing three balls of the same metal, 4 inches in diameter, on which a conical roof revolves, having two glazed windows in it, and shutter-flaps reaching beyond the zenith, similarly counterpoised with those before described; and in order that no possible damage may be done to the instrument, or injury accrue to the observer, the dome is turned round from a *fixed* platform of steps. On the north side, a stone pier, on a foundation of brick, rises to the height of ten feet above the floor, bearing a cast-iron frame, the apex of which, furnished with the requisite adjustments, constitutes the Y for the upper pivot of the polar axis; while the lower one turns on a polished metal centre, imbedded in a stone pier on the south side. The body of the axis resembles, in shape, a large anchor-stock: it is made of four mitred slabs of well-seasoned mahogany, strongly braced together by screws that pass through them to interior brass squares, and terminating in large bell-metal pivots, through the shoulders of which fine holes are drilled for the admission of air: its length is 13 feet by 10 inches square in the middle, and 8 at the ends. The telescope is carried by a stout axle through a hollow centre of bell-metal firmly secured by flanches, and is attached by three broad clasps to a brass trapezium, five feet in length, over a declination circle of the same metal, three feet in diameter, fixed and put into slow motion by a spiral spring-clamp and tangent-screw, and which, by its vernier, is divided to every 10″. These are counterpoised by a ball of lead supported with an iron crow-foot on the opposite side; but I have not yet decided whether I shall not shortly remove this, and substitute a telescope, now in the observatory, of 10 feet focal length, and $3\frac{3}{4}$ inches of aperture, of which project and its object I may have more to say hereafter. The hour circle is of the same metal and magnitude with the declination one; it reads both time and space, and is fitted with a very efficient clamp, and also an endless screw, on a wormed edge, to which a clock-work motion may be applied. The whole of the movements are remarkably easy, so that the telescope may be directed either equatorially or in declination, by the finger; nor is there as yet any detected flexure in the axis, or expansion in its supports. A small horary circle, divided on silver, made for me by Mr. Fayrer, is screwed to the axis, under the counterpoise, as an expeditious finder in right ascension when the observer is far from the vernier of the hour circle, or in a hurry: it is

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moved with a rack and pinion, and is furnished with a swinging level, as the plane of the circle must make a right angle with the axis, and therefore assumes an inclination from the vertical position. A clear-toned, dead-beat *journeyman* clock completes this room; and well-made marks of enamel, silver, and mother-of-pearl, fixed in a distant house, afford means for adjusting the eye-pieces and their foci.

It now remains to describe the telescope itself. It is an achromatic of $8\frac{1}{2}$ feet focal length, with a double object-glass of $5\frac{9}{10}$ inches clear aperture, which may perhaps be deemed the finest specimen of the late Mr. Tulley's skill: the flint-glass portion was made from a disc purchased at Paris, in 1828, by Sir James South, who obligingly disposed of it to me, on his acquiring the gigantic one which he is now mounting. When it came into my possession, I engaged Mr. Dollond to make a concerted range of eye-pieces, which were afterwards carefully proved to have powers from 22 to 1200; and, on repeated trials, I find the instrument bears its highest magnifiers with remarkable distinctness, as is especially evinced by the roundness of small discs, the dark increase of vacancy between close double stars, and from particular portions of the moon when dichotomised. A fine double-line position micrometer, whose screws have been rigidly examined under every revolution, and a spherical rock-crystal micrometer by Dollond, for measuring minute angles where illumination cannot be used, accompany the eye-pieces, with a scale of powers from 62 to 850. The whole battery can be rendered diagonal for objects in the zenith, by the instant application of a Wollaston Prism made to fit them: there is also a contrivance, of the utility of which I am as yet doubtful, called "Budd's Centre," for viewing satellites by hiding the body of the planet, and a pearl screen for shading the moon's limb during occultations. In giving this high character of my telescope, it is proper to state that I have tried its light by the cluster in the sword-handle of *Perseus*, by several of Messier's nebulæ, and by resolving portions of the *Via Lactea* into stars. Its distinctness is proved by the ready vision of the companions of *Polaris*, *Rigel*, *α Lyræ*, and *α*^{1} *Capricorni*; and also by the facility with which *λ Ophiuchi*, *τ Aquarii*, *θ Persei*, *μ Cephei*, *δ Serpentis*, *ζ Herculis*, and *ε Boötis*, are seen double; *ζ Orionis*, and *ξ Libræ* triple; *β Capricorni* quadruple; and *σ Orionis* multiple. Lastly, I estimate its general action by the lunar mountains, cavities, and shadows, under all powers; the lucid polar regions of *Mars*, the sharpness of the double ring

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of *Saturn*, the gibbous aspect of *Venus*, the shadows of *Jupiter's* satellites across his body, the splendid contrast of colours in α *Herculis*, γ *Andromedæ*, and other superb double stars, and the comparative facility with which such tests as σ *Coronæ Borealis*, τ *Aquarii*, θ *Virginis*, η *Boötis*, and δ *Equulei*, admit of measurement. Of these it may not be uninteresting to add, that, in consequence of a letter from Mr. Herschel, I examined the remarkable orbital change of quadrant which has occurred in the first, since 1825; and that I have had a fair comparison with him, in measuring the position and distance of the last, to very considerable accuracy.

Outside the walls of the observatory, for the space of ten feet, the earth was entirely removed, and the vacancy filled up with broken bricks and gravel; and as all the water from the top is carried off by pipes to a distant cess-pool, the effects of damp are guarded against, which is a very necessary precaution where no fire should be lighted. In front of the building there is a solid pedestal for a magnetic transit instrument, of great delicacy of action, and capable of every variety of adjustment.

The secondary arrangement of my plan relates to meteorology, a department of knowledge which has, I think, been hitherto injuriously undervalued in astronomical registers: for who that has observed much in opposite winds, or seen the increased scintillation and flitting of small stars, or the opening of others previous to rain, would deny that many atmospherical variations still require to be studied to render our theories of refraction less imperfect? There can be but little doubt that many of the minor faults of which instruments and observers have usually borne the *onus*, ought to have been attributed to this uncertain element. In order that my own observations should have all the consistency which equalised temperature can confer, there is a double thermometer of Six's on the wall which divides the meridian and equatorial rooms, hanging parallel to a barometer by Dollond, which some years' experience enables me to rely upon: its cistern is $3\frac{1}{2}$ feet from the floor, and about 28 above the River Ouse. A self-registering thermometer, by Troughton, is placed on the outside of the north wall, under the transit window, perfectly screened from the sun, and from any reflection of solar rays. Previous to observation, I usually see that all the instruments are in proper state for action, and open the door and north windows, so as to bring the outer and inner thermometers to a near agreement. At the outer angles of the roof are placed an evaporator

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and a rain-gauge. The first is a hollow cylindrical vessel of copper, 12 inches in diameter and 5 in depth, furnished with a cover elevated 3 inches above it, but of larger circumference, to prevent the intrusion of birds, and occasion a current of air free from rain and sun. The second is a copper funnel of the same periphery, and the water caught in its area is measured off in an adapted glass tube, which is graduated to thousandths of an inch. To these is added a neat hygrometer, made by Robinson, with twisted filaments of the *andropogon contortum*, a grass brought from India by Captain Kater, and which, from its extreme sensibility, admits of an index being graduated to a thousand parts, from immersion in unslacked lime to extreme moisture. It may be trite; but after Lalande's eulogy of the tinman on *Quai des Augustins*, I may mention, that an arrow, clear of all obstructions, shews the direction of the wind: it is above the centre of the dome, but, from the interior arrangement of the piers, quite clear of the zenith of the telescope.

Such being the means in my possession for carrying on future observations, I have now to state the *position* of the observatory, in a geographical point of view. And here I must relate an error into which I fell on commencing the building. Desirous of obtaining a temporary latitude for tabulating the Greenwich stars for the transit instrument, I took a micrometrical measurement to the clock on St. Paul's spire, in the town of Bedford, on an azimuth bearing, which gave 20″ from the perpendicular, and 17″ from the meridian. This I applied to a manuscript note given me by a friend, with an assurance of its having been written by the late General Mudge; and therefore concluded my latitude to be about 52° 8′ 48″, and longitude 27′ 12″, until, on working several polar distances which I afterwards took, with the Beaufoy Circle, the results came out 52° 8′ 25″,9. As I was then also reducing some observed occultations, and was aware that 23″ of difference must be sensible in the lunar parallax, I determined to prove the point. But that circle being, by the Council's permission, transferred to the Rev. M. Ward, I awaited the arrival of the Lee one; and then the erection of the polar-axis room, the delays of workmen, and other causes,—of more annoyance to me than interest to others,—prevented my attending to it till the end of August, when the accompanying observations were commenced. It is due, however, to that great national undertaking, the Trigonometrical Survey, to add, that in the mean time I found

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my friend was unable to substantiate the authenticity of his note; and that I believe the position of St. Paul's steeple, as printed in the *Philosophical Transactions*, to be extremely correct.

Having experienced much loss of time, when on public service, from the necessity of awaiting consecutive periods for completing observations, I resolved to give Capt. Kater's vertical collimator a strict trial as a zenith point, from its obvious dioptric property of converging parallel rays. In using it with the Beaufoy Circle, I was much pleased with its action; for the convenience of each altitude being complete in itself, without the necessity of reversing the circle, constitutes an invaluable quality. In the fifteen months which elapsed between the taking down of the one circle, and working the other, the collimator was covered up on account of the dust occasioned by bricklayers and masons. Yet, soiled as it necessarily became, when it was occasionally uncovered for examination by astronomical friends, it constantly and readily formed as rigid a zero as before the interruption. In the annexed observations,—which are amenable to the collimator, without any reference to either level or plumb-line,—it will be seen that the inclination of the floating optical axis was purposely varied, by weights, without at all affecting the final deductions. Now, as the accuracy of all celestial labours depends upon proper compensating adjustments, every improvement in applying them must be cheerfully welcomed by astronomers. The instability of levels, and the difficulty of pronouncing a plumb-line either perfectly straight or cylindrical, are universally acknowledged; but the obviating the necessity of these is only a portion of the praxis of the vertical floating collimator; its principal claim to regard is, that, by its azimuthal motion of 180°, it shews the amount of the error of collimation in altitude, and of any deviation in the circle's vertical axis, and thus gives the means of yielding a complete and final result for every single observation.

On the whole, from witnessing that it possesses sufficient stability for its times of action, the conclusion I have arrived at is, that this powerful appendage—whether used above or below—will, in the end, be deemed an integral part of every meridian circle; that its cheapness, portability, and facility of correction, render it highly desirable and available to officers and others employed on scientific missions; and that its results harmonise in a more remarkable degree than by the usual means of level and plumb-line, taken with twice the time and trouble. And when all the obstacles to the

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extensive use of reflection are considered, the collimator presents advantages too obvious to be overlooked.

The refractions in the subjoined list are reduced by Ivory's tables, as inserted in Mr. Baily's useful volume; and as the *modus operandi* is in some respects new, I have tabulated the various stars, almost to the type of calculation. The whole were observed with the same eye and eye-piece; and in estimating the ultimate differences, it should be borne in view that the zenith point is not answerable for the amount of the discrepancies; on the contrary, instrumental eccentricity, faults of reading, imperfections of division, anomalies of refraction, casualties of bisection, and a probable constant error in the diagonal lens, are all combined;—added to which, I so far disregarded the inventor's directions, as not to close the shutters during the operation of bisecting the diaphragm; because my object was not so much bent upon measuring minute agreements, as the justly estimating the power of the instrument, and ascertaining what might be effected by its more rapid and exposed application. I must also correct an erroneous impression which has obtained, as to the necessity of the vertical floating collimator being returned *exactly* to a zenith bearing over the telescope of the circle. This is by no means called for: it is the ready recurrence of the simple optical law of parallel lines which renders the instrument so eminently useful; for any descending rays, entering whatever part of the field of view, must be converged in the centre of the ocular focus.

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OBSERVATIONS.

No.	Date.	Star.	Face.	Mic.	Readings.	Vertical Collimator. Direct.	Vertical Collimator. Reversed.	Thermometer. Exter.	Thermometer. Inter.	Barom.
	1830.					z	z'			Inches.
1	Aug. 30	α Aurigæ	E	A	83° 38′ 12″,6	89° 57′ 46″,8	89° 57′ 52″,5	45°·8	50°·0	30·00
				B	38 12,2	57 41,5	57 45,2			
2	—	γ Orionis	—	A	44 1 47,6	89 57 53,3	89 57 48,8	47·8	50·5	30·09
				B	1 45,5	57 50,6	57 45,0			
3	—	α Canis majoris	—	A	21 22 41,5	89 57 54,3	89 57 55,5	51·6	53·0	30·10
				B	22 37,8	57 51,8	57 50,9			
4	—	α Canis minoris	—	A	43 29 40,5	89 57 53,3	89 57 56,9	54·0	55·2	30·10
				B	29 38,7	57 50,0	57 53,8			
5	31	α Tauri	W	A	35 56 6,5	89 57 59,6	89 58 4,9	45·0	47·0	30·19
				B	56 4,9	57 58,8	58 3,5			
6	—	γ Aquilæ	—	A	41 52 54,3	89 58 8,8	89 58 9,2	57·0	57·0	30·23
				B	52 48,7	57 59,5	58 0,7			
7	—	β Aquilæ	—	A	46 5 52,3	89 58 9,6	89 58 12,8	56·8	57·0	30·23
				B	5 44,6	58 1,4	58 3,1			
8	—	α^2 Capricorni	—	A	65 8 2,5	89 58 13,5	89 58 4,8	56·0	56·0	30·23
				B	7 52,5	58 1,3	57 59,5			
9	—	α Piscis Australis	—	A	82 30 22,5	89 58 4,5	89 58 8,9	54·0	54·0	30·24
				B	30 18,4	58 0,6	58 4,4			
10	Sept. 1	γ Draconis	—	A	0 35 14,1	89 58 6,6	89 58 5,6	62·0	60·7	30·23
				B	35 9,5	58 1,7	57 59,1			
11	—	β Lyræ	—	A	18 55 31,8	89 58 5,4	89 58 8,9	60·5	59·0	30·23
				B	55 30,2	57 58,9	58 0,8			
12	—	ζ Aquilæ	—	A	38 28 18,0	89 58 8,0	89 58 3,3	59·4	58·3	30·24
				B	28 11,1	58 4,5	57 56,0			
13	—	α^2 Capricorni	—	A	65 7 47,5	89 58 1,9	89 57 55,4	57·5	56·4	30·24
				B	7 43,8	57 51,5	57 44,1			
14	—	α Aquarii	—	A	53 13 9,2	89 57 56,2	89 57 59,5	55·0	54·0	30·23
				B	13 6,1	57 50,3	57 53,8			
15	3	α Boötis	E	A	57 54 28,8	89 57 57,5	89 57 53,4	66·4	64·5	29·80
				B	54 30,5	57 58,6	57 54,1			
16	11	α Scorpii	—	A	11 51 14,8	89 58 1,4	89 57 58,7	59·0	57·7	29·75
				B	51 19,9	58 7,9	58 2,8			
17	—	α Ophiuchi	—	A	50 32 6,6	89 57 57,6	89 57 59,9	56·1	55·8	29·75
				B	32 10,5	58 1,4	58 3,2			
18	—	α Lyræ	—	A	76 27 55,7	89 57 54,1	89 57 55,3	53·5	53·8	29·75
				B	28 1,5	57 57,2	57 56,9			
19	—	β Lyræ	—	A	71 0 26,2	89 57 54,4	89 58 1,7	53·0	53·7	29·76
				B	0 30,5	57 57,1	58 3,2			
20	—	δ Aquilæ	—	A	40 38 11,8	89 58 7,6	89 58 15,7	52·5	53·0	29·76
				B	38 1,4	57 56,8	58 3,6			

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DEDUCTIONS.

No.	Inclin. of collimator. $\frac{z-z'}{2}$	Zenith Point. $\frac{z+z'}{2}$	Correction.	Refraction.	Zenith Distance.	Latitude.	Remarks.
1	2″,350	89° 57′ 46″,500	+2′ 13″,500	0′ 6″,500	6° 19′ 40″,600	52° 8′ 21″,500	Wind W.S.W. Fine weather.
2	2,525	89 57 49,425	+2 10,575	1 0,587	45 57 3,462	21,482	Indistinct from daylight.
3	0,075	89 57 53,125	+2 6,875	2 27,727	68 37 41,202	21,902	Full glare of day.
4	1,850	89 57 53,500	+2 6,500	1 1,016	46 29 14,916	23,956	Glare, but well bisected.
5	2,500	89 58 1,700	+1 58,300	0 42,885	35 58 46,885	22,525	Fine morning. Wind S.W.
6	1,225	89 58 4,550	+1 55,450	0 52,020	41 55 38,970	20,640	Indifferently bisected.
7	0,400	89 58 6,725	+1 53,275	1 0,290	46 8 42,015	22,925	Light westerly airs.
8	2,625	89 58 4,775	+1 55,225	2 4,925	65 11 57,650	24,020	Indifferent. Evening hazy.
9	2,050	89 58 4,600	+1 55,400	7 0,230	82 39 16,080	22,189	Wind W.S.W. and tolerably fine.
10	0,900	89 58 3,250	+1 56,750	0 0,614	0 37 10,664	20,664	Beautiful weather: fair bisection.
11	1,350	89 58 3,500	+1 56,500	0 19,800	18 57 47,300	26,820	Indistinct from light haze.
12	3,300	89 58 2,950	+1 57,050	0 45,955	38 30 57,555	22,875	B over a faulty dot.
13	3,475	89 57 53,225	+2 6,775	2 4,703	65 11 57,128	23,488	Very fairly bisected.
14	1,700	89 57 54,950	+2 5,050	1 17,936	53 16 30,636	21,576	B on a bad dot.
15	2,150	89 57 55,900	+2 4,100	0 35,141	32 4 1,391	24,871	A fresh N.W. wind on the collimator.
16	1,950	89 58 2,700	+1 57,300	4 23,620	78 11 8,970	27,430	Hazy. Difficult bisection.
17	1,025	89 58 0,525	+1 59,475	0 46,996	39 26 38,871	24,811	Tolerable.
18	0,225	89 57 55,875	+2 4,125	0 13,797	13 30 11,066	27,866	After α *Lyræ* put a weight on the float.
19	3,350	89 57 59,100	+2 0,900	0 19,764	18 57 50,514	31,134	Very difficult bisection.
20	3,725	89 58 5,925	+1 54,075	1 6,958	49 21 6,283	52 8 25,643	Well bisected. Took the weight off.

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OBSERVATIONS.

No.	Date.	Star.	Face.	Mic.	Readings.	Vertical Collimator. Direct.	Vertical Collimator. Reversed.	Thermometer. Exter.	Thermometer. Inter.	Barom.
	1830.					z	z'			Inches.
21	Sept. 11	γ Aquilæ	E	A	48° 3′ 19″,0	89° 58′ 13″,5	89° 58′ 10″,9	51°·9	52°·4	29·76
				B	3 12,4	58 3,1	57 58,5			
22	—	β Aquilæ	—	A	43 50 32,3	89 58 10,3	89 58 17,4	51·7	52·0	29·76
				B	50 20,5	57 55,5	58 4,4			
23	—	α^2 Capricorni	—	A	24 48 18,2	89 58 14,2	89 58 9,6	51·4	51·1	29·75
				B	48 7,2	58 3,7	57 58,1			
24	—	α Cygni	—	A	82 30 58,4	89 58 10,4	89 58 17,8	50·9	50·5	29·75
				B	30 50,7	57 59,6	58 6,1			
25	12	α Leonis	—	A	50 38 2,8	89 58 14,7	89 58 10,8	58·0	58·9	29·37
				B	37 58,5	58 10,2	58 3,9			
26	—	α Boötis	—	A	57 54 41,3	89 58 9,3	89 58 6,6	57·6	57·6	29·37
				B	54 37,2	58 2,0	57 59,7			
27	—	γ Draconis	—	A	82 20 59,5	89 58 9,3	89 58 13,5	54·0	55·5	29·35
				B	20 56,9	58 0,4	58 3,4			
28	—	α^2 Capricorni	—	A	24 48 22,8	89 58 16,9	89 58 14,4	52·0	52·8	29·34
				B	48 10,1	58 9,4	58 6,6			
29	—	β Aquarii	—	A	31 32 54,3	89 58 17,5	89 58 12,7	50·7	50·5	29·34
				B	32 42,1	58 10,5	58 3,6			
30	—	α Aquarii	—	A	36 43 3,9	89 58 16,8	89 58 14,6	49·8	49·9	29·35
				B	42 57,1	58 7,7	58 8,3			
31	13	ζ Aquilæ	W	A	38 28 30,3	89 58 15,7	89 58 17,8	55·2	55·2	29·55
				B	28 18,1	58 1,4	58 3,6			
32	—	α Aquilæ	—	A	43 39 52,8	89 58 19,2	89 58 13,0	53·9	53·7	29·58
				B	39 41,7	58 4,5	57 55,7			
33	—	α^2 Capricorni	—	A	65 8 14,5	89 58 16,0	89 58 18,7	53·0	53·0	29·55
				B	7 58,8	58 0,5	58 1,4			
34	—	β Aquarii	—	A	58 23 35,0	89 58 13,3	89 58 8,5	51·4	50·7	29·54
				B	23 25,8	58 2,3	57 55,8			
35	—	α Piscis Australis	—	A	82 30 36,7	89 58 11,2	89 58 3,9	50·5	49·7	29·53
				B	30 27,3	58 4,9	58 0,5			
36	26	δ Ursæ minoris	—	A	55 31 47,1	89 58 21,8	89 58 18,3	54·5	54·7	30·22
				B	31 35,2	58 7,9	58 4,6			
37	—	δ Draconis	—	A	74 44 40,9	89 58 18,6	89 58 21,5	54·0	53·8	30·22
				B	44 30,9	58 3,5	58 4,4			
38	—	γ Ursæ majoris	—	A	16 48 16,9	89 58 22,2	89 58 19,8	48·5	48·5	30·24
				B	47 58,1	58 9,7	58 6,4			
39	28	α Ursæ majoris	—	A	79 27 2,1	89 58 11,9	89 58 9,4	64·0	59·0	30·19
				B	26 58,3	58 8,5	58 5,3			
40	29	α Ursæ minoris	—	A	50 31 38,5	89 58 12,7	89 58 7,1	58·0	58·4	30·02
				B	31 33,7	58 5,9	57 58,4			

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DEDUCTIONS.

No.	Inclin. of collimator.	Zenith Point.	Correction.	Refraction.	Zenith Distance.	Latitude.	Remarks.
	$\frac{z-z'}{2}$	$\frac{z+z'}{2}$					
21	1,″800	89° 58′ 6,″500	+1′ 53,″500	0′ 51,″750	41° 55′ 42,″550	52° 8′ 25,″130	Fair and easy bisection. Put two weights on.
22	4,000	89 58 6,900	+1 53,100	0 59,975	46 8 40,475	22,115	Good observation. Took one weight off.
23	2,550	89 58 6,400	+1 53,600	2 4,218	65 11 57,918	24,178	Very fair.
24	3,475	89 58 8,475	+1 51,525	0 7,566	7 27 21,491	24,491	Tolerable.
25	2,550	89 58 9,900	+1 50,100	0 45,991	39 20 55,241	30,891	Light W.S.W. wind. A a bad dot.
26	1,250	89 58 4,400	+1 55,600	0 35,220	32 4 0,370	23,020	Daylight glare; but tolerable.
27	1,800	89 58 6,650	+1 53,350	0 0,603	0 37 9,053	19,853	Pretty good, though light haze.
28	1,325	89 58 11,825	+1 48,175	2 2,221	65 11 57,596	23,846	Tolerable.
29	2,925	89 58 11,075	+1 48,925	1 32,582	58 26 55,457	25, 07	Indifferent, from haze.
30	0,400	89 58 11,850	+1 48,150	1 16,470	53 16 27,820	19,320	Ditto. A mere hazy point.
31	1,075	89 58 9,625	+1 50,375	0 45,231	38 30 59,806	25,966	Wind west. Fair observation.
32	3,750	89 58 8,100	+1 51,900	0 54,550	42 42 33,700	30,020	Tolerable.
33	0,900	89 58 9,150	+1 50,850	2 2,935	65 12 0,434	26,675	Very fair bisection.
34	2,825	89 58 4,975	+1 55,025	1 32,938	58 26 58,363	28,823	Rather obscure.
35	2,925	89 58 5,125	+1 54,875	6 53,955	82 39 20,830	25,510	Tolerable.
36	1,700	89 58 13,150	+1 46,850	0 39,946	34 27 11,946	24,214	Wind W. by S. and cloudy. Fair observation.
37	0,950	89 58 12,000	+1 48,000	0 15,888	15 13 51,988	24,602	Poor bisection.
38	1,425	89 58 14,525	+1 45,475	3 12,945	73 13 19,970	25,020	Unfavourably bisected.
39	1,425	89 58 8,775	+1 51,225	0 10,637	10 31 19,212	25,668	After this, cleaned out collimator.
40	3,275	89 58 6,025	+1 53,975	0 47,209	39 27 17,134	52 8 26,706	Wind N.W. Fair bisection.

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OBSERVATIONS.

No.	Date.	Star.	Face.	Mic.	Readings.	Vertical collimator. Direct.	Vertical collimator. Reversed.	Thermometer. Exter.	Thermometer. Inter.	Barom.
	1830.					z	z'			Inches.
41	Oct. 4	α Cephei	E	A	9° 42′ 9″,9	89° 58′ 19″,5	89° 58′ 14″,6	50°·0	50°·5	30·26
				B	42 0,8	58 2,8	57 53,0			
42	—	β Cephei	—	A	17 38 56,3	89 58 14,3	89 58 20,2	50·0	50·3	30·26
				B	38 45,6	57 51,7	57 58,2			
43	—	α Ursæ majoris	—	A	65 7 58,3	89 58 17,8	89 58 16,5	47·7	48·2	30·28
				B	7 40,9	57 56,2	57 54,3			
44	5	δ Ursæ minoris	—	A	34 24 37,4	89 58 3,2	89 58 7,5	54·2	55·4	30·35
				B	24 26,8	57 52,9	58 0,5			
45	9	α Ursæ majoris	W	A	24 49 47,7	89 59 30,2	89 59 29,0	51·0	51·5	30·45
				B	49 42,7	59 28,7	59 28,5			
46	—	γ Ursæ majoris	—	A	16 49 21,1	89 59 27,8	89 59 23,1	49·0	49·6	30·46
				B	49 17,5	59 26,7	59 22,4			
47	—	α Andromedæ	—	A	23 57 49,8	89 59 20,4	89 59 22,7	49·0	49·1	30·46
				B	57 48,8	59 19,6	59 20,8			
48	—	δ Ursæ majoris	—	A	20 9 4,2	89 59 22,2	89 59 20,3	48·7	48·8	30·46
				B	9 1,8	59 21,4	59 18,3			
49	—	α Cassiopeæ	—	A	86 31 23,1	89 59 31,5	89 59 22,5	48·2	48·0	30·46
				B	31 22,3	59 30,3	59 20,8			
50	—	α Ursæ minoris	—	A	53 44 19,4	89 59 21,3	89 59 30,9	47·5	47·5	30·46
				B	44 17,5	59 19,6	59 29,5			
51	—	ζ Ursæ majoris	—	A	17 59 52,5	89 59 31,9	89 59 25,8	47·0	47·2	30·46
				B	59 46,5	59 33,5	59 26,4			
52	—	η Ursæ majoris	—	A	12 22 14,8	89 59 27,4	89 59 33,3	46·8	47·0	30·46
				B	22 10,9	59 24,3	59 28,0			
53	26	α Leonis	E	A	50 47 55,9	0 4 14,9	0 11 43,6	45·5	50·2	29·98
				B	47 42,5	4 5,6	11 39,5			
54	—	α Cygni	—	A	82 40 49,5	0 4 12,5	0 11 45,3	42·0	46·7	30·19
				B	40 39,6	4 2,5	11 42,5			
55	—	α Piscis Australis	—	A	7 35 58,6	0 4 13,0	0 11 46,9	39·6	41·5	30·26
				B	35 41,5	4 1,6	11 43,6			
56	—	α Andromedæ	—	A	66 9 26,3	0 4 11,1	0 11 51,1	37·3	39·4	30·27
				B	9 37,5	4 7,8	11 47,5			
57	—	α Ursæ minoris	—	A	36 23 19,6	0 4 11,1	0 11 53,9	36·5	39·5	30·28
				B	23 13,4	4 3,9	11 50,4			
58	—	δ Ursæ majoris	—	A	69 58 29,2	0 11 48,7	0 4 13,2	37·1	39·6	30·27
				B	58 20,4	11 43,5	4 0,9			
59	29	α Leonis	—	A	50 49 16,6	0 5 42,6	0 13 6,3	47·0	48·5	29·65
				B	49 9,3	5 37,5	12 59,9			
60	—	α Aquarii	—	A	36 54 15,3	0 13 9,4	0 5 43,6	44·7	49·0	29·72
				B	54 6,1	13 3,5	5 38,5			

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DEDUCTIONS.

No.	Inclin. of collimator. $\frac{z-z'}{2}$	Zenith Point. $\frac{z+z'}{2}$	Correction.	Refraction.	Zenith Distance.	Latitude.	Remarks.
41	0′ 3″,675	89° 58′ 7″,475	+1′ 52″,525	0′ 10″,144	9° 44′ 8″,019	52° 8′ 25″,651	Clear N.W. winds. Good obs.
42	0 3,100	89 58 6,100	+1 53,900	0 18,773	17 41 3,623	23,527	B over a faulty dot.
43	0 0,800	89 58 6,200	+1 53,800	2 7,350	65 11 50,750	26,290	A fair bisection. Took off two weights.
44	0 2,975	89 58 1,025	+1 58,975	0 40,084	34 27 11,159	25,041	Poor bisection. Microscopes adjusted.
45	0 0,350	89 59 29,100	+0 30,900	2 5,861	65 11 49,761	28,879	Wind W. N. W. Replaced a weight.
46	0 2,250	89 59 25,000	+0 35,000	3 14,008	73 13 19,708	29,532	Bisected in an Aurora Borealis.
47	0 0,875	89 59 20,875	+0 39,125	0 26,437	23 58 54,863	22,462	Cleaned the collimator cases.
48	0 1,250	89 59 20,550	+0 39,450	2 40,646	69 52 56,996	33,885	Indifferently bisected.
49	0 4,625	89 59 26,275	+0 33,725	0 3,605	3 28 7,180	24,100	Tolerable.
50	0 4,875	89 59 25,325	+0 34,675	0 44,110	36 15 50,985	28,915	Very fairly bisected.
51	0 3,300	89 59 29,400	+0 30,600	3 1,740	72 2 41,640	26,640	In a bright coruscation of Aurora.
52	0 2,400	89 59 28,250	+0 31,750	4 26,080	77 41 41,480	26,560	In the Aurora.
53	3 45,650	0 7 55,900	−7 55,900	0 48,040	39 20 54,740	25,290	Collimator cleaned, and loaded to a larger circle of the diaphragm's revolution.
54	3 48,200	0 7 55,700	−7 55,700	0 7,779	7 27 18,929	27,299	Tolerable observation.
55	3 48,975	0 7 56,275	−7 56,275	7 17,468	82 39 25,986	24,626	Light haze; but well seen.
56	3 49,925	0 7 59,375	−7 59,375	0 26,899	23 58 54,374	24,344	Very fairly bisected.
57	3 52,325	0 7 59,825	−7 59,825	0 44,381	36 16 1,056	25,184	Rather indistinct.
58	3 59,525	0 7 56,575	−7 56,575	2 39,555	69 53 7,780	30,080	Indifferent. Put another weight on the inner pin, and inserted a new set of wires in the circle's telescope.
59	3 41,525	0 9 21,575	−9 21,575	0 47,482	39 20 56,107	26,287	
60	3 42,700	0 9 23,750	−9 23,750	1 17,900	53 16 30,950	52 8 22,550	A fair bisection.

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From the foregoing list, there appears,

$$\left.\begin{array}{l}\text{By 26 stars, S. of zenith, and face E. } 52^\circ\,8' + \dfrac{639'',742}{26} = 24'',605 \\ \text{16 stars, S. of zenith, and face W. } 52\ 8 + \dfrac{387'',178}{16} = 24'',198\end{array}\right\} = 24'',401$$

$$\left.\begin{array}{l}\text{6 stars, N. of zenith, and face E. } 52\ 8 + \dfrac{155'',673}{6} = 25'',945 \\ \text{12 stars, N. of zenith, and face W. } 52\ 8 + \dfrac{324'',721}{12} = 27'',060\end{array}\right\} = 26'',502$$

As the latitude of any place of observation is a point of interest, I now determined upon giving the circle a close trial, by means of its plumb-line and levels only; and as I did not wish to disturb the newly-introduced spider-lines, I resorted to the upper and lower culminations of *Polaris:* for albeit I do not consider the slow motion of this star as at all favourable to the nicest bisections, it offers the most perfect theory of latitude attainable, by affording observations entirely independent of tabulated corrections. And though I knew the collimation of the telescope to be wide, I was also aware that it would only partake of the general affections of the circle, as arising from temperature. I therefore adjusted the axes accordingly; and the following results, corrected by Dr. Brinkley's refractions, are very satisfactory, as regards instrumental permanency, however they may fall short of establishing the absolute altitude of the polar point.

Date.	Mic.	Readings.	Face.	Thermometer. Exter.	Thermometer. Inter.	Barom.	Refraction.	Altitudes. Supra Polum.	Altitudes. Sub Polo.
1830.						Inches.			
Oct. 29	A	39° 35′ 29″,3	E	50°·1	50°·3	29·67	0′ 47″,522	° ′ ″	50° 23′ 46″,078
	B	35 23,5							
—	A	36 24 37,9	E	41·5	46·5	29·79	0 43,036	53 34 44,714	
	B	24 26,5							
30	A	50 43 4,5	W	44·6	45·2	29·99	0 48,582	.....	50 42 13,368
	B	42 59,4							
—	A	53 54 3,3	W	51·5	52·0	30·00	0 42,676	53 53 17,324	
	B	53 56,7							
Nov. 1	A	36 24 35,6	E	48·7	50·0	30·8	0 43,007	53 34 46,283	
	B	24 25,8							
2	A	39 35 27,4	E	55·0	52·7	30·9	0 47,820	.....	50 23 46,880
	B	35 23,2							
7	A	53 53 58,0	W	42·6	45·5	29·39	0 42,507	53 53 12,693	
	B	53 52,4							
8	A	50 43 2,1	W	44·1	45·0	29·65	0 48,074	.....	50 42 10,376
	B	42 54,8							
							Means.....	53 44 0,254	50 32 59,175
							Sum of the means	= 104 16 59,429	
							½ Sum = Latitude	52 8 29,715	
							Latitude by collimator.....	52 8 25,451	
							General mean	52 8 27,553	

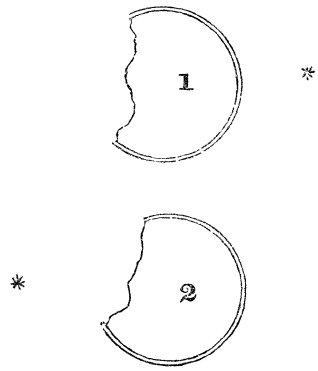
Mean app. pol. dist. by obs. = 1° 35′ 30″,54. By the Tables = 1° 35′ 31″,51, or ~ +0″,97

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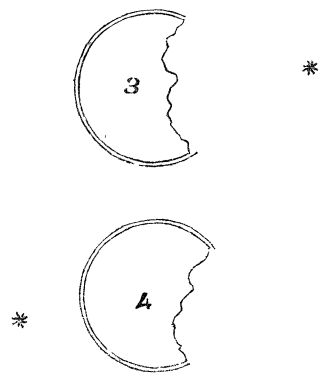
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The longitude of the Observatory had been pretty fairly established last year as $1^m\ 51^s,305$, by means of many sets of moon-culminating stars, taken in correspondence with Greenwich, Biggleswade, and Cambridge, of which the deductions were forwarded to the Society by Mr. Maclear. But although it is therefore unnecessary to repeat the whole, yet an example after Mr. Baily's formula may be given, as expressing the mode I have followed for correcting the irradiation, or indistinctness of the lunar limb,—a consequence which seems to constitute the only limit to the accuracy of this admirable and easy process of obtaining an arc. It should be noted that the moon's place has been calculated carefully, including the third order of differences. It will be seen, according to the following diagrams, that by 1 and 2 the irradiation diminishes the apparent difference of moon and star's right ascension between Greenwich and Bedford; while by 3 and 4 it increases the same. On this point, however, it is extremely desirable to establish a value by transits of the moon's bright and dark limbs, when they can be obtained. Therefore, the transits of the first limb have been algebraically increased, and those of the second diminished, by the assumed irradiation

*Moon's First Limb — **



*Moon's Second Limb — **



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Date.	Stars.	☽ ~ ✱ Greenwich.	☽ ~ ✱ Bedford.	Irrad.	Incr. Æ.	Longitude.	Irrad.	Incr. Æ.	Longitude.
1829.		m s	m s		s	m s		s	m s
May 13	ν Leonis	13 29,08	13 32,282	+·02	3,222		+·32		
	213 Virginis	10 36,08	10 32,704	−·02	3,396		−·32		
	η Virginis	29 29,04	29 25,752	−·02	3,308		−·32		
		☽ 1		Mean	3,309 =	1 42,0818		3·609 =	1 51,324
May 16	*m* Virginis	34 4,02	35 7,614	+·02	3,614 =	1 42,130	+0·32	3,914 =	1 50,579
		☽ 1							
May 17	α^2 Libræ	17 25,12	17 29,199	+·02	4,099		+·32		
	υ^1 Libræ	1 34,90	1 48,457	+·02	3,577		+·32		
	τ Libræ	6 4,58	6 0,772	−·02	3,828		−·32		
	η Libræ	35 36,92	35 33,414	−·02	3,526		−·32		
		☽ 1		Mean	3,7575=	1 41,279		4,057 =	1 49,318
May 18	η Libræ	21 15,32	21 20,066	−·02	4,676		−·32		
	49 Libræ	4 58,86	5 3,400	−·02	4,520		−·32		
	ν Scorpii	6 20,98	6 16,180	+·02	4,780		+·32		
	φ Ophiuchi	25 38,44	25 33,775	+·02	4,645		+·32		
		☽ 2		Mean	4,6553=	1 59,8716		4,355 =	1 52,139
May 19	φ Ophiuchi	31 25,06	31 29,771	−·02	4,691		−·32		
	251 Ophiuchi	2 59,32	3 04,540	−·02	5,200		−·32		
		☽ 2		Mean	4,9455=	2 02,628		4,6455	1 55,212
May 20	ξ Serpentis	23 51,76	23 56,832	−·02	5,052		−·32		
	281 Serpentis	5 10,82	5 15,780	−·02	4,940		−·32		
	μ′ Sagittarii	11 52,64	11 47,436	+·02	5,184		+·32		
		☽ 2		Mean	5,0587=	2 02,391		4,7587	1 54,7433
					Means.....	1 51,7302			1 52,2192
					Longitude of the observatory.....				1 51,9747

The average of several eclipses of the satellites of *Jupiter*, taken in 1828 and 1829, in some measure corroborate this deduction; but it is to be regretted that these phenomena have fallen into too great a disrepute, for, through all their attendant uncertainties, they afford a ready com-

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parison with telescopes of similar powers and apertures; and in a series, there is a compensation arising from the mean of the negative and positive errors. Even for that fine evening, May 18th of last year, although the planet was in such splendour as to invite attention, I can only find its observation recorded at Cambridge. Nor was I much more fortunate with simultaneous occultations of stars by the moon, till the Society's invitation aroused general notice, and the four following were watched in several places of known difference of meridian. Greenwich, of course, has been selected.

Date.	Stars.	Sidereal Time of observation.	Long. W.	Remarks.
1829.		h m s	m s	
Aug. 21	α Tauri. Em.	4 59 49,63	1 54,353	Wind S. S.W. and rather hazy.
Oct. 9	67 Aquarii. Im.	21 48 33,45	1 49,479	Wind N. by W. and cloudy, but fine at intervals.
15	α Tauri. Im.	22 48 18,96	1 49,271	W.N.W. and misty. $*$ projected $2\frac{1}{4}^s$ on $\mathfrak{D}$'s disc.
	——— Em.	23 24 7,89	1 52,841	Wind still W.N.W.; instantaneous.
			$\frac{7\ 25,944}{4}$	$= 1^m\ 51^s,486$ for Bedford.

As Mr. Riddle's ingenious formula, recently printed in the Society's *Memoirs*, brings out the observation of the 15th of October to a mean of $1^m\ 50^s,42$, it may be proper to mention, that the method I adopted for the parallaxes was suggested to me by Mr. Maclear, for trial, as a modification of Cagnoli's. The equation is

$$\sin \pi = \frac{\sin p \cos \mathrm{L} \sin \mathrm{P}}{\cos (\mathrm{D} + \pi)}$$

and

$$\sin \pi = \sin p \sin \mathrm{L} \cos \mathrm{D} - \sin p \cos \mathrm{L} \sin \mathrm{D} \cos \left(\mathrm{P} - \frac{\pi}{2}\right)$$

viz.

$$\text{sin par. in } \mathrm{R} = \frac{\text{sin hor. par.} \times \text{cos lat. of place} \times \text{sin star's hor. ang.}}{\text{cos (star's declin.} + \text{par. in declin.)}}$$

and

$$\text{sin par. in dec.} = \text{sin hor. par.} \left\{ \begin{array}{l} \text{sin lat.} \times \text{cos star's declin.} \\ -\text{cos lat.} \times \text{sin star's declin.} \times \text{cos (star's hor. ang.} - \tfrac{1}{2} \text{par. in R} \end{array} \right\}$$

The peculiarity of this mode consists in the parallax in right ascension being added to the star's right ascension if west, or subtracted if east of the meridian, to find the right ascension of the point of occultation, and then using the geocentric semidiameter without augmentation. The

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difference of the squares of the moon's true declination—the declination of this point, and of the moon's horizontal equatorial semidiameter reduced to the equator, subtracted from at immersion, or added to at emersion, the right ascension of the point of occultation, gives the right ascension of the moon's centre; a method by which the errors of the moon's place in right ascension are evaded. I also found Mr. Herschel's equations extremely simple in practice. Here the co-ordinates, instead of being referred to the equator and its perpendicular, are expressed by the method of azimuths and altitudes, with the horizon as a fundamental circle, by which the reduction of parallax to right ascension and declination is avoided.

From the tenour of these investigations, being desirous of fixing my longitude to a greater degree of certainty, it was my intention to unite Cambridge, Biggleswade, and Bedford, by flashes of gunpowder at concerted stations. On reconnoitering the country for this object, I was gratified to find that not only Professor Airy and the Rev. R. Sheepshanks promised every aid in their power; but also that Mr. Maclear, with his wonted ardour in all matters of science, on hearing of my intention, voluntarily sent me a tender of his services, and closed by offering to bear a portion of the expense. Circumstances, however, have, as yet, delayed the measure.

During the current year the accompanying occultations* have been observed with a view to the same object. I have added the reductions for an approximate average, in the absence of proper comparisons; but as they depend entirely upon the lunar tables, where an error of $0^s,6$ in time on the moon's place produces one of 12^s or 13^s in longitude, it will be seen that the disparity in the differences must exist until corresponding observations can be met with; for they are not only affected by inflection, irradiation, and the minor discrepancies of the stars, but also by the position, parallax, semidiameter, and hourly motion of the moon. Indeed, I hold these observations, when only hanging on the tables, and especially those wherein the stars are oblique to the paths, to be of little use for accurate points, unless they are watched for a lunar cycle, because the slow motion of the moon's nodes causes her, in short spaces of time, to eclipse nearly the same stars at each sidereal conjunction, and also because the errors

* The observations here alluded to have, for the sake of convenience, been arranged, with others, in chronological order, in the paper entitled "Astronomical Observations," at the end of the present volume.

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in her place are mostly constant for each point of her orbit. And though occultations, particularly when *fully* calculated, have been deservedly ranked amongst the most interesting and useful of the heavenly phenomena, there cannot be a doubt of the existence of some undetected source of fallacy in the computations. From corresponding observations, it appears that, if the immersion is positive, the emersion, as regards the assumed longitude, is generally negative, shewing that something, as yet unexplained, depends on the direction of the parallax; and that the agreement of the sines, or chords of small arcs, with the arcs themselves, is not sufficiently investigated. Thus, in the Observations of the 5th of last October, it is evident that there exists a constant error in the moon's place; the right ascension is too much, or the declination too little, for either would produce the same effect upon the longitude, because the difference of declination squared — the square of the semidiameter, is greater in proportion to the diminution of the former. The same appears in that of the 31st, or the star's place is erroneous. In all these reductions the lunar declination has been calculated to the apparent time at Bedford + $1^m 51^s$; and the interpolation of the moon's place is by the differential method. The intermixed longitudes by the satellites are only rough estimations from the Ephemeris, but the corrections suggested in the Supplement for 1830 have been applied.

Addition by Thomas Henderson, Esq., extracted from a Letter to Capt. Smyth.

Edinburgh, 72, Broughton Street, December 9, 1830.

"I return you many thanks for your kind attention to my request. Your observations are of great service to me. In comparing them, as well as Mr. Maclear's, and those at Greenwich, with the corresponding ones made here, I have deduced the following results.

BEDFORD FROM GREENWICH.			Diff. of Long.
			m s
Emersion.	Aldebaran.	August 21, 1829, ...	1 52,4
Immersion.	Aldebaran.	January 5, 1830, ...	1 50,6
Imm. and Em.	θ^2 Tauri.	March 28, 1830, ...	1 52,7
		Mean	1 51,9

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BIGGLESWADE FROM GREENWICH.

Emersion.	Aldebaran.	August 21, 1829, ...	1	4,1
Immersion.	Aldebaran.	January 5, 1830, ...	1	2,7
Imm. and Em.	θ^2 Tauri.	March 28, 1830, ...	1	2,4
		Mean	1	3,1

BEDFORD FROM BIGGLESWADE.

Emersion.	Aldebaran.	August 21, 1829, ...	0	48,3
Immersion.	75 Tauri.	January 5, 1830, ...	0	48,2
Immersion.	(99) Tauri.	January 5, 1830, ...	0	47,3
Immersion.	Aldebaran.	January 5, 1830, ...	0	47,9
Imm. and Em.	θ^2 Tauri.	March 28, 1830, ...	0	50,3
		Mean	0	48,4

"Many more such comparisons may be obtained from the observations, but the above are all which I have yet computed, not having entered upon the computation of those for which I had no corresponding observations made at Edinburgh. I had proceeded a considerable way in the investigation of the longitude of Edinburgh from occultations observed here, compared with the corresponding observations made in England and on the Continent; but I have been obliged to leave the work unfinished for the present, by the necessity of attending closely to business of a different description. The same cause has compelled me to stay away from the observatory. So far as I had gone, it appeared that the longitude obtained from the trigonometrical survey *recalculated* ($12^m\,43^s,6$) would be confirmed; and, as the uncertainty in our latitude (which I consider $55^\circ\ 57'\ 20''$) must be less, for the present I reckon our geographical position pretty well determined.

"Occultations compared with the Lunar Tables alone, I consider scarcely superior to ordinary lunar distances. They are much better when the Tables have been corrected by meridian observations made at regular observatories; but full advantage is only to be had from them when the errors of the Tables are eliminated by means of corresponding observations, or when, the places being near each other, the tabular errors affect the observations nearly in the same manner."

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XXXI. *On the Longitude of the Havannah.* By the late Don Jose Joachim de Ferrer, Member of the Philosophical Society of Philadelphia, Corresponding Member of the Royal Academy of Sciences in Paris, and of the Historical Society of Madrid, &c. Communicated by Don Felippe Bauza, late Director of the Hydrographical Department in Spain, &c.*

Read June 11, 1830.

THE occultations of the stars and planets, as well as the eclipses of the moon and of *Jupiter's* satellites, were observed with an excellent achromatic telescope, made by Mr. Edward Troughton, five Burgos feet focal length, three inches aperture, with four eye-pieces, one direct and the rest inverting. It is mounted so as to observe in the zenith, as well as in every other point of the heavens.

The occultations of the stars and of the planets were calculated previously, to determine the time and the point of the lunar disc at which the emersions were to take place. For all these observations I used the second inverting eye-piece, which has a magnifying power of 170.

The time was taken from the chronometers, No. 63 Arnold, and $\frac{1062}{466}$ Pennington, both of the highest quality, and going as exactly as could be desired for such delicate observations. Their *absolute* errors were generally determined by corresponding altitudes of the sun; but when, from clouds or other accidents, these failed, recourse was had to *single* altitudes of the sun and stars, observed to the east and west. In no case have I been uncertain more than 1^s, either of the time of occultation, or of the state of the chronometers.

* This paper is translated and extracted from two memoirs by Don Jose Joachim de Ferrer upon the longitude of the Havannah, dated April 15th, 1812, and April 5, 1816, the latter of which is the most important, and contains the details of all the computations. For the sake of economy, the great mass of calculations has been omitted, and merely one specimen given, by which the industry and talents of this accomplished astronomer may be fairly appreciated. The observations and results are given entire, with some remarks by M. de Ferrer on the subject of inflexion.

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I have observed the difference of time between the contact of the stars with the illuminated limb of the moon and the instantaneous immersion.

It is known that the stars are variously affected by irradiation, and that in the best telescopes they shew a planetary disc, more or less defined; for which reason I took the precaution of waiting till the star projected itself so far upon the bright limb of the moon, that the centre of the star coincided with the limb; and from this moment I began to count the beats of the chronometer until the star disappeared. The result of these observations, and the diameter of the moon deduced from the *duration* of the occultations, will be the object of a memoir which I hope to commence shortly.

In all my computations, I have assumed the *constant equatorial parallax* = 57′ 1″,0; the semidiameter of the moon corresponding to this constant = 15′ 33″,69, diminishing it by 1″,8, on account of inflexion, for occultations and solar eclipses. The compression of the earth is supposed = $\frac{1}{315}$.

As corresponding occultations in Europe are uncommon, I was obliged to compare my observations with the *meridian* observations of the moon at the Royal Observatories of Paris and Greenwich. For these comparisons, it was indispensable to determine the positions and annual variations of the occulted stars with the greatest possible accuracy. It is not sufficient that the place of a star should be well known at one epoch, if we wish to refer it to another distant epoch. Undoubtedly, the determination of the proper motion of the stars is very uncertain: observation gives this motion, mixed up with that belonging to the precession of the equinoxes; but, luckily, what is required for our purpose is the absolute annual motion.

For this investigation, I calculated the longitudes and latitudes of certain zodiacal stars, from the right ascensions and declinations observed by Bradley, Lacaille, and Mayer, in 1756, supposing the mean obliquity of the ecliptic at that epoch to be 23° 28′ 16″. I also calculated the longitudes and latitudes of the same stars for the epoch 1800, from the observations made by Maskelyne, Piazzi, Zach, and Lalande, between 1800 and 1810, supposing the mean obliquity in 1810 = 23° 27′ 50″,4, and the annual diminution = 0″,49. The differences between the longitudes and latitudes of the catalogues of 1756 and 1800, divided by the number of years elapsed, give the annual variations.

The following catalogue of 29 stars, so obtained, refers to the year 1800.

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Longitudes and Latitudes of 29 *Zodiacal Stars, with their annual Variations for* 1800.

Name.	Mag.	Longitude.	Annual Variation.	Latitude.	Annual Variation.
		s ° ′ ″	″	° ′ ″	″
l Piscium	5·6	0 15 18 23,1	49,780	1 29 41,2 S	−0,440
ν Piscium	4·5	0 22 42 48,4	50,080	4 42 27,9 S	−0,207
1*ξ* Ceti	4	1 1 14 58,1	50,220	4 16 51,3 S	−0,370
M Ceti	4	1 9 7 57,4	50,440	5 34 39,0 S	−0,300
ν Tauri	3	2 3 0 23,6	50,394	5 45 13,9 S	−0,388
1*δ* Tauri	4	2 4 4 17,8	50,238	3 59 28,8 S	−0,452
2*δ* Tauri	5	2 4 19 48,6	50,286	4 7 54,8 S	−0,486
3*δ* Tauri	6	2 4 44 09,7	50,254	3 42 26,5 S	−0,552
Aldebaran	1	2 6 59 38,2	50,267	5 28 50,9 S	−0,277
ν Geminorum	3·4	3 4 0 39,6	50,250	3 4 49,0 S	−0,407
1*α* Cancri	.	4 10 18 43,5	50,190	5 29 37,5 S	−0,350
π Leonis	.	4 26 31 23,5	50,100	3 55 12,5 S	−0,222
Regulus	1	4 27 2 56,4	50,006	0 27 31,7 N	+0,123
48 Leonis	.	5 4 55 52,8	49,860	1 51 40,3 S	−0,160
β Virginis	.	5 24 19 36,7	51,000	0 41 33,5 N	+0,120
Spica	1	6 21 3 3,5	50,140	2 2 23,9 S	−0,250
38 Virginis	6	6 10 49 56,4	49,650	1 59 18,0 N	−0,470
θ Virginis	.	6 15 26 47,8	50,190	1 45 23,7 S	−0,280
1*α* Libræ	6	7 12 14 13,4	50,110	0 23 20,7 N	−0,440
2*α* Libræ	2·3	7 12 17 39,7	50,110	0 21 31,8 N	−0,470
ν Libræ	3·4	7 22 20 28,0	50,220	4 24 31,3 N	−0,290
Antares	1	8 6 58 12,0	50,190	4 32 41,0 S	−0,518
β Capricorni	.	10 1 15 15,3	50,283	4 36 37,3 N	−0,264
σ Aquarii	5	11 2 35 48,0	50,190	1 13 4,0 S	+0,140
1*h* Aquarii	6	11 11 36 16,2	50,160	1 40 35,0 S	+0,080
2*h* Aquarii	9	11 11 37 14,7	50,160	1 44 53,0 S	+0,080
3*h* Aquarii	7	11 11 40 45,7	50,160	1 58 12,0 S	+0,080
4*h* Aquarii	7	11 12 4 31,5	50,160	1 52 18,1 S	+0,080
14 Piscium	.	11 20 46 38,4	50,100	1 25 30,4 N	−0,000

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Occultations of Stars and Planets by the Moon, observed at the Havannah, with an achromatic Telescope, focal length 4·86 *Burgos feet,* 2·9 *inches aperture, magnifying power* 170,

			Mean Time.
1808.	April 5.	Immersion of 1 α Cancri, *dark limb*	11h 56m 7s,0
	May 2.	Immersion of 347 Mayer, ———	8 58 14,0
	3.	Immersion of ω Leonis, ———	10 31 26,0
			Apparent Time.
1809.	Mar. 23.	Immersion of a star 7th mag., *dark limb*	9 19 41,0
	24.	Ditto ditto ditto	7 27 19,0
	April 3.	Emersion of the first anse of Saturn's ring, *dark limb*	11 22 44,5
		Emersion of the centre of Saturn	11 23 34,0
		External contact, or total emersion of the planet	11 23 49,9
		Total emersion of the ring	11 24 19,0
	29.	Immersion of 1 α Libræ, *bright limb*	11 6 25,8
		Immersion of 2 α Libræ, very exact	11 13 21,0
		Emersion of 2 α Libræ, ———	12 31 51,8
	June 23.	Immersion of 1 α Libræ, *dark limb*	7 42 40,8
		Immersion of 2 α Libræ, ———	7 51 52,8
	28.	Immersion of β Capricorni, *bright limb*	15 41 22,4
		Emersion of β Capricorni, *dark limb*	16 54 53,5
	Nov. 12.	Immersion of β Capricorni, ———	5 15 31,0
		Emersion of β Capricorni, *bright limb*	6 40 59,0
1810.	Jan. 15.	Immersion of δ Tauri, *dark limb*	7 15 51,0
	Feb. 8.	Total immersion of Jupiter, *dark limb*	0 12 42,5
		Emersion of first limb of Jupiter, *bright limb*	0 28 7,0
		Total emersion of Jupiter, ———	0 32 38,0
		Distance of Moon and Jupiter, nearest limbs 5′ 7″,4	0 55 56,0
		——— 9 4 ,0	1 9 12,0
		——— 10 5 ,7	1 12 33,0
		Distance of Jupiter's centre from Moon's nearest limb, by observations of both limbs of Jupiter 19 44 ,2	1 41 2,5
			Mean Time.
	Feb. 18.	Immersion of π Leonis	9 12 28,9
1811.	Jan. 28.	Immersion of a star 7th mag., *dark limb*	7 27 21,6
		Immersion of a star 8th mag., ———	7 37 59,6
	May 27.	Immersion of 389 Mayer, 7th mag., *dark limb*	7 29 51,2
	28.	Immersion of a star, 8th mag	8 1 37,2
	29.	Immersion of 48 Leonis, 6th mag.	8 4 16,4
	July 15.	Contact of Aldebaran with moon's *bright limb*	17 8 22,4
		Immersion of ditto, instantaneous	17 8 32,4
	July 26.	Immersion of θ Virginis, *dark limb*	9 31 31,8
	Aug. 22.	Immersion of the following star of 38 Virginis	7 25 31,2

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			Mean Time.
1811.	Sept. 20.	Emersion of χ Virginis, *bright limb*	6 57 10,0
	Oct. 8.	Contact of Aldebaran with moon's *bright limb*	14 43 38,1
		Immersion of ditto, instantaneous	14 43 46,1
		Emersion of ditto, *dark limb*	15 49 9,1
	23.	Immersion of 2ϱ Sagittarii, *dark limb*	7 50 26,4
	Nov. 21.	Immersion of a star, 6·7th mag. ———	6 21 12,0
1812.	May 24.	Immersion of ν Libræ, ———	14 56 15,8
	Aug. 28.	Contact of Aldebaran with moon's *bright limb*	13 23 37,6
		Immersion of ditto, instantaneous	13 23 42,4
		Emersion of ditto, *dark limb*	14 21 30,2
	Oct. 19.	Immersion of ν Piscium, *dark limb*.....	7 33 12,1
	Nov. 10.	Immersion of 847 Mayer, ———	7 4 6,0
	24.	Contact of Regulus with moon's *bright limb*	11 44 56,3
		Immersion of Regulus, instantaneous	11 45 9,8
		Emersion of Regulus, *dark limb*.....	12 4 10,3
	Dec. 10.	Immersion of 3*h* Aquarii.....	7 34 0,3
		Immersion of 4*h* Aquarii.....	8 36 22,0

Eclipses of the Moon observed at the Havannah.

Total eclipse, May 9, 1808.

Immersion.	Mean solar time.	Emersion.	Mean solar time.
	h m s		h m s
Beginning of the eclipse ...	12 22 29	End of total obscurity	14 55 10
Beginning of Grimaldus....	12 27 18		
End of ditto	12 27 58	End of Grimaldus	15 1 50
Beginning of Aristarchus ..	12 28 38		
End of ditto	12 30 8	End of Aristarchus.....	15 5 45
Beginning of Mare Humorum	12 37 57	Beginning of Tycho	15 14 14
Beginning of Copernicus ...	12 39 37	End of ditto	15 15 47
End of ditto	12 40 57	Centre of Schickardus	15 19 28
Beginning of Plato.....	12 43 57		
End of ditto	12 45 7	End of Plato	15 21 23
Beginning of Mare Serenitatis	12 50 57	Beginning of Mare Serenitatis	15 28 29
Centre of ditto	12 55 16	Centre of ditto	15 33 7
Beginning of Tycho	12 56 46	End of ditto	15 37 57
End of ditto	12 58 41	End of Farantius	15 44 17
Beginning of Mare Crisium	13 9 21	Beginning of Mare Crisium	15 46 46
End of ditto	13 14 20	End of ditto	15 49 26
End of Langrenus	13 18 0		
Total obscurity	13 21 25	End of the eclipse	15 54 36

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The foregoing observations were made with a magnifying power of 70. The sky was very clear; and, except the beginning and end of the eclipse, which, on account of the penumbra, may be uncertain to $1\frac{1}{2}^{m}$, the other observations are very exact.

Partial Eclipse of the Moon, April 9, 1809.

	Apparent time.
Emersion of Tycho, beginning ..	$8^{h}\ 14^{m}\ 15^{s}$
———————, end	8 14 59
End of the eclipse	8 36 25

Partial Eclipse of the Moon, March 9, 1811.

Immersions.	Mean solar time.	Emersions.	Mean solar time.
	h m s		h m s
Penumbra	11 30 0	Beginning of Aristarchus ..	13 16 7
Ditto, very dark	11 49 0	End of ditto	13 17 17
Beginning of eclipse doubtful	11 51 37	Heraclides, centre	13 51 22
———————— visible	11 55 7	Beginning of Plato.....	13 56 37
Beginning of Aristarchus ...	12 5 7	Centre of ditto	13 58 22
End of ditto	12 5 37	End of ditto	13 59 12
Beginning of Plato	12 16 37	Beginning of Mare Crisium	14 0 57
End of ditto	12 17 37	End of ditto	14 15 9
Beginning of Mare Serenitatis	12 21 57	Beginning of Mare Serenitatis	14 6 47
Beginning of Menelaus	12 43 27	Centre of Eudoxus.....	14 8 37
Beginning of Copernicus ...	12 43 37	End of Posidonius.....	14 10 34
Beginning of Mare Crisium	12 49 37	End of the eclipse doubtful..	14 22 52
End of ditto	13 7 27	End with certainty.....	14 24 37

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Total Eclipse of the Moon, February 26, 1812.

Immersions.	Mean solar time.	Emersions.	Mean solar time.
	h m s		h m s
Beginning of the eclipse ..	10 39 0	End of the total obscurity ..	13 28 2
Beginning of Aristarchus ..	10 45 40	Beginning of Aristarchus ...	13 35 39
End of ditto	10 46 20	End of ditto	13 36 42
Beginning of Kepler	10 55 49	Beginning of Plato.....	13 50 27
End of ditto	10 57 39	End of ditto	13 51 58
Beginning of Plato	11 3 59		
End of ditto	11 5 39		
Beginning of Tycho	11 11 34	Beginning of Tycho	13 52 44
End of ditto	11 12 39	End of ditto	13 53 36
Beginning & end of Menelaus	11 16 29	Beginning of Mare Crisium	14 20 55
Beginning of Mare Crisium	11 32 32	End of ditto	14 26 55
End of ditto	11 36 41		
Total obscurity	11 43 51	End of the eclipse	14 32 35

Partial Eclipse of the Moon, February 14, 1813.

Immersions.	Mean solar time.	Emersions.	Mean solar time.
	h m s		h m s
Beginning of the eclipse....	13 54 45	Beginning of Galileo	15 34 15
Beginning of Grimaldus....	14 2 0	Centre of ditto	15 36 30
End of ditto	14 5 0	End of ditto	15 38 45
Beginning of Tycho	14 11 45		
Centre of ditto	14 13 15	End of Grimaldus	15 42 30
End of ditto..	14 14 0		
Beginning of Galileo	14 37 15	End of Tycho	16 23 15
End of ditto	14 39 40	End of the eclipse	16 46 55

Eclipses of the satellites of Jupiter, observed at the Havannah with the same telescope, and with a magnifying power of 170.

			Mean solar time.
1809.	Sept. 15.	Immersion of third	10^h 38^m 13^s
	16.	Immersion of first	9 50 54
1810.	Feb. 3.	Immersion of first	8 0 0
	Dec. 15.	Emersion of first.....	8 54 2,6
	19.	Emersion of second.....	7 17 36

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Distances of the Moon and Stars, observed with Troughton's Reflecting Circle.

1830.	Apparent time.	Distance between				Long. of moon.
Mar. 23.	$8^h\ 33^m\ 48^s$	Aldebaran and moon's nearest limb	22° 37′	35″,5	3^s	0° 38′ 12″,5
		Corrected distance.....	23 26	58 ,9		
24.	7 41 25	Aldebaran and moon's nearest limb	34 32	2 ,5	3	12 18 8 ,8
		Corrected distance.....	35 2	10 ,0		
	8 01 51	Regulus and moon's furthest limb	45 31	42 ,5	3	12 28 22 ,0
		Corrected distance.....	44 58	45 ,5		
25.	7 31 00	Regulus and moon's furthest limb	33 19	55 ,7	3	24 34 6 ,4
		Corrected distance.....	33 3	28 ,5		
	7 52 59	Aldebaran and moon's nearest limb	47 2	59 ,7	3	24 45 32 ,0
		Corrected distance.....	47 25	5 ,5		
30.	7 42 42	Regulus and moon's nearest limb	35 39	38 ,2	6	1 57 53 ,0
		Corrected distance.....	34 54	50 ,3		
	8 09 57	Spica and moon's furthest limb..	18 22	31 ,5	6	2 14 32 ,0
		Corrected distance...	18 56	26 ,0		
31.	7 38 20	Regulus and moon's furthest limb	50 28	25	6	16 26 12 ,0
		Corrected distance.....	49 17	12		
	8 10 11	Regulus and moon's furthest limb	50 46	41	6	16 46 0 ,0
		Corrected distance.....	49 36	56		

Each of these observed distances is the mean of a series of six or eight observations, half in the direct and half in the inverted position of the circle. After calculating, by the corrected distances, the differences in longitude of the moon and star, I have deduced the longitudes of the moon which are found in the last column.

I made these observations for the purpose of deducing the longitude of the Havannah by a comparison with the lunar tables, believing that I should not be able to observe a sufficient number of occultations; but having obtained 32 occultations of stars and planets, it was not worth while to use these distances.

Note. Extract from the earlier Memoir.

	Havannah W. of Greenwich.
By 14 series of lunar distances from the stars, in 1807 and 1808....	$5^h\ 29^m\ 41^s,7$
By 13 ——————— from the stars, in 1809	5 29 48 ,0
By 12 ——————— from the sun, in 1811	5 29 47 ,0

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Observations of the Winter Solstice, 1810, *at the Havannah.*

Date.	Meridian altitudes of sun, corrected for refraction & parallax	Reduction to the solstice.	True meridian altitudes of the sun at the solstice.
1810.	° ′ ″	′ ″	° ′ ″
Dec. 21	43 24 8,9	−0 7,3	43 24 1,6
22	43 24 5,4	−0 1,0	43 24 4,4
23	43 24 26,0	−0 23,4	43 24 2,6
24	43 25 21,8	−1 42,2	43 24 7,6
26	43 28 26,3	−4 20,7	43 24 5,6
27	43 30 41,2	−6 36,0	43 24 5,2
Mean.....			43 24 4,5
Latitude of the sun			+ 0,4
Solar and lunar nutation			−10,0
Mean altitude of the winter solstice =			43 23 54,9

Observations of the Meridian Altitudes of Capella and Rigel, corrected for refraction.

	Mer. alt. of Capella.		Mer. alt. of Rigel.	
1811. Jan. 28	67° 20′ 49″	1811. Feb. 4	58° 25′	40″,1
30	67 20 45	9	58 25	45,7
31	67 20 50,2	11	58 25	51,4
Feb. 1	67 20 54,4	18	58 25	50,0
2	67 20 54,6	21	58 25	39,9
Mean, Jan. 31	67 20 50,6	Mean, Feb. 12·6 ..	58 25	45,4

The circle of reflection* which I made use of for these observations and for the lunar distances, was constructed by Mr. TROUGHTON, of about 12 Burgos inches diameter, graduated on silver to 10′, and with three indices, which divide the circle into three equal parts, and subdivide the divisions to 10″. It is mounted on a stand, and has a telescope with a magnifying power of about 17. Two observations being made, one direct and the other inverted, each having three readings, the error of the divisions is reduced to $\frac{1}{6}$, and the eccentricity destroyed, as well as the errors of the index, of the coloured glasses, and of the small mirror, and the greatest part of the error of the large mirror.

All the observations have been taken with a mercurial horizon, covered with a roof of plane glasses; after every observation I have reversed the roof, to destroy the error arising from the want of parallelism in the glasses.

* For a complete description of this circle, and the mode of using it, see BREWSTER's *Encyclopædia*, Article "Circle," and Dr. PEARSON's *Practical Astronomy*.

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Each of the foregoing results is the mean of six or eight observations, half direct and half inverted, observed from 4^m to 6^m before the passage over the meridian to 4^m or 6^m after, and reduced to the meridian by the tables of M. Delambre. For the horary angles, I regulated the chronometer by corresponding altitudes of the sun. In the observations of the sun, I observed alternately the upper and lower limb, to eliminate any error in the tabular diameter of the sun.

Determination of the Latitude of the Havannah. The house of Don Antonio Robredo.

		North Latitude.
Meridian altitude of Capella..... 67° 20′ 50″,6 Apparent N.P.D. (Piazzi)..... 44 12 33 ,4	by Capella.....	23° 8′ 17″,2
Meridian altitude of Rigel..... 58 25 45 ,4 Apparent N.P.D. (Piazzi)..... 81 33 59 ,4	by Rigel.....	23 8 14 ,0
By observations of the sun about the autumnal equinox, 1807.....		23 8 18 ,5
——————————— vernal equinox, 1809		23 8 15 ,0
———————————, 1811		23 8 17 ,0
	Mean	23 8 16 ,5

Mean Obliquity of the Ecliptic.

By the preceding observations, we have the mean altitude of the winter solstice by a mean of six series = 43° 23′ 54″,9; or zenith distance = 46° 36′ 5″,1

Latitude as above = 23 8 16 ,5

Hence, mean obliquity of the ecliptic at the beginning of 1811 = 23 27 48 ,6

Mr. Pond, by solstices observed in 1812 and 1813 with the mural circle at Greenwich, determined the mean obliquity, at the beginning of 1813 to be 23° 27′ 50″, using the refractions of Bradley. Now, correcting these according to the formula of Laplace, we have

1810. Jan. 1.	By Mr. Pond's observations ..	23° 27′ 50″,0
	By Mr. Groombridge's	23 27 52 ,0
	By the preceding observations	23 27 49 ,1
	Mean obliquity =	23 27 50 ,4

Bearings or Azimuths of various Points in the City of Havannah, determined by Astronomical Observations from the terrace of the house of Don Antonio Robredo.

Great Tower of the Moro	16° 45′ 40″ N.W.
Flagstaff of Cabana	12 8 15 N.E.
Convent of St. Francisco de Guanabacoa....	79 15 5 S.E.
Flagstaff of the Castle of Atares	40 22 59 S.W.
Flagstaff of the Castle of the Prince.....	87 47 59 S.W.
Church of the Calvary	14 37 40 S.E.
Indian Cross	74 35 45 S.E.

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Results of the Observations of the Occultations of Stars, when computed with the New Tables of Burg, *published by M. Delambre, after correcting Equation XIX., the signs of which are equivocal.*

Epochs.	Name of Star.	Apparent time of observation.	Difference of App. lat.	Conjunction, M. T. Havannah.	Long. West of Greenwich.
1809.		h m s	′ ″	h m s	h m s
Apr. 29	Im. 1α Libræ	11 6 25,8	6 39,0	12 10 13,0	5 29 21
—	Im. 2α Libræ	11 13 21,0	5 3,0		
—	Em. 2α Libræ	12 31 51,8	6 49,0	12 5 41,0	5 29 22
June 23	Im. 1α Libræ	7 42 40,8	0 41,5	8 48 13,2	5 29 24
—	Im. 2α Libræ	7 51 52,8	2 8,6	8 53 55,0	5 29 22
28	Im. β Capricorni	15 41 22,4	1 39,1	15 13 38,8	5 29 27
—	Em. β Capricorni	16 43 53,4	4 14,0		
Nov. 12	Im. β Capricorni	5 15 34,0	0 22,0	5 7 36,0	5 29 25
—	Em. β Capricorni	6 40 59,0	4 41,0		
1810.					
Jan. 15	Im. 3∂ Tauri	7 15 51,0	0 30,0	8 23 10,7	5 29 28
Feb. 18	Im. π Leonis	8 58 14,0	2 40,0	10 52 5,0	5 29 47
1811.					
May 27	Im. 389 Mayer	7 33 7,0	6 47,4	6 54 24,4	5 29 26
29	Im. 48 Leonis	8 7 17,7	6 6,0	7 53 35,7	5 29 39
July 15	Im. Aldebaran	17 3 0,0	10 40,0	18 44 34,0	5 29 28
26	Im. θ Virginis	9 25 24,0	1 6,5	8 50 24,7	5 29 32
Aug. 22	Im. foll^{s} * 38 Virginis	7 22 49,0	8 2,0	6 40 24,0	5 29 34
Oct. 5	Im. Aldebaran	14 55 21,2	10 18,0	15 21 13,0	5 29 17
—	Em. Aldebaran	16 0 45,0	12 26,0		
1812.					
May 24	Im. ν Libræ	14 59 43,9	6 46,0	14 17 6,3	5 29 24
Aug. 28	Im. Aldebaran	13 22 56,1	10 21,0	15 6 7,8	5 29 27
—	Em. Aldebaran	14 20 45,0	5 35,0		
Oct. 19	Im. ν Piscium	7 48 13,5	5 4,0	8 57 56,0	5 29 33
Nov. 10	Im. 847 Mayer	5 28 39,8	7 52,0	11 58 21,6	5 29 41
—	Im. Regulus	11 57 58,3	15 5,2		
—	Em. Regulus	12 16 58,6	13 24,9	13 35 54,7	5 29 54
—	Im. 3h Aquarii	7 40 34,4	6 15,1	6 57 27,0	5 29 26
—	Im. 4h Aquarii	8 42 55,8	9 17,1	7 39 16,0	5 29 33

By a mean of the whole, the Havannah west of Greenwich = 5 29 30

* Correction of the epoch 1810·5 = +1″,4; in longitude = −2,6

Corrected longitude ..... = 5 29 27,4

Greenwich west of Paris 9 21,0

The Havannah west of Paris..... 5 38 48,4

* See Burckhardt, *Tables de la Lune*, p. 2.

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* *Occultations of* 1α *and* 2α Libræ, *observed at the Havannah, April* 29, 1809.

1st. *Determination of the State of the Chronometer.*

	m s	Daily rate. s
Chronometer fast at mean noon, April 26	12 20,5	+19,4
——— 28	12 59,4	+17,4
——— 29	13 16,8	+17,4 } Mean = +17,33
——— 30	13 34,2	+17,2
——— 31	13 51,4	

	By Chronometer. h m s	Chron. fast. m s	Mean time of observation. h m s
April 29. Immersion of 1 α Libræ	11 16 58	— 13 24,8	= 11 3 33,2
——— 2 α Libræ	11 23 53	— 13 24,9	= 11 10 28,2
Emersion of 2 α Libræ	12 42 24,6	— 13 25,9	= 12 28 58,7

2dly. *Determination of the Errors of the Lunar Tables, by Observations of the Moon, made in the Royal Observatory of Paris.*

	Observed Transits. h m s	
1809. May 27. Procyon.....	7 30 3,60	
Pollux.....	7 34 22,38	
Moon's first limb	12 25 25,27	= 10h 2m 50s,6 M. T.
Spica.....	13 15 56,28	
Daily rate of the transit clock ..	+1,29	
May 30. Spica.....	13 16 0,38	
Arcturus.....	14 7 48,44	
2 α Libræ	14 41 11,54	
Moon's second limb	15 32 6,56	= 12 57 9,7 M. T.
α Serpentis.....	15 35 43,52	
Daily rate of the transit clock ..	+1,28	

	Centig. therm.	Barom.		
May 27.	+10°,2 ..	747m,32 ..	Z. D. moon's U. L., (82s after transit of 1st L.)	54° 36′ 17″,85
30.	+ 2 ,4 ..	750 ,52 ..	——— L. L., (74 before ——— 2nd L.)	67 2 25,70

To discover the error of collimation of the mural quadrant, we have the following observations.

* The results in the preceding page were probably deduced by M. de Ferrer before he was acquainted with the new tables of Burckhardt, or had access to the meridian observations made in the observatories of Europe. He subsequently re-computed the whole series by Burckhardt's tables, after correcting the tables for the time of each occultation by the nearest meridian or other observations which he could obtain. The present example is adduced as a specimen of his mode of proceeding.

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Date.	Observed zenith dist.	Barom.	C. Ther.	Date.	Observed zenith dist.	Barom.	C. Ther.
April 27	Spica.. 58° 58′ 43″,7	747	+ 9·4	April 30	α Libræ 64° 2′ 57″,5	751	+ 2·4
May 9	——— 58 58 46,0	760	+16·7	May 6	——— 64 2 54,6	767	+ 6·2
10	——— 58 58 44,1	758	+13·0	8	——— 64 3 2,0	764	+13·1
11	——— 58 58 44,7	760	+17·9	10	——— 64 3 2,7	758	+12·9
Mean, May 7	Spica.. 58 58 44,6	756·3	+14·3	May 6	α Libræ 64 2 59·1	760	+ 8·6

In the *Philosophical Transactions* of the Royal Society of London for 1813, page 283, the N.P.D. for these two stars, for the beginning of 1813, is stated to be, of *Spica*, 100° 10′ 51″,3, and of 2 α *Libræ*, 105° 15′ 22″,7.

These determinations have been obtained by Mr. Pond with the excellent mural circle of the Royal Observatory of Greenwich, using the refractions of Bradley: whence, if we correct them by the refractions of La Place, we shall have the south declinations of these stars for 1813, 10° 10′ 54″,6, and 15° 14′ 26″,5, and their apparent declinations at the respective times of observation, −10° 9′ 52″,7 and −15° 14′ 33″,7; which, subtracted from the latitude of Paris, =48° 50′ 13″,0, give the apparent true distances 59° 0′ 5″,7 and 64° 4′ 46″,7 respectively.

Observed Z. D. Spica	58° 58′ 44″,6	Z. D. 2 α Libræ	64° 2′ 59″,1
Refraction.....	+1 34,9	Refraction....	+2 0,0
Z. D. Spica, corrected for refraction ..	59 0 19,5	Z. D. 2 α Libræ	64 4 59,1
True Z. D.	59 0 5,7	True Z. D. ...	64 4 45,7
Corrections of the mural quadrant	−13,8		−12,4

Mean correction of the mural quadrant ..... = −13″,0

Computation of the Moon's Place by the new Tables of Burckhardt, for the 27th of April, at 10ʰ 2ᵐ 50ˢ,6 *M.T., when the Transit of her first limb was observed.*

Longitude of the moon	6ˢ	7° 59′ 25″,2
South latitude		2 15 26,6
Equatorial parallax +1″,7		59 50,4
Horizontal semidiameter		6 19,92

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	Clock fast.
By observations of April 27, we have, by Procyon	44s,734
Pollux	44,527
Spica	44,742
∴ At 9h 26m of the clock, we have, clock fast.....	44,677
Daily rate = +1s,29, ∴ proportional part.....	+,162
At transit of moon's first limb, clock fast....	44,839
Moon's transit observed.....	12h 25m 25,27
True time of moon's transit	12 24 40,431 = 186° 10′ 6″,46
Semidiameter of moon in AR	= +16 24,04
Observed AR of moon's centre	186 26 30,50

Again,

The observed Z. D. of moon's upper limb	54° 36′ 17″,85
Correction of quadrant	— 13,00
Refraction	+1 20,25
Z. D. corrected for collim. and refract.	54 37 25,10
Parallax in altitude, (ratio of axes 316 : 315). .	−48 35,6
Semidiameter	+16 19,9
Zen. dist. of moon's centre	54 5 9,4
Latitude of observatory	48 50 13,0
South declination	5 14 56,4
Difference of declination in 82s	−15,7
Moon's south declination at time of observed transit	5 14 40,7

And the apparent obliquity of ecliptic 23° 27′ 42″,8

Hence we have,

	Longitude of Moon.	Latitude.
By observation	6s 7° 59′ 21″,5	..... 2° 15′ 22″,9 S
By Burckhardt's Tables ..	6 7 59 25 ,2	..... 2 15 26 ,6
Correction to Tables	−3 ,7	..... −3 ,7

Similarly, by the observations of April 30, we should find the corrections of Burckhardt's Tables = −4″,5 in longitude, and −0″,6 in north latitude; hence, taking a mean, we have, for April 29,

The correction of the Tables in longitude....	= −4″,1
in polar distance	= −1 ,5
or in north latitude	= +1 ,5

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Now, at the time of observed occultations we have

	Apparent Longitude.				Apparent Latitude.			
1α Libræ	7^s	12°	22′	31″,1	0°	23′	13″,0	N
2α Libræ	7	12	25	57 ,4	0	21	26 ,5	N

Hence we have

	Immersion of 1α Libræ.	Immersion of 2α Libræ.	Emersion of 2α Libræ.
	h m s	h m s	h m s
Mean time of observation....	11 3 33,2	11 10 28,2	12 28 58,7
Approx. west long. from Paris	5 38 48,0	5 38 48,0	5 38 48,0
Mean time at Paris	16 42 21,2	16 49 16,2	18 7 46,7
Equatorial parallax +1″,7 ...	61 2,8	61 2,9	61 3,8
Parallax in longitude.....	+26 15,9	+24 47,2	+ 7 7,8
Parallax in latitude	−30 36,5	−31 13,3	−37 29,9
App. semidiam. −1″,8 *inflexion*	16 51,6	16 51,5	16 52,3
Difference of apparent latitudes	6 34,0	5 2,9	6 49,3
Conjunction at Paris, *corrected*	17 48 52,7	17 54 21,3	17 54 21,5
Conjunction at Havannah....	12 10 9,3	12 15 37,7	12 15 43,7
West long. of the Havannah..	5 38 43,4	5 38 43,6	5 38 37,8

Mean of the three observations.... 5 38 41,6
The observatory more to the west.. 0,4
Longitude of the Havannah..... 5 38 42,0 W. of Paris.

Remarks of M. de Ferrer upon the Occultation of Aldebaran, October 5, 1811.

It will be remarked, that from these observations I have deduced two values of the inflexion; the first from the time which elapsed between the contact and the instantaneous disappearance, and the second from the time which the star remained occulted, compared with the apparent *calculated* semidiameter, supposing the proportion of the constant equatorial parallax to the semidiameter to be as 57′ 1″ : 15′ 33″,69. This proportion is the same as that of Burg's Tables.

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The apparent semidiameter resulting from this occultation.....	16′	7″,91
Which corresponds to the constant equatorial semidiameter.....	15	32 ,34
By the time elapsed between contact and disappearance, the inflexion		1 ,93
Hence the apparent semidiameter for meridian or similar observations	15	34 ,27
——————————— for eclipses and occultations	15	32 ,34

In this manner I intended to determine the two different semidiameters by a comparison of a great number of observations, which would be independent of those resulting from micrometrical measures which hitherto have alone been used. Although the greater part of astronomers have remarked the extraordinary phenomenon when the star appears interposed between the observer and the moon, I do not know that any one has thought of using it for determining the true inflexion.

In effect, the semidiameter which is required by occultations is less than the *apparent visible* semidiameter, since the star is not occulted until it has entered about 2″ within the edge, and re-appears when 2″ from the other edge; and hence the difference which is found between the semidiameter deduced from micrometrical measurement and from the duration of occultations.

On the occultation of *Aldebaran*, July 15, 1811, M. de Ferrer says:—

The contact of *Aldebaran* with the bright limb of the moon was observed 10^s before the occultation, which was instantaneous. To deduce the value of the inflexion, I have calculated the apparent place of the star at this moment, and found the difference of apparent latitudes = 10′ 39″,45; apparent elongation, 686·17; apparent inclination of the orbit, 8° 8′,0; least distance of the centres, 730″; the arc described in 10^s = 4″,16, and the inflexion = −2″,56.

At the occultation of *Regulus* by the moon, November 24, 1812, the time between the contact and the occultation was 13^s,5, and the corresponding value of the inflexion = −2″,05.

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Summary of the Longitudes deduced by Occultations observed at the Havannah, compared with corresponding Observations made in Europe, or with Meridian Observations of the Moon.

	Occultation of	Havannah W. of Paris. h m s
1808. April 5.	α Cancri, compared with merid. obs. of the moon at Greenwich	5 38 59,1
1809. 3.	Saturn, compared with ditto at Paris	5 38 46,7
29.	1α Libræ, compared with ditto at Paris	5 38 43,3
	2α Libræ, compared with ditto at Paris	5 38 40,8
June 23.	1α Libræ, compared with ditto at Greenwich and Paris	5 38 41,7
	2α Libræ, compared with ditto at Greenwich and Paris	5 38 40,4
28.	β Capricorni, compared with ditto at Paris	5 38 49,0
Nov. 12.	β Capricorni, compared with ditto at Paris	5 38 41,3
1810. Jan. 15.	3δ Tauri, compared with the occultation of 2δ Tauri, observed the same day at Greenwich	5 38 44,5
Feb. 8.	Jupiter, compared with corresponding observations at Göttingen and Dresden	5 38 52,1
18.	π Leonis, compared with meridian observations at Greenwich, and the occultation of 2α Cancri, observed at Gotha	5 38 47,1
1811. July 15.	Aldebaran, compared with corresponding obs. at Königsberg	5 38 47,0
26.	θ Virginis, compared with meridian observations at Greenwich	5 38 47,0
Oct. 5.	Aldebaran, compared with the occultation of ν Tauri, observed the same day at Königsberg and Gotha	5 38 46,5
1812. May 24.	38 Libræ, compared with meridian observations at Greenwich	5 38 49,0
Oct. 19.	ν Piscium, compared with ditto at Paris	5 38 47,0
	ν Piscium, compared with the corresponding observation at Paris	5 38 48,8
Nov. 24.	Regulus, compared with meridian observation at Greenwich	5 38 54,0
Dec. 10.	3*h* Aquarii, compared with ditto at Greenwich	5 38 55,2
	4*h* Aquarii, compared with ditto at Greenwich	5 38 54,6
	Mean of 20 results	5 38 47,7

The mean of 21 occultations of stars, inserted at p. 579, after correcting the epochs for 1810·5, according to the determinations of Burckhardt, gives $5^h\ 38^m\ 48^s,4$. Among the occultations which I have compared with meridian observations, I have selected a mean of eight which were observed to the east, and seven to the west of the meridian. The mean of these two results is $5^h\ 38^m\ 47^s,4$, which is independent of the small error which may perhaps exist in the constant of parallax and in the compression which I have adopted.

For every one of these observations I have formed a differential equation for the parallax, which expresses the variation of the longitude of the

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Havannah, when this element varies by a certain quantity; and by a combination of all the comparisons, whether of corresponding observations, or of those which are compared with meridian observations, I find a correction $= -0'',57$ for the constant $57'\ 1''$, which I had adopted. Hence the constant of the equatorial parallax is, according to my observations, $= 57'\ 0'',43$.

Longitude of the Havannah west of Paris	$5^h\ 38^m\ 47^s,7$	or $84^\circ\ 41'\ 55'',5$
———— Cadiz west of Paris.....	34 31,0	8 37 45
Hence the Havannah west of Cadiz	5 4 16,7	76 4 10,5
The great tower of the Moro, west of the observatory ..	1,6	24
Longitude of the Moro west of Cadiz	5 4 18,3	76 4 34,5

Note from the earlier Memoir.

	Latitude.	Long. from the Observatory.
The observatory (house of Don Antonio Robredo)	23° 8′ 17″,5	..... 0° 0′ 0″,0
House of the Marquis del Real Socorro	23 8 31 ,8	..... 0 0 11 ,8 E
Great Tower of the Moro	23 9 26 ,2	..... 0 0 23 ,6 W
Flagstaff of the Castle of the Prince.....	23 8 16 ,9	..... 0 2 7 ,2 W
Flagstaff of the Castle of Atares	23 7 38 ,8	..... 0 0 36 ,5 W
Church of the Calvary	23 3 47 ,5	..... 0 1 16 ,8 E

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XXXII. *Practical Rules for the approximate Prediction of Occultations.*

By THOMAS HENDERSON, *Esq. Communicated by Lieut. W. S.* STRATFORD, *R.N.*

Read Nov. 12, 1830.

HAVING been requested to explain the method which I have generally adopted in computing the approximate predictions of lunar occultations of planets and fixed stars, published from time to time by the Astronomical Society, I beg leave to lay before the Society the following practical rules, which I have drawn up in the hope that they will tend to facilitate the predictions of these useful phenomena. The rules are founded upon the well-known theory of eclipses subject to parallaxes, and require no demonstration in this place; for the only point in which they differ from methods heretofore prescribed is in the employment of the traverse table, and of TAYLOR's millesimal table of proportional parts adapted to sexagesimal proportions, in consequence of which the operation, which would otherwise require the use of trigonometrical and arithmetical computations, is performed with sufficient accuracy by the inspection of these tables, and a considerable saving of time and labour is effected. The traverse table which I have found most convenient for the purpose is the one contained in the second edition of MENDOZA RIOS's *Nautical Tables*, published in 1809, as the arguments are there given in time as well as in arc, and the distances, or variable *radii*, are extended as far as 480; but any other good table will be sufficient. Many of the calculations in astronomy may be much abridged by a proper use of the traverse table, particularly where small corrections are to be computed, or approximate solutions applied.

RULES.

I. By means of the auxiliary quantities contained in the Berlin Ephemeris.

1. Each of the quantities, p, q, p', and q', is to be multiplied by 1000, or the decimal point is to be removed three places to the right hand. The

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single decimal figure which then remains may be rejected. Then p represents the true difference of right ascension of the moon and star reduced to a great circle, q the true difference of declination, (both for the mean Berlin time denoted by T), p' the moon's true horary motion in right ascension reduced to a great circle, and q' her true horary motion in declination, all expressed in parts, of which the moon's equatorial horizontal parallax contains 1000, and her horizontal semidiameter $272\frac{1}{2}$.

2. All the trigonometrical computations which are required are to be solved by means of a traverse table, where the results may be taken out on inspection, or at least by an easy interpolation between the numbers answering to two consecutive arguments; and the proportions, in which the quantity 60 minutes is always one of the terms, are performed by means of the millesimal table of proportional parts contained in Taylor's sexagesimal table (pp. 263—312), where, in like manner, the results may be obtained on inspection; and, in all cases, one place of decimals in the minutes of time will be sufficient.

3. The time T, and star's horary angle h, which are adapted to the meridian of Berlin, are to be reduced to the given meridian for which the prediction is to be made, by applying its longitude with the sign + if east, and − if west, expressed in time to T, and in space to h. Denote the quantities thus obtained by T′ and h'; h' may be expressed in degrees and tenths.

4. With h' as a course, and the cosine of the reduced latitude of the given place to radius 1000, properly diminished for the spheroidal figure of the earth (for Greenwich 624) as a distance, enter the traverse table, and take out the departure, which will denote the parallax in right ascension, and will have a contrary sign to that of h', unless h' be greater than 180°, when it will have the same sign; and the sum of p (multiplied by 1000) and the parallax, paying proper regard to their signs, will represent the apparent difference of right ascension between the moon and star, reduced to a great circle, at the mean time T′.

5. By means of the traverse table, multiply the cosine of the reduced latitude of the given place to radius 1000, corrected for the spheroidal figure of the earth, by the sine of the star's declination, and with the product as a distance, and h' as a course, enter the traverse table, and take out the difference of latitude, which will denote the first part of the parallax in

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declination, and which has the sign + when h' is less than 90°, and − when greater, the star's declination being north, and the contrary when south.

6. The second part of the parallax in declination is equal to the sine of the reduced latitude to radius 1000, corrected for the earth's figure, multiplied by the cosine of the star's declination; and it is negative or positive according as the latitude is north or south. The sum of the two parts represents the parallax in declination, which being applied, as its sign requires, to q, (multiplied by 1000), the apparent difference of declination between the moon and star at the time T′ is obtained.

Note.—For a particular place, a short table may be framed, exhibiting the products of the cosine of the latitude and the sine of the declination, and of the sine of the latitude and the cosine of the declination, as in the following Table for Greenwich.

Arg. star's declin.	1000 × cos lat. × sin declin.	1000 × sin lat. × cos declin.	Arg. star's declin.	1000 × cos lat. × sin declin.	1000 × sin lat. × cos declin.
0°	00	779	16°	172	749
1	11	779	17	182	745
2	22	779	18	193	741
3	32	778	19	203	737
4	43	777	20	213	732
5	54	776	21	224	727
6	65	775	22	234	722
7	76	773	23	244	717
8	87	771	24	254	712
9	98	769	25	264	706
10	108	767	26	274	700
11	119	765	27	283	694
12	130	762	28	293	688
13	140	759	29	303	681
14	151	756	30	312	674
15	161	752			

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7. Assume another time T″ one hour before or after the time T′, according as the apparent difference of right ascension at the former time has the sign + or −; and for the time T″ find the corresponding values of p and q, by applying to their values, given in the elements, the quantities p' and q' (the whole being always multiplied by 1000), either with the signs there stated, or with the signs reversed, according as T″ is after or before T′. The hour angle h'' corresponding to T″ is obtained by applying $+15^{\circ},0$, or $-15^{\circ},0$ to the value of h' corresponding to T, according as T″ is after or before T′. Then, according to the rules already laid down, find the parallaxes in right ascension and declination for the time T″, and thence the apparent differences of right ascension and declination. It will be proper that the two instants of time should be so assumed as that the apparent conjunction in right ascension fall between them nearly in the middle of the interval, as the prediction, in this case, is to be more relied on.

8. Subtract the apparent differences of right ascension and declination corresponding to the earlier of the times T′ and T″ from those corresponding to the later: the remainders are the apparent horary motions in right ascension and declination, the former having always the sign +; but the latter may have either + or −, the sign denoting whether the apparent motion is northerly or southerly. Then the approximate prediction of the occultation is conducted upon the assumed principle of the moon describing her apparent motion along a straight line at an equable rate, which, in almost every instance, will be found sufficiently correct, particularly when the apparent conjunction in right ascension falls between the assumed times. There are many methods for performing the remaining part of the operation upon this principle. The following is the one that has appeared most convenient in practice.

9. As the apparent horary motion in right ascension is to the apparent difference of right ascension, at either of the times T′ and T″, so are 60 minutes to the interval between the said time and the apparent conjunction in right ascension; the former being sooner or later than the latter, according as the apparent difference of right ascension has the sign − or +. Hence the apparent conjunction in right ascension is known. And as 60 minutes are to the said interval, so is the apparent horary motion in declination to the apparent motion in declination during the interval of the same or contrary sign to that of the apparent horary motion, according as

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the conjunction is later or earlier than the said time; and the apparent motion in declination, during the interval, being applied, as its sign directs, to the apparent difference of declination at the said time, the apparent difference of declination at the conjunction is obtained.

10. Search in the traverse table till the apparent horary motions in right ascension and declination are found beside each other under the same course, the former as a difference of latitude, and the latter as a departure; then the corresponding distance represents the horary motion in the apparent orbit. Under the same course, and with the apparent difference of declination at the apparent conjunction as a distance, take out the difference of latitude, which represents the least distance between the moon's centre and star. Also, take out the corresponding departure, and say, as the horary motion in the apparent orbit is to the departure, so are 60 minutes to the interval between the apparent conjunction and the time of the least distance, the former being sooner or later than the latter, according as the apparent difference of declination at the apparent conjunction, and the apparent horary motion in declination, have different signs or the same sign. Hence the time of the least distance is obtained. If the least distance is greater than 272·5, there will be no occultation; if equal to 272·5, there will be a contact; but if less, there will be an occultation, in which case set down the angle of the course two several times, with the sign of the apparent horary motion in declination, in order that they may be employed in the computation of the angles of immersion and emersion, and proceed as follows:

11. Search the traverse table till 272·5 and the least distance are found under the same course, the former as a distance and the latter as a difference of latitude, and take out the departure; and as the horary motion in the apparent orbit is to this departure, so are 60 minutes to the semiduration of the occultation, which, being subtracted from, and added to, the time of the least distance, gives the times of immersion and emersion. When the apparent difference of declination at the apparent conjunction has the sign +, the angle of the course just now found,—or when the apparent difference has −, the supplement to 180°,—is to be set down under the former angle of course found by the preceding precept; and, in either case, the complement to 360° of the latter angle, or of its supplement to 180°, is also to be set down under the former angle; and the sums of these angles will denote the angular distances of the points of immersion

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and emersion, respectively reckoned from that part of the moon's limb which is nearest to the north pole of the heavens towards the west, round the circumference, as viewed in an inverting telescope. But if the angular distances of these points from the moon's apparent vertex be required, which, for ordinary telescopes, appears more convenient, the parallactic angles, or the angles at the moon, between the circle of declination and vertical passing through her centre, must be found for the times of immersion and emersion. This angle, for any particular time, is equal to the course in the traverse table, the parallax in declination being the difference of latitude, and the parallax in right ascension the departure; and if the parallax in declination has the sign +, the supplement to 180° of the course is to be employed. The parallactic angle has the same sign as the horary angle h' or h'', or the contrary sign to that of the parallax in right ascension. For the immersion and emersion, the parallactic angles are most readily got by interpolating between those for the two assumed times, which may be had by inspection; and being applied, according to their signs, to the angular distances from the point nearest the north pole, the angular distances from the moon's apparent vertex towards the west, round the circumference, as viewed in an inverting telescope, are found.

II. By means of the Elements contained in the Nautical Almanac.

12. At the apparent time of the conjunction in right ascension, contained in the first column, the star's horary angle, expressed in time or h, is equal to this apparent time + the sun's apparent right ascension at the same time − the star's right ascension contained in column fifth. For the same time, $p = 0$; q = diff. dec. in col. 2nd $\times \frac{1000}{\text{Moon's equat. hor. par.}}$, and q has the sign + or −, according as the diff. dec. has N. or S. annexed to it; p' = H. M. in col. 3rd × sine orb. ang. in col. 4th $\times \frac{1000}{\text{Moon's equat. hor. par.}}$ and is always positive; q' = H. M. × cos. orb. ang. × $\frac{1000}{\text{Moon's equat. hor. par.}}$ and is + or −, according as the orbital angle has N. or S. prefixed to it. p' and q' may be obtained from the traverse table, and the moon's horary motion and horizontal parallax may be expressed in minutes and tenths. The computation of the occultation is then to be performed as above directed.

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But it seems preferable to dispense with the factor $\frac{1000}{\text{Moon's equat. hor. par.}}$ in the computation of q, p', and q', in which case the moon's horizontal parallax and horizontal semidiameter given in the ephemeris must be employed. For a particular place, a Table of the quantities required in the computations of parallaxes may be formed similar to the following, adapted for Greenwich.

Moon's equatorial hor. par.	Reduced hor. par. × cos red. lat.	Reduced hor. par. × sin red. lat.	Proportional Parts.		
			Moon's equat. hor. par.	Red. hor. par. × cos red. lat.	Red. hor. par. × sin red. lat.
53′,0	33′,08	41′,28	0,1	0,06	0,08
54,0	33,71	42,06	0,2	0,12	0,16
55,0	34,33	42,83	0,3	0,19	0,23
56,0	34,95	43,61	0,4	0,25	0,31
57,0	35,58	44,39	0,5	0,31	0,39
58,0	36,20	45,17	0,6	0,37	0,47
59,0	36,83	45,95	0,7	0,44	0,54
60,0	37,45	46,73	0,8	0,50	0,62
61,0	38,07	47,51	0,9	0,56	0,70

III. Without the Elements contained in the Berlin Ephemeris or Nautical Almanac.

13. When the auxiliary quantities or elements of the occultation are not found in any of the ephemerides, assume two moments of time distant one hour from each other, having, if possible, the middle of the occultation between them; and for each of these times compute the difference of right ascension and declination between the moon and star in minutes of space and tenths, the differences of right ascension being multiplied by the cosine of the moon's declination, and also the star's horary angles, and find the parallaxes and apparent differences of right ascension and declination for these two instants, and thence the particulars of the occultation as before directed.

14. In all cases, the sign + prefixed to a difference of right ascension denotes the moon to be east of the star, and the sign − the contrary. The sign + prefixed to a difference of declination denotes the moon to be north

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of the star, and the sign − the contrary. p' has always the sign +, denoting the moon's motion from the star to be easterly, and q' has the sign + or −, according as her motion from the star is northerly or southerly.

15. When two or more stars are situated near to each other, the moon's parallaxes computed for one may be assumed as the parallaxes computed for the others at the same moment of time, and hence the computations are much abridged.

EXAMPLES.

I. By means of the Elements contained in the Berlin Ephemeris.

Occultation of Aldebaran, January 23, 1831, *for Greenwich.*

T 11h 18m,1	p +452	q +375
−53 ,6	Par. in Æ −332	−748
T′ 10 24 ,5	App. diff. of Æ +120	+147
h +45 ,5		Par. in dec. −601
−13 ,4		App. diff. of dec. −226
h' +32 ,1		Parallactic angle +29°

Numbers for parallax in declination, from Table in § 6, are 174 and 748.

T″ 9 24,5	+452	+375	Parallactic angle +17°
h'' +17,1	p' −594	q' −100	
	−142	+275	
	Par. in Æ −183	−748	
	App. diff. of Æ −325	+166	
		Par. in dec. −582	
		App. diff. of dec. −307	
App. diff. of Æ and dec. 1h afterwards	+120	−226	App. hor. mot. in orbit, 452,
App. horary motion in Æ and dec.	+445	+ 81	and inclin. of app. orbit +10°

445 : 325 :: 60m : 43m,8 :: + 81 : + 59

	9h 24 ,5		−307
App. conjunction	10 8 ,3	App. dec.	−248
452 : 60m :: 43 :	+ 5 ,7	Least dist.	244
Middle	10 14 ,0		
452 : 60m :: 122 :	16 ,2	Semiduration.	
Immersion	9 57 ,8	Mean time.	
Emersion	10 30 ,2		

Angles at	Immersion.	Emersion.
	+ 10	+ 10
	154	206
From N. P.	164	216
	+ 24	+ 30
From vertex	188	246

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II. By means of the Elements contained in the Nautical Almanac.

Same Occultation.

Moon's equatorial horizontal parallax, 59′,6.
Number from Table, § 12, for parallax in Æ, 37′,2.
Numbers by § 12, for parallax in dec. 10′,4 and 44′,6.
Horary motion, 35′,9 × sin 80°,3 orbital angle = +35′,4 horary motion in Æ.
Horary motion, 35′,9 × cos 80°,3 orbital angle = +6′,0 horary motion in dec.

T′	9h 27m,0	*p* 0,0	*q* +17,7	Par. ang. +21°
Sun's Æ	20 22 ,0	Par. in Æ −13,1	−44,6	
Sidereal time	5 49 ,0	App. diff. of Æ −13,1	+ 9,7	
Star's Æ	4 26 ,2		Par. in dec. −34,9	
h′ (in time)	+1 22 ,8		App. diff. of dec. −17,2	

T″	10 27,0	0,0	+17,7	Parallactic angle +31°
h″ (in time)	+2 22,9	Hor. mot. +35.4	+ 6,0	
		+35,4	+23,7	
		Par. in Æ −21,7	−44,6	
		App. diff. of Æ +13,7	+ 8,4	
			Par. in dec. −36,2	
			App. diff. of dec. −12,5	
App. diff. of Æ and dec. 1h before		−13,1	−17,2	
App. horary motions in Æ and dec.		+26,8	+ 4,7	

Apparent horary motion in orbit 27,2; inclination of apparent orbit 10°

26′,8 : 13′,1 :: 60m : 29m,3 :: + 4,7 : + 2,3

	9h 27 ,0		−17,2
App. conjunction	9 56 ,3	App. dec.	−14,9
27′,2 : 60m :: 2′,6	+5 ,8	Least dist.	14,7
Middle	10 2 ,1	Semidiam.	16,2
27′2 : 60m :: 6′,8	15 ,0	Semiduration.	
Immersion	9 47 ,1	Apparent time.	
Emersion	10 17 ,1		
Equation of time	+12 ,2		
Immersion	9 59 ,3	Mean time.	
Emersion	10 29 .3		

Angles at	Immersion.	Emersion.
	+ 10	+ 10
	155	205
From N. P.	165	215
	+ 24	+ 29
From vertex	189	244

Each of these computations occupied 14 minutes of time.

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III. By means of the Berlin Ephemeris.

Occultation of Venus on 14th October, 1830, for Greenwich.

Venus Æ.		Venus Dec.	
180° 42′,6	+2° 17′,2	+1° 19′,5	−59′,1
182 59,8	2 17,3	0 20,4	59,3
185 17,1	2 17,4	−0 38,9	59,3
187 34,5		1 38,2	
Aberration −0,6		Aberration +0,3	

Moon's Æ.				Moon's Dec.			
175° 54′,5	+5° 43′,4	−2′,1	−1′,6	+3° 14′,9	−1° 55′,1	−0′,3	+0′,2
181 37,9	5 41,3	1,2		1 19,8	1 55,4	+0,7	
187 19,2	5 40,1			−0 35,6	1 54,7		
192 59,3				2 30,3			

Moon's horizontal parallax 54′,3
Venus ——————— 0,1
54,2

With this argument, from Table, § 12, we have 33′,8 = hor. par. × cos. lat.
42,2 = hor. par. × sine lat.

And from Traverse Table 33′,8 × sine 0°,5 (Venus dec. at conjunction) = 0′,3
And 42,2 × cos. 0,5 = 42,2

		Venus Æ.	Dec.	Moon's Æ.	Dec.
T	18h 0m,0	185 17,1	−0 38,9	181 37,9	+1° 19′,8
T′	17 6,4	−17,2	+7,4	2 50,6	−57,7
	2,8	− 0,6	+0,3	0,2	−0 22,1
	13 30,1	184 59,3	−0 31,2	184 28,7	−0 31,2
Sidereal time	6 39,3			184 59,3	q = +53,3
Venus Æ	12 20,0			−30,6	−42,2
h'	−5 40,7	p = 30,6 × cos. moon's dec.		−30,6	0,0
				Par. in Æ +33,7	Par. in dec. −42,2
Parallactic angle	−39°			App. diff. of Æ + 3,1	App. diff. of dec. +11,1

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T″	16 h 6,4 m		
h″	−6 40,7	Moon's hor. mot. in Æ × cos. moon's dec.	+28′,4
		Venus	+ 2,9
		Difference = *p*′	+25,5
		Moon's hor. mot. in dec.	− 9,6
Parallactic angle	−39°	Venus	− 1,2
		Difference = *q*′	− 8,4

	−*p*′ = −25,5	−*q*′ =	+ 8,4
	−30,6		+53,3
	−56,1		+61,7
Par. in Æ	+33,3		−42,2
App. diff. of Æ	−22,8		+ 0,1
Par. in dec.			−42,1
App. diff. of dec.			+19,6
App. diff. one hour after	+ 3,1		+11,1
App. hor. mot. in Æ	+25,9	in dec.	− 8,5

Horary motion in apparent orbit 27′,2

As 25′,9 : 22′,8 :: 60^{m} : 52^{m},8 :: −8′,5 : − 7′,5

	16 6 ,4		+19 ,6
Apparent conjunction	16 59 ,2	App. dec.	+12, 1
27′,2 : 60^{m} :: 3′,7 :	8 ,2	Least dist.	11 ,5
Time of least dist.	17 7 ,4	Semidiam.	14 ,8
27′,2 : 60^{m} :: 9′,3 :	20 ,5	Semiduration.	
Immersion	16 46 ,9	} Mean time.	
Emersion	17 27 ,9		

	Immersion.	Emersion.
Course	−18°	−18°
	39	321
Angles from N. P.	21	303
	−39	−39
Angles from vertex	342	264

(Time occupied, 30 minutes.)

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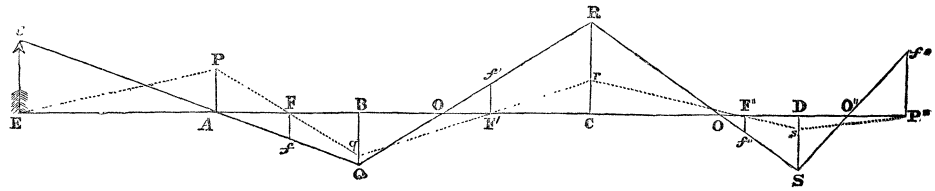
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XXXIII. *On the Theory of Telescopic Eye-glasses.* By Professor Littrow, *Associate of the Society.*

Read March 11, 1831.

Having developed, in two preceding papers, my views on the theory of double object-glasses, I beg now likewise to consider the second important part of telescopes; viz. the construction of the eye-pieces.



Section I.—Let AP (fig. 1) be the first, BQ the second, CR the third, &c. spherical lens, which are all, as well as the object E*e*, supposed to be perpendicular to the common axis of these lenses, or to the line EABC. Let the ray of light from the extreme point *e* of the object, which passes, without suffering refraction, through the middle A of the first lens, and is the *principal ray*, describe the path *e*AQRS; and let the path of the one proceeding from the point E of the axis, and incident near the *border*, be EP*qrs*. Let p, p', p'' be the focal distances of the first, second, and third lens, and EA = a, AF = α, the distances from the glass of the two points of union of the rays of the first lens. In like manner, let FB = a', BF′ = α', the same distances belonging to the second lens; and F′C = a'', CF″ = α'', those of the third lens; and lastly, let AB = Δ, BC = Δ', CD = Δ'', &c., the distances of the lenses.

On these suppositions, we have, from the first principles of optics, for *small* angles of incidence, EA*e*, which are here always assumed, the following simple equations:

$$\frac{1}{p}=\frac{1}{a}+\frac{1}{\alpha}, \qquad \frac{1}{p'}=\frac{1}{a'}+\frac{1}{\alpha'}, \qquad \frac{1}{p''}=\frac{1}{a''}+\frac{1}{\alpha''}, \text{ &c.}$$

Section II.—The farther from the axis the border ray EP*qr* can be inci-

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dent, the greater will be the light of the telescope. We may, therefore, call the quantities AP = x, Bq = x', CR = x'', the radii of aperture of the lenses for the light. In like manner, the farther from the axis the principal ray eAQR is incident on the lenses, the greater extent of the object Ee will be viewed by the eye at the end of the last lens, or the greater will be the *field of view* of the telescope. The quantities BQ = Z′, CR = Z″, DS = Z‴, are therefore called the radii of aperture of the lenses for the field of view. The following equations are usually assumed, $Z' = p'w'$, $Z'' = p''w''$, $Z''' = p'''w'''$, &c., where the quantities w', w'', w''', are evidently small fractions, (at most 0,2 or 0,3), as the apertures of the lenses are always small parts only of their focal distances.

We now denote the following angles, which are all considered small, in this manner: EAe = φ, AFP = φ', BF′q = φ'', CF″r = φ''', and BOQ = ψ', CO′R = ψ'', SO″D = ψ'''.

Section III.—In the points of intersection of the border ray with the axis, or in the points F, F′, F″, the images Ff, F′f', F″f'', of the object Ee perpendicular to the axis are formed. But as the rays, after passing through the last lens, must reach the eye parallel to each other, it is clear that, if, for example, the second lens is the last, the ray of Q must, after its refraction in Q, meet the eye O in the direction QO, which is parallel to every other ray issuing from the second lens; consequently, likewise parallel to the ray fB, which passes through the middle of the lens without refraction. The eye in O views, therefore, the image Ff under the angle BOQ = ψ', while it would see the object, without the assistance of the telescope, under the angle EAe = φ. But as BOQ = FBf, and EAe = BAQ, we have

$$\frac{\tan \psi'}{\tan \phi} = \frac{\alpha}{a'}; \text{ or, as these angles are small, } \frac{\psi'}{\varphi} = \frac{\alpha}{a'}$$

Now, the ratio of the angles under which the eye sees an object through the telescope, and without the telescope, is called the *magnifying power* of the telescope. If we call, therefore, the magnifying power of the telescope m', we have

For two lenses..... $m' = \frac{\psi'}{\varphi}$

For three lenses .... $m'' = \frac{\psi''}{\varphi}$

For four lenses..... $m''' = \frac{\psi'''}{\phi}$ &c.

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Lastly, the eye of the observer is most conveniently placed in that point of the axis in which all rays issuing from the last eye-glass unite; viz. in the points O, O′, O″. We shall put these distances of the eye from the last lens, namely, BO = K′, CO″ = K″, DO″ = K‴, &c.

Section IV.— The mere inspection of the diagram will now give a set of equations, which we place here together, without the demonstrations, which may be easily deduced by every reader, from the simplest rules of plain trigonometry.

$$\left.\begin{aligned}\Delta &= \alpha + a'\\ \Delta' &= \alpha' + a''\\ \Delta'' &= \alpha'' + a''', \text{ \&c.}\end{aligned}\right\} \quad \ldots\ldots\ldots\ldots \text{(I.)}$$

$$\left.\begin{aligned}\varphi' &= \frac{x}{\alpha}\\ \varphi'' &= \frac{a'x}{\alpha\alpha'}\\ \varphi''' &= \frac{a'a''x}{\alpha\alpha'\alpha''}\\ \varphi^{\text{IV}} &= \frac{a'a''a'''x}{\alpha\alpha'\alpha''\alpha'''}\end{aligned}\right\} \quad \ldots\ldots\ldots\ldots \text{(II.)}$$

$$\left.\begin{aligned}\psi' &= w' - \varphi\\ \psi'' &= w'' - w' + \varphi\\ \psi''' &= w''' - w'' + w' - \varphi\\ \psi^{\text{IV}} &= w^{\text{IV}} - w''' + w'' - w' + \varphi, \text{ \&c.}\end{aligned}\right\} \quad \ldots \text{(III.)}$$

$$\left.\begin{aligned}m' &= \frac{\alpha}{a'}\\ m'' &= \frac{\alpha\alpha'}{a'a''}\\ m''' &= \frac{\alpha\alpha'\alpha''}{a'a''a'''}\\ m^{\text{IV}} &= \frac{\alpha\alpha'\alpha''\alpha'''}{a'a''a'''a^{\text{IV}}}\end{aligned}\right\} \quad \ldots\ldots\ldots \text{(IV.)}$$

As the rays of light, when entering the telescope, are parallel, and likewise so when issuing out of it, we have, for all telescopes, the first $a = \infty$, and the last $\alpha = \infty$; consequently, the first $\alpha = p$, and the last a equal to the last p. The equations (IV.) are, therefore, likewise

For a telescope of two lenses ..... $m' = \frac{p}{p'} = \frac{w' - \varphi}{\varphi}$

For a telescope of three lenses .... $m'' = \frac{\alpha' p}{a' p''} = \frac{w'' - w' + \varphi}{\varphi}$

For a telescope of four lenses .... $m''' = \frac{\alpha'\alpha'' p}{a'a''p'''} = \frac{w''' - w'' + w' - \varphi}{\varphi}$

If one of these expressions for m is negative, the image is upright for an even number of lenses, and inverted for an odd number.

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We have next

$$\left.\begin{aligned} x' &= \frac{x}{m'} \\ x'' &= \frac{x}{m''} \\ x''' &= \frac{x}{m'''} \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots \text{(V.)}$$

$$\left.\begin{aligned} Z' &= \Delta\varphi \\ Z'' &= (w' - \varphi)\,\Delta' - Z' \\ Z''' &= (w'' - w' + \varphi)\,\Delta'' - Z'' \end{aligned}\right\} \quad \ldots\ldots \text{(VI.)}$$

For the magnitude of the images, we have

$$\left.\begin{aligned} &\text{First image} \ldots\ldots\ldots Ff = \alpha\varphi \\ &\text{Second image} \ldots\ldots F'f' = \frac{\alpha\alpha'\varphi}{a'} \\ &\text{Third image} \ldots\ldots F''f'' = \frac{\alpha\alpha'\alpha''\varphi}{a'a''} \\ &\text{Fourth image} \ldots\ldots F'''f''' = \frac{\alpha\alpha'\alpha''\alpha'''\varphi}{a'a''a'''} \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots \text{(VII.)}$$

If one of these expressions becomes negative, the image is upright for an odd number of lenses, and inverted for an even number of them.

For the best place of the eye, we have

$$\left.\begin{aligned} K' &= \frac{p'w'}{m'\varphi} \\ K'' &= \frac{p''w''}{m''\varphi} \\ K''' &= \frac{p'''w'''}{m'''\varphi} \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(VIII.)}$$

These expressions prove that the greater the magnifying power m, or, also, the greater the field of view φ of the telescope, the nearer the eye must be approached to the last lens, in order to see the whole field of view. It is evident that the quantities K', K'', K''', must be always positive, as the place of the eye for a negative value would be between the lenses, in order to see the whole field of view, which is impossible.

For the radius of the field of view, which is expressed by tan φ, or more shortly by φ, we have

$$\left.\begin{aligned} \varphi &= \frac{w'}{m' + 1} && \text{for two lenses} \\ \varphi &= \frac{w'' - w'}{m'' - 1} && \text{for three lenses} \\ \varphi &= \frac{w''' - w'' + w'}{m''' + 1} && \text{for four lenses} \\ \varphi &= \frac{w^{IV} - w''' + w'' - w'}{m^{IV} - 1} && \text{for five lenses} \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots \text{(IX.)}$$

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In order to obtain these values of φ in minutes of a degree, they are to be multiplied by 3437·75. The expressions shew that the field of view is lessened if the magnifying power increases, or if the aperture of the last eye-glass diminishes. We have, further,

$$\left.\begin{aligned}
p'w' &= (\alpha + a')\,\varphi \\
p''w'' &= \left(\frac{\alpha\alpha'}{a'} - a''\right)\varphi + a''w' \\
p'''w''' &= \left(\frac{\alpha\alpha'\alpha''}{a'a''} + a'''\right)\varphi + a'''(w'' - w') \\
p^{\mathrm{IV}}w^{\mathrm{IV}} &= \left(\frac{\alpha\alpha'\alpha''\alpha'''}{a'a''a'''} - a^{\mathrm{IV}}\right)\varphi + a^{\mathrm{IV}}(w''' - w'' + w') \\
p^{\mathrm{V}}w^{\mathrm{V}} &= \left(\frac{\alpha\alpha'\alpha''\alpha'''\alpha^{\mathrm{IV}}}{a'a''a'''a^{\mathrm{IV}}} + a^{\mathrm{V}}\right)\varphi + a^{\mathrm{V}}(w^{\mathrm{IV}} - w''' + w'' - w')
\end{aligned}\right\} \quad \text{(X.)}$$

Section V.—These are the principal expressions which will be required for the construction of eye-glasses. If we pursue the path of the principal ray *e*AQRS through all its refractions, we shall obtain *the place of the eye*, by finding the last point of intersection of this principal ray with the axis ABC of the lenses; and *the magnifying power of the telescope*, by finding the last angle of this principal ray with the axis of the lenses; and lastly, *the field of view* of the telescope, by finding the first angle EA*e* of this principal ray with the axis of the lenses.

Denoting the ratio of refraction of the glass, or the ratio of the sine of the angle of incidence to the sine of the angle of refraction, by n, and the radii of the two spherical surfaces of the lens by r and ϱ, we have

$$\frac{1}{a} + \frac{1}{\alpha} = (n-1)\left(\frac{1}{r} + \frac{1}{\varrho}\right)$$

hence, also,

$$\frac{1}{p} = (n-1)\left(\frac{1}{r} + \frac{1}{\varrho}\right)$$

and, in like manner, for a second lens of a different kind of glass, of which let n' be the ratio of refraction, we have

$$\frac{1}{a'} + \frac{1}{\alpha'} = (n'-1)\left(\frac{1}{r'} + \frac{1}{\varrho'}\right) \quad \text{or} \quad \frac{1}{p'} = (n'-1)\left(\frac{1}{r'} + \frac{1}{\varrho'}\right)$$

If we suppose these values of n and n' to belong to the middle rays of the coloured spectrum, and if we suppose the ratio of refraction for the

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extreme rays of the spectrum to be $n \pm dn$, the last equation, differentiated with respect to p' and n', will give, r' and ϱ' being constant,

$$dp' = -\frac{p'dn'}{n'-1}$$

By these colours, the image of an object in the telescope will appear with coloured edges, and this coloured border of the image will be equal to the change of the angle ψ' produced by the change of n'. But, by Sect. 4 (III.) this angle $\psi' = w' - \varphi$; hence, likewise, φ being constant, $d\psi' = dw'$. We have, again, by (X.) Sect. 4, $w' = \frac{(\alpha+\alpha')\varphi}{p'}$, and the differential $dw' = -\frac{w'dp'}{p'}$ If we substitute, in this expression, for dw' or $d\psi'$ the preceding value of dp', we shall have, for the two lenses, $d\psi' = \frac{w'dn'}{n'-1}$. In like manner, we shall find, for three lenses, putting throughout, for brevity, dn in place of $\frac{dn}{n-1}$,

$$d\psi'' = (w'dn + \frac{a''}{\alpha'} w''dn'') \frac{a'}{\alpha'}$$

and for four lenses,

$$d\psi''' = \left(w'dn + \frac{a''}{\alpha'} w''dn'' + \frac{a''a'''}{\alpha'\alpha''} w'''dn''' \right) \frac{\alpha'\alpha''}{a''a'''} \quad \&c.$$

If, therefore, the coloured borders of the images are to disappear, or if the images are to be achromatic, these values of $d\psi'$, $d\psi''$, $d\psi'''$, must be $= 0$.

I. The preceding formulæ are sufficient for a complete development of the theory of eye-glasses, as the spherical aberration is usually not regarded, the lenses being mostly small. If it is, however, required to take notice of it, let x be the radius of the object-glass, and let μ, ν, and $\mathfrak{S}$ be the numbers which may be taken for every value of n from the table which I have annexed to my paper on BARLOW's new telescopes. We shall then have, for the radius R of the spherical aberration for any number of lenses, the well-known expression,

$$R = \frac{mx^3}{4p^4} \left\{ \mu\mathfrak{S}p + \frac{\mu'a'^2}{p'} Q' + \frac{\mu''a''^2}{p''} \left(\frac{a'}{\alpha'}\right)^4 Q'' + \frac{\mu'''a'''^2}{p'''} \left(\frac{a'a''}{\alpha'\alpha''}\right)^4 Q''' + \ldots. \right\}$$

where, for two lenses.... $Q' = \mathfrak{S}' \left(\frac{a'}{p'}\right)^2 + \frac{\nu'a'}{\alpha'}$

for three lenses .. $Q'' = \mathfrak{S}'' \left(\frac{a''}{p''}\right)^2 + \frac{\nu''a''}{\alpha''}$

for four lenses.... $Q''' = \mathfrak{S}''' \left(\frac{a'''}{p'''}\right)^2 + \frac{\nu'''a'''}{\alpha'''}$ &c.

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Section VI.—After these preparations, it will now be proper to proceed to the construction of the eye-glass itself.

In general, there are three kinds of eye-glasses in use: the first has only one lens, the second two, and the third four lenses. We shall consider these three kinds successively, without touching on those unusual ones of 3, 5, 6, and more lenses, which would take up too much space in this paper. The greater the number of lenses, the greater will likewise be the number of equations which are to be taken from Sect. 4 and Sect. 5, in order perfectly to determine the eye-glass. But as the number of quantities which are to be determined usually exceeds that of the equations, it is necessary to assume some of those quantities arbitrarily; otherwise, the problem would be indeterminate. Those assumptions are usually made with a view of attaining certain purposes: for example, a great magnifying power, a large field of view, &c. It is evident, from this circumstance, that the solution of our problem may assume various forms, and that one of the main objects is to arrange the equations of Sect. 4 and Sect. 5, in such a manner as to satisfy all, or at least the greatest possible number of conditions. After several trials, I have found the following process most applicable.

Let the following auxiliary quantities be introduced:

$$A = \frac{\alpha'}{a'} \quad \text{and} \quad B = \frac{\alpha}{a'}$$

$$A' = \frac{\alpha''}{a''} \qquad B' = \frac{\alpha'}{a''}$$

$$A'' = \frac{\alpha'''}{a'''} \qquad B'' = \frac{\alpha''}{a'''}$$

$$A''' = \frac{\alpha^{IV}}{a^{IV}} \qquad B''' = \frac{\alpha'''}{a^{IV}} \text{ &c.}$$

By substituting these quantities in the equations (X.) of Sect. 4, and applying likewise the equations $\frac{1}{p} = \frac{1}{a} + \frac{1}{\alpha}$, and following Sect. 1, the former equations will assume these forms:

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$$\left.\begin{aligned}
&\text{For two lenses} \ldots\ldots\ldots \frac{Aw'}{A+1} = (B+1)\,\phi \\
&\text{For three lenses} \ldots\ldots \frac{A'w''}{A'+1} = (BB'-1)\,\phi + w' \\
&\text{For four lenses} \ldots\ldots \frac{A''w'''}{A''+1} = (BB'B''+1)\,\phi + w'' - w' \\
&\text{For five lenses} \ldots\ldots\ldots \frac{A'''w^{IV}}{A'''+1} = (BB'B''B'''-1)\,\varphi + w''' - w'' + w'
\end{aligned}\right\} \ldots\ldots\ldots\ldots \text{(A)}$$

These equations may be easily continued, as the law of their progress is clear. In general, the number of lenses being n, the last of the equations (A), if n denotes an even number, is

$$\frac{A^{(n-2)}\,w^{(n-1)}}{A^{(n-2)}+1} = (BB'B''B''' \ldots\ldots B^{(n-2)}+1)\,\phi + w^{(n-2)} - w^{(n-3)} + \ldots\ldots + w'' - w'$$

or the last α; consequently, likewise, the last A (in this case $A^{(n-2)}$) being infinite,

$$\varphi = \frac{w^{(n-1)} - w^{(n-2)} + w^{(n-3)} \ldots\ldots - w'' + w'}{m+1}$$

and if n denotes an odd number,

$$\varphi = \frac{w^{(n-1)} - w^{(n-2)} + w^{(n-3)} \ldots\ldots + w'' - w'}{m-1}$$

consequently, the last of the equations (A) coincides always with the equations (IX.) of Sect. 4. The equations (IV.) of Sect. 4 gives further

$$m = BB'B''B''' \ldots\ldots B^{(n-2)} \ldots\ldots\ldots \text{(B)}$$

and if the coloured border of the image is to be destroyed, according to Sect. 5, we have, for lenses all made of the same kind of glass, or for $n = n' = n''$, and $dn = dn' = dn''$,

$$0 = w' + \frac{w''}{B'} + \frac{w'''}{B'B''} + \frac{w^{IV}}{B'B''B'''} \ldots\ldots + \frac{w^{(n-1)}}{B'B''B''' \ldots B^{(n-2)}} \ldots\ldots\ldots \text{(C)}$$

We have now, consequently, a number of equations, (A), (B), and (C), in which, to the right of the sign of equality, no quantities but B, B′, B″, w', w'', w''', and lastly, the quantity φ, occur. If, therefore, these quantities are given, or if some of them are given, and if some of them are assumed arbitrarily, or determined so as to answer certain purposes, or if the symbols

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representing them are for a time retained in the calculation, we shall immediately be able thereby to determine the values of m and A, A′, A″.

As soon as the values of A, A′, A″ and B, B′, B″ are known, it will be easy to determine the focal distances p', p'', p''' of the lenses, as also their distances Δ, Δ′, Δ″. If all dimensions are expressed in parts of the focal distance α of the first lens, (that distance being assumed as unity), the equations of Sect. 1 and Sect. 4 (I.) will yield the following values of the focal distances of the single lenses, and of their distances from each other.

Focal Distances.

$$\left.\begin{aligned} p' &= \frac{A\alpha}{(1+A)\,B} \\ p'' &= \frac{AA'\alpha}{(1+A')\,BB'} \\ p''' &= \frac{AA'A''\alpha}{(1+A'')\,BB'B''} \\ p^{IV} &= \frac{AA'A''A'''\alpha}{(1+A''')\,BB'B''B'''} \end{aligned}\right\} \quad \ldots\ldots\ldots \text{(D)}$$

Distances of Lenses.

$$\left.\begin{aligned} \Delta &= (1+B)\frac{\alpha}{B} \\ \Delta' &= (1+B')\frac{A\alpha}{BB'} \\ \Delta'' &= (1+B'')\frac{AA'\alpha}{BB'B''} \\ \Delta''' &= (1+B''')\frac{AA'A''\alpha}{BB'B''B'''} \end{aligned}\right\} \quad \ldots\ldots\ldots \text{(E)}$$

The distance of the eye from the last or n^{th} lens is

$$K = \frac{AAA\ldots A^{(n-2)}\,\alpha w^{(n-1)}}{(1+A^{(n-2)})\,B^2B'^2B''^2\ldots B^{(n-2)^2}\varphi} \quad \ldots\ldots\ldots \text{(F)}$$

These formulæ contain the solution of our problem. It is to be observed, first, that the first a and the last α are infinite; consequently, the first $\alpha = p$, and the last $a =$ the last p;—secondly, that the quantities Δ, Δ′, Δ″, by their nature, never can be negative, and that, consequently, the quantities B, B′, B″ must be chosen accordingly; — thirdly, that the distance R must always be positive when the eye sees the whole field of view; — fourthly, when B, or B′, or B″ is negative, no real, but an imaginary image is formed between the lenses I. II., or II. III., or III. IV., &c.; — fifthly, if m (in the equation (B)) is negative, the image is erect for an even, and inverted for an odd number of lenses; — sixthly, the quantities w', w'', w''' can be positive or negative, but never greater than 0,2 or 0,3; — seventhly, as the radii of aperture for the field of view (Sect. 2) must always be greater than the radii of aperture for the light, the following will be the equations of condition, if x denotes the radius of the object-glass, or if $x =$ AP,

$$w' > \frac{x}{Bp'}, \quad w'' > \frac{x}{A'BB'p''}, \quad w''' > \frac{x}{A''BB'B''p'''} \quad \&c.$$

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We shall now consider every one of the above-mentioned classes of eye-glasses.

Eye-glasses with One Lens.

Section VII.—We here suppose that the object-glass is already free from the spherical aberration and from the dispersion of the rays of light: we also assume the focal distance p of the object-glass to be positive.

For telescopes with two lenses, we have, therefore, by Sect. 6 (A) and (B), these equations:

$$\frac{Aw'}{A+1} = (B+1)\,\phi \qquad \text{and} \qquad m = B$$

The equation (C) of Sect. 6, or the achromatic equation, gives $w' = o$, which is impossible, because (Sect. 4, IX.) likewise $\varphi = 0$ would result from it, or the whole field of view would vanish. It is, therefore, impossible entirely to remove the coloured edges with two lenses only.

As $a' = \alpha' = \infty$, or $a = p$ and $\alpha' = p'$, we have also $A = \infty$ and $B = \frac{\alpha}{\alpha'} = \frac{p}{p'}$, or $B = m$. Hence B itself is determined. If we suppose, therefore, the quantities $B = m$, p, and the factor w', as given, we obtain for these telescopes,

From Sect. 6, equation (A) ..... $\varphi = \frac{w'}{m+1}$, or $\phi = 3438\,\frac{w'}{m+1}$ minutes.

(D) ..... $p' = \frac{p}{m}$

(E) ..... $\Delta = (1+m)\,\frac{p}{m}$ or $\Delta = p + p'$

and (F) ..... $K = \frac{pw'}{m^2\phi} = \frac{p'w'}{m\phi} = \frac{(m+1)\,p'}{m}$

and by these four equations the quantities φ, p', Δ, and K, are determined, and the construction of the telescope is perfectly known.

If the quantity m is assumed positive in these equations, we obtain the astronomical or Keplerian telescope. In this telescope, the distance of both lenses is equal to the *sum* of the focal distances; and as p' is likewise positive, the eye-lens is *convex*. As K is likewise positive, the eye at the distance K from the eye-glass sees the whole field of view φ.

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But if we assume m negative, we obtain the Dutch telescope. In this telescope, p' is negative, or the eye-glass is *concave* and the distance of the two lenses is equal to the *difference* of the focal distances. As the radius of the field of view $Z' = p'w'$ (Sect. 2) is by its nature a positive quantity, and as p' is negative, w' must likewise be a negative quantity; and hence K, or the distance of the eye, is likewise negative, or the eye should properly be between the two lenses. But as this is impossible, the eye placed outside of the two lenses does not see the whole field of view. Finally, m being positive for astronomical telescopes, and negative for Dutch telescopes, it is clear, by Sect. 4, that in the former case the image is inverted, and in the latter erect.

I. If it be required to find the deviation which the images undergo in the direction of the axis by the different colours, or if it be required to find the changes of the angles φ', φ'', φ''' by the change of n', n'', n''', we have, for one lens, (Sect. 4, II.) $\varphi' = \frac{x}{p}$, and (as Sect. 5) $dp = -pdn$, writing again, for brevity, dn in place of $\frac{dn}{n-1}$. We have, therefore, likewise, $d\varphi' = -\frac{xdp}{p^2} = -\frac{xdn}{p}$. For two lenses, (Sect. 4, II.) $\varphi'' = \frac{a'x}{p\alpha'}$; therefore, likewise, $\frac{d\varphi''}{\varphi''} = \frac{da'}{a'} - \frac{d\alpha}{\alpha} - \frac{d\alpha'}{\alpha'}$, whence will easily be found, if $dn = dn'$,

$$d\phi = -\left(\frac{1}{p} + \frac{a'^2}{\alpha^2 p'}\right)\frac{\alpha x dn}{a'} \quad \text{or} \quad d\phi'' = -(m+1)\frac{xdn}{p}$$

and for three lenses,

$$d\phi''' = -\left(\frac{1}{p} + \frac{a'^2}{\alpha^2 p'} + \frac{a'^2 a''^2}{\alpha^2 \alpha'^2 p''}\right)\frac{\alpha\alpha' x dn}{a'a''} \text{ \&c.}$$

II. If we put $dn = \frac{1}{55}$, and the semidiameter of the object-glass $x = \frac{m}{50}$ inches, we have, for two lenses,

$$d\phi = -\frac{m(m+1)}{2750\, p}$$

where p is expressed in numbers. If, therefore, in different telescopes of these classes, the dispersion of colours is to be the same, their focal distances must be proportional to $m(m+1)$, or, when the magnifying power

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is very great, nearly proportional to m^2. This is the reason why these telescopes, for high magnifying powers, must be so exceedingly long, if the object-glass is a single lens. Experiments have proved that the value of $d\varphi$ may amount to 10, or even 15 minutes, without producing any perceptible indistinctness of the image on account of the colours.

III. The radius of the spherical aberration is (Sect. 5, I.)

$$\mathrm{R} = \frac{mx^3}{4p^4}\,(m\vartheta p + m'\vartheta' p')$$

For $n = n' = 1{\cdot}55$, and $dn = dn' = \frac{1}{55}$, we have, therefore,

$$\mathrm{R} = 1314\,m^3\,(m+1)\,\frac{x'^3}{p^3} \text{ and}$$

$$d\varphi = \frac{3438}{55}\,.\,m\,(m+1)\,\frac{x'}{p}$$

These two expressions for R and $d\varphi$ prove that, for strong magnifying powers, the quantity p, and therefore also the length of the telescope, must be very great, if the two deviations $d\varphi$ and R are to be small, as $d\varphi$ increases as the square, and R even as the fourth power of m. If we assume $\mathrm{R} = 1''$, or $\left(\frac{1}{60}\right)'$, the last two equations give

$$d\phi = 1{\cdot}45779\,(m+1)^{\frac{2}{3}} \text{ minutes, and}$$
$$p = 42{\cdot}8794\,m\,(m+1)^{\frac{1}{3}}\,x'$$

If we, therefore, consider the quantities m, x', and φ as given, we obtain the quantities p, p', x' by the following equations:

$$p = 42{\cdot}8794\,m\,(m+1)^{\frac{1}{3}}\,x'$$
$$p' = \frac{p}{m}$$
$$x = mx'$$
$$\Delta = p + p'$$
$$w' = \frac{(m+1)\phi}{3438} \text{ and } \mathrm{Z}' = p'w'$$

Example.— If $m = 26$, $x' = 0{\cdot}02$ inch, and $\varphi = 25$ minutes, we shall have $d\varphi = 13{\cdot}12$ minutes, and $x = mx' = 0{\cdot}52$, $p = 66{\cdot}89$, $p' = 2{\cdot}57$, $\Delta = 69{\cdot}46$, $w = 0{\cdot}196$, and $\mathrm{Z} = 0{\cdot}50$.

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Eye-glasses with Two Lenses.

Section VIII.—These are the telescopes with three lenses, which are generally used for astronomical observations. As the rays are to emerge from the last lens in a parallel direction, α'', and consequently $A' = \frac{\alpha''}{\alpha'}$, will be infinite. The equations derived from Sect. 6 will, therefore, for these eye-glasses, be as follows:

$$\text{Equation (A)} \ldots \begin{cases} \frac{Aw'}{A+1} = (B+1)\phi \\ w'' = (BB'-1)\phi + w' \end{cases}$$

$$\text{Equation (B)} \ldots \quad m = BB'$$

$$\text{Achromatic Equation (C)} \ldots \quad 0 = w' + \frac{w''}{B'}$$

From these equations, the whole theory of these astronomical eye-glasses with two lenses must result.

It is always a great advantage to have the field of view as large as possible. For this reason, we shall assume $w'' = -w'$, as by Sect. 4, IX. the quantity $\varphi = \frac{w''-w'}{m-1}$. The four preceding equations will then assume this form:

$$\left.\begin{aligned} \frac{A}{A+1} &= -\frac{2(B+1)}{m-1} \\ \phi &= -\frac{2w'}{m-1} \\ m &= BB' \\ B' &= 1 \end{aligned}\right\} \ldots\ldots\ldots \text{(G)}$$

The two quantities B and B′ are, therefore, already determined, because we have $B' = 1$ and $B = m$: and hence A is likewise determined; for we have

$$\frac{A}{A+1} = -\frac{2(m+1)}{m-1}, \quad \text{or} \quad A = -\frac{2(m+1)}{3m+1}$$

These expressions for A, B, and B′ being substituted in the equations (D) and (E) of Sect. 6, we obtain, for determining the focal distances of the lenses, and their distances from each other, these equations:

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$$\left.\begin{aligned} p' &= -\frac{2(m+1)\alpha}{m(m-1)} & \Delta &= \frac{(m-1)\alpha}{m} \\ p'' &= -\frac{2(m+1)\alpha}{m(3m+1)} & \Delta' &= -\frac{4(m+1)\alpha}{m(3m+1)} \end{aligned}\right\} \ldots\ldots \text{(H)}$$

where $\alpha = p$ denotes the focal distance of the object-glass. If we assume the two lenses of the eye-glass convex, as is the case in all our telescopes, p and p' will be negative; therefore, m, and B, which is equal to it, will likewise be a negative quantity, while $B' = 1$, and is positive. Hence it follows that, as B is negative, (Sect. 6, remark 4) only an imaginary image will be formed by the object-glass and the first eye-glass lens, and that, as B' is positive, a true image will be formed between the two lenses of the eye-glass. For this reason, a wire micrometer cannot well be applied to this kind of eye-glass, because this micrometer would have its place between the two lenses of the eye-glass, in the place of the true image; and the least change of position of the eye-glass would consequently derange its place and adjustment, which would be exceedingly inconvenient for astronomical observations. The wire micrometer must, therefore, be between the first and second lens, in order to be able to move the eye-glass without disturbing the micrometer. But, in that case, the true image of the telescope must likewise be between the first and second lens, or B must be positive and B' negative. The formulæ (H) prove, however, that this is impossible, as $B' = 1$, and is, consequently, invariably positive; and for a positive B, m would likewise be positive, and the quantities p' and p'' negative, or the two eye-lenses must be concave; and lastly, Δ' would even be negative, which (Sect. 6, remark 2) is impossible.

This class of eye-glasses with two convex lenses is, therefore, inapplicable to *micrometer observations;* but for the mere *viewing* of the stars they are very good, as they are perfectly achromatic, and at the same time have a large, indeed, the greatest possible field of view. They have, therefore, been used for this purpose by DOLLOND, RAMSDEN, FRAUNHOFER, and others, with great success.

The radius of the field of view of these eye-glasses is

$$\varphi = \frac{6876\, w'}{m-1}$$

For finding the distances at which the rays unite for these eye-glasses, we have

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$$\alpha' = \frac{\alpha}{B} = \frac{\alpha}{m}, \text{ and } \alpha' = \frac{A\alpha}{B} = -\frac{2(m+1)\alpha}{m(3m+1)}$$

Accordingly, as $\alpha' = p''$, and $\Delta' = 2p''$, the true image falls exactly in the middle between the eye-glasses II. and III., which is advantageous; because, if the image is too near to one of the eye-glasses, all dust, veins, &c. of the lens will be visible, which disturbs the observations. The image is, in this case, inverted, m being negative, (Sect. 4, IV.)

Example I.—Let the focal distance of the object-glass $\alpha = 70$ inches, the magnifying power $m = -26$, and the semi-aperture of the first eye-glass lens $Z' = 1{\cdot}43$. In order to find the focal distances, and the distance of the two lenses of the eye-glass, we have, by the equations (H),

$p' = 4{\cdot}986$ inches $\quad \Delta = 67{\cdot}308$ inches
$p'' = 1{\cdot}748$ —— $\quad \Delta' = 3{\cdot}496$ ——

Next, as $w' = \frac{Z'}{p'} = 0{\cdot}287$; therefore, also, $w'' = -w' = -0{\cdot}287$, $Z'' = p''w'' = 0{\cdot}502$, and half the angle subtended by the field of view $\varphi = 73{\cdot}04$ minutes.

Example II.—If $\alpha = 70$, $m = -100$, and $Z' = 0{\cdot}3$, we obtain,

$p' = 1{\cdot}372$ $\quad \Delta = 69{\cdot}300$
$p'' = 0{\cdot}463$ $\quad \Delta' = 0{\cdot}927$

$w'' = -w' = 0{\cdot}219$, $Z'' = 0{\cdot}101$, and $\varphi = 14{\cdot}91$ minutes.

Example III.—If $\alpha = 60$, $m = -30$, $Z' = 0{\cdot}93$, we find,

$p' = 3{\cdot}742$ $\quad \Delta = 58$
$p'' = 1{\cdot}304$ $\quad \Delta' = 2{\cdot}607$

$w' = -w'' = \frac{1}{4}$, $Z'' = 0{\cdot}33$, and $\varphi = 55{\cdot}45$ minutes.

These values of p', p'', Δ', Δ'' very nearly agree with the construction which DOLLOND, FRAUNHOFER, and others, have given to these eye-glasses with two lenses and without micrometers.

With a view to give one more example of a telescope with less magnifying power, but a very large field of view, let $\alpha = 25$ inches, $m = -10$, and $Z' = 1{\cdot}15$. We shall find

$p' = 4{\cdot}091$ $\quad \Delta' = 22{\cdot}500$
$p'' = 1{\cdot}552$ $\quad \Delta'' = 3{\cdot}104$

$w' = -w'' = 0{\cdot}28$, $Z'' = 0{\cdot}43$, and $\phi = 175{\cdot}02$ minutes.

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This construction nearly agrees with the one used by FRAUNHOFER for his sweepers, or night-telescopes.

Section IX.—Astronomers have, besides this, another kind of eye-glass with two lenses, in which the image falls outside of both, where, consequently, the micrometer is placed between the object-glass and the eye-glass, in such a manner that the whole eye-glass may be moved, or even exchanged for another, without disturbing the adjustment of the telescope or of the circle connected with it. But for this important class of eye-glasses we look in vain in the numerous writings of EULER, or other authors on optics. The first who practically introduced it for astronomical instruments, and thereby conferred a great benefit on astronomy, was RAMSDEN, who likewise attempted to give a kind of theory of this eye-glass in the *Phil. Trans.* for the year 1783, p. 94. He well knew, as might have been expected from an artist of his talents, the disadvantages of the eye-glasses described in Sect. 8 for telescopes destined for proper *measurements*. He observes, that every small displacement of the eye-glass, which is often unavoidable, on account of the difference of the eyes of different observers, disturbs the position of the wire-micrometer; that, in the next place, the first lens of the eye-glass, or the second lens, diminishes the image produced by the object-glass, for which reason the focal distance of the third lens must be considerably shortened; the consequence of which is, that even the smallest threads appear very thick, and become thereby less applicable to delicate measurements; and, lastly, he observes, that in those eye-glasses equal distances of the wires, or an equal number of revolutions of the micrometer-screw, do not correspond to equal parts of the objects observed, as is assumed. With a view to remedy these disadvantages, he was on the point of even having recourse again to the single lenses for eye-glasses; but as the field of view became thereby so much contracted, he again abandoned this plan. Afterwards he attempted to take for the single lens a double one, after the manner of the object-glass, and to compose it of a convex and a concave lens; but he soon convinced himself that such eye-glasses would require too large an aperture, cause too great a loss of light, and that they could not be easily freed from the spherical aberration. At last he conceived the idea of constructing eye-glasses for which the only true image has its place between the object-glass and the lens of the eye-glass nearest to it, or

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between the first and second lenses of the telescope, and he was much satisfied with the success of the practical trials made with a view to this subject; less so, however, with what he calls the theory of it. For this reason he remarks, at the conclusion of his paper: " That to give a proper demonstration, would require more leisure than is consistent with the situation of one not very conversant with mathematics; and, therefore, the whole is only given, in hopes that some person of more ability in the science of optics will favour us with a general theorem, in order that its application may be more universal." This open avowal, so honourable to the great artist, has found few imitators among our present opticians, who are very fond of making a parade of deep mathematical knowledge, in which, however, they are generally lamentably deficient.

With a view of obtaining the theory of these eye-glasses of RAMSDEN, we observe that if, in the achromatic equation, viz.

$$0 = w' + \frac{w''}{B'},$$

we put again, for the sake of having a large field of view, $w' = -w''$, then $B = 1$, and is positive; whereas, if the place of the image is to be between I. and II., the quantity B' is to be negative, and B positive. It is, therefore, evident that, for RAMSDEN's eye-glasses, the achromatic equation, or the equation (C) of Sect. 6, must be entirely neglected.

It might be objected, that perhaps, by a small diminution of the field of view, the plan might be effected without entirely losing sight of the achromatic equation. Let therefore, $w'' = \vartheta w'$, where ϑ denotes some real fraction. Hence we have $\varphi = \frac{w'' - w}{m - 1} = \frac{(\vartheta - 1)\, w'}{m - 1}$. The achromatic equation gives, however, $B' = -\vartheta$, and, as B' is to be negative, ϑ must be a positive quantity. But, when ϑ is positive, the field of view, viz.

$$\phi = \frac{(\vartheta - 1)\, w'}{m - 1},$$

is very small, and not even as large as it would be for a single eye-glass lens, for which we have (Sect. 4, IX.)

$$\phi = \frac{w'}{m + 1}$$

It is, therefore, clear that, for RAMSDEN's eye-glasses, the diminution of the field of view, resulting from the regard to the destruction of the

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coloured edges, would be so great as to render it preferable to lose sight of that circumstance altogether.

Neglecting, therefore, the achromatic equation, we have, for determining RAMSDEN's eye-glass, the following equations by Sect. 6:

$$\text{Equation (A)....} \quad \begin{cases} \dfrac{Aw'}{A+1} = (B+1)\,\phi \\ w'' = (BB'-1)\,\phi + w' \end{cases}$$

$$\text{Equation (B)....} \quad m = BB'$$

If we put again, in order to obtain the largest possible field of view, $w'' = -w'$, we have,

$$\left.\begin{aligned} \frac{A}{A+1} &= -\frac{2(B+1)}{m-1} \\ \phi &= -\frac{2w'}{m-1} \\ m &= BB' \end{aligned}\right\} \ldots\ldots\ldots \text{(F)}$$

One of the quantities B and B′ remains, therefore, indeterminate. If we suppose that B is to be assumed arbitrarily, the equations (F) will give

$$A = -\frac{2(B+1)}{m+2B+1} \quad \text{and} \quad B' = \frac{m}{B}$$

With these values of A and B′, the equations (D) and (E) of Sect. 6 give

$$\left.\begin{aligned} p' &= -\frac{2(B+1)\,\alpha}{(m-1)B} & \Delta &= \frac{(B+1)\,\alpha}{B} \\ p'' &= -\frac{2(B+1)\,\alpha}{m(m+2B+1)} & \Delta' &= -\frac{2(B+m)(B+1)\,\alpha}{mB(m+2B+1)} \\ \text{And also, } \alpha' &= \frac{\alpha}{B}, \text{ and } \alpha'' = A\alpha' = -\frac{2(B+1)\,\alpha}{B(m+2B+1)} \end{aligned}\right\} \ldots\ldots\ldots \text{(K)}$$

If, therefore, as in the new eye-glasses, the only true image is situated between the first and second lenses, B will be positive, B′ and m, on the contrary, negative.

It follows from the expression for Δ', that as $-\frac{2(B+1)\,\alpha}{mB}$ is a positive quantity, $\frac{B+m}{(m+2B+1)}$ must also be positive. Consequently, B must be greater than $-m$.

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Example I.—If $B = -2m$, we have

$$p' = -\frac{(1-2m)\,\alpha}{m\,(1-m)} \qquad \Delta = -\frac{(1-2m)\,\alpha}{2m}$$
$$p'' = -\frac{2\,(1-2m)\,\alpha}{m\,(1-3m)} \qquad \Delta' = -\frac{(1-2m)\,\alpha}{m\,(1-3m)}$$

Example II.—If $B = -5m$, we have

$$p' = -\frac{2\,(1-5m)\,\alpha}{5m\,(1-m)} \qquad \Delta = -\frac{(1-5m)\,\alpha}{5m}$$
$$p'' = -\frac{2\,(1-5m)\,\alpha}{m\,(1-9m)} \qquad \Delta' = -\frac{8\,(1-5m)\,\alpha}{5m\,(1-9m)}$$

Both these constructions agree very nearly with the double eye-glasses which FRAUNHOFER has used for his transits and meridian circles. The equations (K) contain, therefore, the theory of these and all such double eye-glasses for which the place of the true image is between the two first lenses I. and II.

It is, however, possible to make other suppositions for B, by which other kinds of these eye-glasses may be obtained; but they are generally not convenient for practical use.

Thus, the supposition, $B = -m$, gives these expressions:

$$p' = p'' = -\frac{2\alpha}{m}, \qquad \Delta = \frac{(m-1)\,\alpha}{m}, \qquad \text{and } \Delta' = 0$$

The focal distances of the two eye-glass lenses are consequently equal, and they are close together, Δ' being $= 0$.

In like manner, $B = \infty$ gives the expressions,

$$p' = -\frac{2\alpha}{m-1}, \qquad \Delta = \alpha, \qquad \text{and } p'' = \Delta' = \frac{\alpha}{m}$$

or the second lens II. is placed in the focus of the third lens.

Generally, if $B = -\vartheta m$, where ϑ is a positive number greater than 1, and if m is considerable compared to 1, the following equations will be derived for all these eye-glasses from the equations (K):

$$p' = -\frac{2\alpha}{m} \qquad \Delta = \alpha \ \ldots\ \text{(nearly.)}$$
$$p'' = -\frac{2\vartheta\alpha}{m\,(2\vartheta-1)} \qquad \Delta' = -\frac{2\,(\vartheta-1)\,\alpha}{m\,(2\vartheta-1)}$$

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Eye-glasses with Four Lenses.

Section X.—The theory of these eye-glasses with four lenses, usually called terrestrial, is capable of many different forms, the number of unknown quantities being much greater than the number of equations by which those quantities are to be determined. As we have not room to exhaust all the possible cases, we shall confine ourselves to the most excellent of them.

We assume, in the first place, that the telescope here under consideration, which, including the object-glass, will consist of five lenses, has two real images whose places are between the second and third, and third and fourth lenses, so that B′ and B″ are positive, and B and B‴ negative. In order to obtain a large field of view, let $w''' = -w$, $w'' = 0$, and $w' = \frac{2w}{\sqrt{m}}$, as also $w^{IV} = +w$. These suppositions change the equations (B), (C), and the second of the equations (A) in Sect. 6, into the following:

$$\left.\begin{aligned} m &= BB'B''B''' \\ o &= \frac{2}{\sqrt{m}} - \frac{1}{B'B''} + \frac{1}{B'B''B'''} \\ o &= \frac{(BB'-1)}{m+\sqrt{m}} + \frac{1}{\sqrt{m}} \quad \text{and} \\ \phi &= \frac{2w}{m+\sqrt{m}} \end{aligned}\right\}$$

From these equations result $BB' = -\sqrt{m}$, $B''B''' = \sqrt{m}$, and $(2B'-1)B'' = \sqrt{m}$. As $B''' = \frac{\alpha'''}{a^{IV}}$ is to be negative, α''' must likewise be negative; and as $\Delta''' = \alpha''' + a^{IV}$ must always be positive, we have $\alpha^{IV} > a'''$, or $B''' < 1$; and hence, as the last equations prove, $B'' > \sqrt{m}$ and $B' < 1$. As B″ is positive, the equation $(2B'-1)B'' = \sqrt{m}$ proves that $B' > \frac{1}{2}$; B′ is therefore contained between the narrow limits of $\frac{1}{2}$ and 1; and as $B = -\frac{\sqrt{m}}{B'}$, B must be contained within the limits of $\sqrt{m}$ and $2\sqrt{m}$. If we assume, therefore, for B the arithmetical mean of those two values; viz. $B = -\frac{3}{2}\sqrt{m}$, we obtain $B' = \frac{2}{3}$, $B'' = 3\sqrt{m}$, and $B''' = -\frac{1}{3}$. With these values, the equations (A) of Sect. 6 give

$$A = \frac{2-3\sqrt{m}}{5\sqrt{m}} \quad \text{and} \quad A'' = -\frac{2(1+3\sqrt{m})}{1+5\sqrt{m}}$$

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and the quantity A′ may be assumed arbitrarily, as $w'' = 0$. These values for A and B being substituted in the equations (D) and (E) of Sect. 6, and putting, for brevity, $P = 3\sqrt{m} - 2$, $Q = \sqrt{m} + 1$, $R = 3\sqrt{m} + 1$, $S = 5\sqrt{m} + 1$, we obtain, for the required determination of our eye-glass, the following expressions:

$$p' = \frac{P\alpha}{3Q\sqrt{m}} \quad \text{and} \quad \Delta = \frac{P\alpha}{3\sqrt{m}}$$

$$p'' = \frac{PA'\alpha}{5m(1+A')} \qquad \Delta' = \frac{P\alpha}{3m}$$

$$p''' = \frac{2PRA'\alpha}{15Qm\sqrt{m}} \qquad \Delta'' = \frac{PRA'\alpha}{15m\sqrt{m}}$$

$$p^{IV} = \frac{2PRA'\alpha}{5Sm\sqrt{m}} \qquad \Delta''' = \frac{4PRA'\alpha}{15Sm\sqrt{m}}$$

For the angle subtended by half the field of view, we have $\varphi = \frac{1719}{m+\sqrt{m}}$ minutes, if $w = \frac{1}{4}$; and, for the place of the eye behind the fifth lens, $K = \frac{PQRA'\alpha}{5m^2S}$. The arbitrary quantity A′ may be so determined as to make, for example, $p^{IV} = 1$ inch. These formulæ, which are identical with those which KLUGEL has found, by a very different method, in his *Analytical Dioptrics*, appear to give very good eye-glasses; but yet they do not represent the terrestrial eye-glasses made by English and German artists.

I have examined several of these eye-glasses of FRAUNHOFER, and found that the ratios of the focal distances, and of the distances of the glasses, were very nearly always the same, although the focal distances and the distances of the lenses themselves, as also the magnifying powers m, differed much from one another. The following Table contains the dimensions of several of FRAUNHOFER's eye-glasses, in inches of Vienna measure.

m	$a = p$	p'	p''	p'''	p^{IV}	Δ'	Δ''	Δ'''
26	20·22	1·56	1·91	2·18	1·20	2·33	3·58	1·84
42	31·15	1·45	1·78	2·02	1·11	2·16	3·32	1·71
60	56·56	1·82	2·23	2·55	1·40	2·72	4·19	2·15
66	58·61	1·71	2·09	2·38	1·31	2·55	3·92	2·01
70	44·43	1·22	1·49	1·70	0·94	1·81	2·79	1·43

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However different these values of p and Δ may be for the different magnifying powers, their ratios agree. We find, from all five dimensions, nearly

$$\frac{p'}{p'} = 0{\cdot}82, \quad \frac{p'}{p'''} = 0{\cdot}71, \quad \frac{p'}{p^{\text{IV}}} = 1{\cdot}30, \quad \text{and likewise } \frac{\Delta'}{\Delta''} = 0{\cdot}65, \quad \text{and } \frac{\Delta'}{\Delta'''} = 1{\cdot}26$$

Knowing the quantities p, p', p'' and Δ, Δ', Δ'', we find the quantities a', a'', a''', and α', α'', α''' by the following equations:

$$\begin{aligned} \alpha''' &= \Delta''' - p^{\text{IV}} \quad \text{and} \quad a''' = \frac{\alpha''' p'''}{\alpha''' - p'''} \\ \alpha'' &= \Delta'' - a''' \qquad\qquad a'' = \frac{\alpha'' p''}{\alpha'' - p''} \\ \alpha' &= \Delta' - a'' \qquad\qquad a' = \frac{\alpha' p'}{\alpha' - p'} \\ \Delta &= p + a' \end{aligned}$$

which expressions belong to the luminous ray EPqr (fig. 1) of a point E in the axis. If we seek, in like manner, a', a'' and α', α'' for the principal ray eAQRS, we find,

$$\begin{aligned} \alpha' &= \frac{\Delta p'}{\Delta - p'} \quad \text{and} \quad a'' = \Delta' - \alpha' \\ \alpha'' &= \frac{a'' - p''}{a'' p''} \qquad\qquad a''' = \Delta''' - \alpha'' \\ \alpha''' &= \frac{a''' p'''}{a''' - p'''} \qquad\qquad a^{\text{IV}} = \Delta^{\text{IV}} - a''' \\ \alpha^{\text{IV}} &= \frac{\alpha^{\text{IV}} p^{\text{IV}}}{\alpha^{\text{IV}} - p^{\text{IV}}} \end{aligned}$$

If, now, Z', Z'', Z''', and Z$^{\text{IV}}$ represent the semidiameters of the lenses, which are known by measurement, and φ half the field of view of the telescope, we have

$$\text{Z}' = \Delta \tan \phi, \qquad \text{Z}'' = \frac{a''}{\alpha'} \text{Z}', \qquad \text{Z}''' = \frac{a'''}{\alpha''} \text{Z}'', \qquad \text{and } \text{Z}^{\text{IV}} = \frac{a^{\text{IV}}}{\alpha'''} \text{Z}'''$$

and with these values we obtain those of w', w'', by these equations:

$$w' = \frac{\text{Z}'}{p'}, \qquad w'' = \frac{\text{Z}''}{p''}, \qquad w''' = \frac{\text{Z}'''}{p'''} \text{ \&c.}$$

These values of a', a'' and α', α'' being known, the quantities A, A' and B, B' may be found by the first equations of Sect. 6.

If we apply this method to the numbers of the preceding Table, it will be found that the quantities B' and B'' are constant for all the eye-glasses of FRAUNHOFER, and that $\text{B}' = -\frac{3}{10}$, and $\text{B}'' = -5$.

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As, therefore, the two quantities B′ and B″ are negative, the two true images will be, for these eye-glasses, between the first and second and fourth and fifth lenses. The same Table gives, lastly, $w' = \frac{8w}{10}$, $w'' = \frac{3w}{10}$, $w''' = -w$ and $w^{IV} = +w$.

The equations (B) and (C) of Sect. 6 give next

$$m = BB'B''B''' \quad \text{and} \quad o = w' + \frac{w''}{B'} + \frac{w'''}{B'B''} + \frac{w^{IV}}{B'B''B'''}$$

the second of which contains the condition of the achromatism. Substituting, in this equation, the values found for w', w'' and B′, B″, we obtain

$$B''' = \frac{10}{10 - 8B'B'' - 3B''}$$

But as, according to Sect. 7, I., the value of $d\varphi$ may amount to 10, or even to 15 minutes, without producing by the colours a perceptible indistinctness in the image, it is sufficient to satisfy the equation for achromatism approximatively. We may, therefore, assume, from the last equation, $B''' = \frac{1}{2}$, by which the equation $m = BB'B''B'''$ gives $B = \frac{4m}{3}$.

All the four quantities B being thus determined, the quantities A, A′, A″ may be found by the equations (A) of Sect. 6. We have

$$\frac{A}{A+1} = \frac{5(4m+3)}{8(m-1)}; \quad \text{therefore, likewise,} \quad A = -\frac{5(4m+3)}{12m+23}$$

$$\frac{A'}{A'+1} = \frac{(2m-23)}{3(m-1)} \qquad A' = +\frac{(2m-23)}{m+20}$$

$$\frac{A''}{A''+1} = -\frac{(5m+4)}{2(m-1)} \qquad A'' = -\frac{(5m+4)}{7m+2}$$

$$\text{and } \phi = \frac{w^{IV} - w''' + w'' - w'}{m-1} = \frac{15w}{10(m-1)}$$

The values of A, A′ and B, B′ thus found being, lastly, substituted in the equations (D) and (E) of Sect. 6, we shall find, for the determination of these eye-glasses, the following expressions:

$$p' = \frac{15(4m+3)\alpha}{32m(m-1)} \quad \text{and} \quad \Delta = \frac{(4m+3)\alpha}{4m}$$

$$p'' = \frac{80(2m-23)p'}{9(12m+23)} \qquad \Delta' = \frac{35\Delta}{12m+23}$$

$$p''' = \frac{3(5m+4)p''}{10(m+20)} \qquad \Delta'' = \frac{8(2m-23)\Delta'}{7(m+20)}$$

$$p^{IV} = \frac{4(m-1)p'''}{7m+2} \qquad \Delta''' = \frac{3(5m+4)\Delta''}{4(7m+2)}$$

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These formulæ very nearly represent FRAUNHOFER's eye-glasses. In order to put them to the test for a particular case, let $m = 70$. The preceding expressions will give

$$\begin{array}{lll} p' = 0{\cdot}02746\,\alpha & \text{and} & \Delta = 1{\cdot}01071\,\alpha \\ p'' = 0{\cdot}03310\,\alpha & & \Delta' = 0{\cdot}04099\,\alpha \\ p''' = 0{\cdot}03906\,\alpha & & \Delta'' = 0{\cdot}06090\,\alpha \\ p^{\text{IV}} = 0{\cdot}02191\,\alpha & & \Delta''' = 0{\cdot}03286\,\alpha \end{array}$$

therefore, likewise, $\frac{p'}{p''} = 0{\cdot}83$, $\frac{p'}{p'''} = 0{\cdot}71$, $\frac{p'}{p^{\text{IV}}} = 1{\cdot}30$, and $\frac{\Delta'}{\Delta''} = 0{\cdot}67$, $\frac{\Delta'}{\Delta'''} = 1{\cdot}25$, very nearly as before.

Vienna, Oct. 1829.

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XXXIV. *Astronomical Observations.*

I. *Observations of the Comet discovered by M.* GAMBART, *at Marseilles, April* 21*st*, 1830.

1. *By M.* NICOLAI;
2. *By M.* SANTINI;
3. *By Sir* JAMES SOUTH.

II. *Observations of the Comet discovered by Mr.* HERAPATH, *January* 1831.

III. *Observed Occultations of the fixed Stars and Planets, by various Observers.*

IV. *Extracts from the various Communications relative to the same.*

I. *Observations of the Comet discovered by M.* GAMBART, *at Marseilles, April* 21*st*, 1830.

1. Extract of a Letter from Professor NICOLAI, of Mannheim, to Mr. STRATFORD.

I send you herewith my observations of this year's comet. They were made with a circular micrometer, applied to my 4½-feet achromatic.

Observations of the Comet of 1830, *made at the Observatory, Mannheim.*

1830.	Mean Time at Mannheim.	Apparent Æ of Comet.	App. N. Decl.	1830.	Mean Time at Mannheim.	Apparent Æ of Comet.	App. N. Decl.
	h m s	° ′ ″	° ′ ″		h m s	° ′ ″	° ′ ″
May 18	13 23 16	319 35 23	23 12 43	June 22	10 23 12	313 42 35	27 28 3
19	12 38 6	319 34 34	23 29 8	24	10 41 41	313 4 41	27 21 50
20	12 13 23	319 33 31	23 45 15	25	10 7 20	312 45 49	27 18 6
22	12 10 8	319 29 17	24 16 15	July 10	10 17 17	307 44 5	25 14 18
23	11 18 5	319 26 29	24 30 17	11	10 41 36	307 23 40	25 1 53
27	11 37 37	319 9 15	25 22 47	13	10 45 40	306 44 9	24 36 11
31	11 10 16	318 42 15	26 6 16	15	11 19 20	306 5 0	24 8 43
June 1	11 59 25	318 33 57	26 16 6	17	10 46 36	305 27 31	23 40 2
2	11 22 29	318 25 28	26 24 38	18	10 45 21	305 9 11	23 24 59
5	11 15 26	317 55 59	26 48 17	20	11 11 11	304 32 58	22 53 56
9	11 57 1	317 8 24	27 12 20	22	10 18 51	303 58 44	22 22 25
10	10 42 53	316 55 51	27 16 22	23	10 29 25	303 41 50	22 5 47
13	11 11 9	316 13 15	27 27 4	25	10 23 34	303 9 18	21 32 6
13	12 16 55	316 12 41	27 26 59	27	10 49 7	302 37 35	20 57 16

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From these observations up to the 25th of June, and from the first Marseilles observation of the 21st of April, I have deduced the following parabolic elements, which represent very exactly the observations of July.

		Mean Time at Mannheim.
Time of the perihelion passage, 1830,	April 9·32533	(24m 30s west of Paris.)
Log. of the perihelion distance	9·9644660	
Long. of the perihelion	212° 11′ 46″,9	
Long. of ascending node.....	206 21 43 ,9	
Inclination of the orbit.....	21 16 29 ,1	Motion direct.

In the computation of these elements, I have taken into account aberration and parallax, as well as precession and nutation.

2. Extract of a Letter from Professor SANTINI, of Padua, to Professor AIRY.

1830.	Mean Time at Padua.	Apparent Æ of Comet.	App. N. Dec. of Comet.	1830.	Mean Time at Padua.	Apparent Æ of Comet.	App. N. Dec. of Comet.
	h m s	° ′ ″	° ′ ″		h m s	° ′ ″	° ′ ″
April 30	13 37 36,9	318 32 2,4	15 51 19,4	May 24	12 33 25,5	319 23 19,6	24 44 42,6
—	14 7 11,0	318 32 4,8	15 52 31,6	—	13 0 26,7	319 23 2,5	24 45 17,4
May 1	14 14 25,7	318 38 18,2	16 25 48,7	25	12 10 39,2	319 19 0,9	24 57 56,3
–	14 40 44,5	318 38 19,8	16 26 48,0	—	12 45 41,1	319 18 41,4	24 58 0,3
3	13 9 4,8	318 50 8,0	17 27 31,6	26	12 6 2,5	319 14 9,1	25 11 0,5
–	13 59 36,8	318 50 2,0?	17 28 36,6	—	12 42 40,6	319 14 39,1	25 11 57,5
5	14 11 48,2	319 1 33,6	18 26 52,6	28	12 7 38,5	319 3 16,2	25 34 36,6
–	14 48 37,3	319 1 42,0	18 27 24,6	—	12 32 41,5	319 2 50,3	25 34 51,6
8	13 59 3,4	319 14 53,3	19 45 36,7	29	12 0 57,6	318 56 29,4	25 45 58,2
–	14 23 29,6	319 14 47,4	19 45 51,4	—	12 29 29,2	318 56 33,4	25 46 16,2
10	13 15 19,1	319 22 39,5	20 32 34,3	30	11 57 18,3	318 49 45,2	25 56 6,4
—	13 24 29,2	319 22 40,2	20 32 36,9	—	12 27 46,6	318 49 37,6	25 56 18,4
12	12 58 11,2	319 28 32,1	21 16 44,9	June 1	12 18 41,8	318 34 0,4	26 16 1,9
—	13 14 59,9	319 28 29,8	21 17 3,2	–	12 49 37,1	318 33 31,3	26 16 14,9
18	14 22 6,9	319 35 19,1	23 13 13,1	2	12 33 18,9	318 25 11,5	26 24 44,1
—	14 32 19,2	319 35 29,1	23 13 37,1	–	13 2 51,1	318 24 49,3	26 25 19,1
19	12 38 3,5	319 34 30,5	23 29 31,6	3	12 21 14,3	318 15 52,8	26 33 17,2
—	13 4 29,3	319 34 42,3	23 29 17,6	–	12 34 33,8	318 15 41,5	26 33 20,2
20	13 12 8,9	319 33 31,7	23 45 45,4	5	11 44 55,5	317 56 32,4	26 48 43,7
21	12 50 1,2	319 31 45,7	24 1 40,3	–	12 2 52,8	317 56 7,2	26 48 43,7
—	13 15 46,3	319 31 41,1	24 1 39,3	6	12 33 42,0	317 44 39,9	26 55 42,9
22	12 32 16,9	319 29 36,8	24 16 7,1	11	11 4 22,2	316 42 15,6	27 20 24,3
—	12 59 54,7	319 29 44,0	24 16 21,1	12	11 33 47,1	316 27 55,4	27 23 59,7
23	12 21 43,0	319 26 57,6	24 30 47,9	—	12 11 59,8	316 27 43,3	27 24 25,7
—	12 51 25,5	319 26 34,3	24 30 55,9	13	11 54 7,8	316 12 59,2	27 27 3,3

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The comet is still observable; but it is very faint, and probably will not be visible much longer. From the above observations of April 30, and May 8 and 18, I have deduced the following parabolic elements, (without regarding the small corrections arising from aberration and parallax), which even now represent the observations with considerable accuracy; whence we may infer that the orbit only requires minute corrections, and that it is very nearly a parabola. In the catalogue of Professor SCHUMACHER, I do not find any one which corresponds to it.

Time of the perihelion passage, 1830, April, 9·63844		Mean Time at Padua.
Log. of the perihelion distance.....	9·9650486	
Long. of the perihelion	212° 23′ 18″,8	
Long. of the ascending node	206 22 43 ,1	
Inclination of the orbit	21 11 8 ,8	Motion direct.

Hence the following formulæ are obtained for calculating the heliocentric co-ordinates of the comet referred to the equator:

$$x = \frac{m \sin (v + 300^\circ\, 49' \, 32'',6)}{\cos^2 \frac{1}{2} v}$$

$$y = \frac{n \sin (v + 210^\circ\, 8' \, 0'',0)}{\cos^2 \frac{1}{2} v}$$

$$z = \frac{p \sin (v + 275^\circ\, 40' \, 51'',5)}{\cos^2 \frac{1}{2} v}$$

where v is the true anomaly in the parabola, and

$$\log. m = 9{\cdot}9593733 \qquad \log. n = 9{\cdot}9638505 \qquad \log. p = 9{\cdot}2127168$$

3. Extract of a Letter from SIR JAMES SOUTH.

"Our indefatigable Associate, M. GAMBART, having had the kindness to transmit me the approximate place of this comet, discovered at Marseilles on the 21st of last month, I had the good fortune to find it on the evening of the day on which his communication reached me; and the following observations of it will, I trust, not be unworthy the Society's notice.

Five-feet Equatorial.

1830.	Sidereal Time.	Comet's Æ.	Comet's Declin.
	h m s	h m s	° ′ ″
May 1	17 50 46	21 14 34	16 27 58
2	16 54 37	21 14 56	16 58 49
3	17 30 35	21 15 21	17 30 2
11	16 0 0	21 17 44	20 56 25
13	16 21 0	21 18 2	21 37 57

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"In the five-feet equatorial, the comet is nearly circular, and about two minutes in diameter: its nucleus is well defined, and bears magnifying power better than that of any comet I have seen. Although the moon's light was very considerable, it was found, on the 1st of May, without the slightest difficulty."

II. *Observations of the Comet discovered by Mr. Herapath, at Cranford, January* 1831.

A Letter from Mr. Herapath to the President, announcing the discovery of a Comet.

"The first sight I had of the Comet was on the 7th of January, on Hounslow Heath, about 6 A.M. The tail was then nearly perpendicular to the horizon, inclining towards the south, and of a white colour, apparently between 1° and 2° long. The head was of the same colour as the tail, but, in proportion, far more splendid. To me, it appeared to equal in light stars of the second magnitude, while it exceeded them in size."

Mr. Herapath took its distance with a sextant from two bright stars, and found the distance of the comet from Arcturus 60° 50′, and from α *Lyræ* 52° 45′, (the latter observation a little uncertain), at about $6^h\ 30^m$ mean solar time.

From these observations, Mr. Herapath concludes, as an approximate place of the comet,

Jan. 7. $6^h\ 30^m$ A.M. Æ $17^h\ 36^m\ 44^s$ S. Dec. 12° 33′

An observation made by Sir James South, about 48 hours afterwards, gives

Æ $17^h\ 27^m\ 57^s$ S. Dec. 12° 1′ 12″

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III. *Observed Occultations of the fixed Stars and Planets, by various Observers.*

No.	Date.	Star.	Place.	Immersion.	Emersion.	Observer.
	1828.			h m s	h m s	
1	Dec. 25	π Leonis	Campden Hill	4 36 14,64 *s*	5 20 36,55 *s*	South
	1829.					
2	Jan. 18	λ Geminorum	Makerstown	4 27 46,80 *s*	5 38 32,30 *s*	Dunlop
3	Feb. 13	E^2 Orionis	———	7 1 28,00 *s*	.....	———
4*	14	Anon, 7^m	Campden Hill	8 38 40,83 *s*	.....	Stratford
5*	—	——, 8	———	10 35 33,90 *s*	.....	———
6	17	h Leonis	Makerstown	7 33 57,60 *s*	.....	Dunlop
7*	Mar. 15	Anon, 6^m	———	10 18 52,80 *s*	.....	———
8	May 9	A^2 Cancri	———	12 23 44,00 *s*	.....	———
9	—	— Comes	———	12 24 35,30 *s*	.....	———
10*	—	Anon, 6^m	Campden Hill	12 41 19,81 *s*	.....	South
11*	—	——, 7^m	———	12 44 18,61 *s*	.....	———
12*	—	——, $7{\cdot}8^m$	———	13 52 43,61 *s*	.....	———
13	—	——, 8^m	———	14 26 27,81 *s*	.....	———
14	July 25	α Tauri	Dorpat	21 35 57,00 *s*	22 29 32,50 *s*	Struve
15	—	———	———	57,10 *s*	33,10 *s*	Preuss
16	—	———	———	56,90 *s*	32,90 *s*	Rosenius
17	—	———	———	57,90 *s*	32,90 *s*	Seuff
18	Aug. 8	θ Libræ	Biggleswade	19 17 36,70 *s*	.....	Maclear
19	—	———	Campden Hill	19 19 0,13 *s*	.....	South & Beaufort
20*	21	70 Tauri	Paris Obs.	.....	23 15 50,60 *s*	Mathieu
21	—	———	———	.....	50,50 *s*	Savary
22	—	———	Campden Hill	.....	23 13 23,96 *s*	South & Stratford
23*	—	75 Tauri	Paris Obs.	23 51 9,00 *s*	0 49 9,30 *s*	Mathieu

4 $R = 7^h\,32^m$, D = + 15° 59′.

5 $R = 7^h\,34^m$, D = + 15° 38′.

7 $R = 8^h\,23^m$, D = + 13° 50′.

10, 11 A double star of the 6th class: A of the sixth magnitude, B of the 7th: position about 67° *nf.*; distance about $3\frac{1}{4}$ minutes. $R = 8^h\,40^m$, Dec. = + 13° 6′. Observed with the 5-feet equatorial; and no projection of either star on the moon's disc.

12 $R = 8^h\,41^m$, D = + 12° 50′.

20 In this, and the following observations at Paris on the same day, the time given is the time by the sidereal clock, which was $1^m\,26^s{,}95$ slow.

23 Both observations of the immersion uncertain.

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No.	Date.	Star.	Place.	Immersion.	Emersion.	Observer.
	1829.			h m s	h m s	
24	Aug. 21	75 Tauri	Paris Obs.	23 51 7,00 *s*	.....	Savary
25*	—	θ^1 Tauri	Edinburgh	13 42 53,00 *m*	14 21 49,00 *m*	Henderson
26	—	(99) Tauri	———	.....	15 38 30,00 *m*	———
27	—	———	Campden Hill	.....	1 43 46,50 *s*	South
28	—	———	Paris Obs.	.....	1 44 19,20 *s*	Mathieu
29	—	———	———	.....	19,00 *s*	Savary
30	—	α Tauri	———	3 57 42,70 *s*	.....	Mathieu
31	—	———	———	42,40 *s*	.....	Savary
32	—	———	Biggleswade	.....	5 0 54,00 *s*	Maclear
33*	—	———	Bedford	.....	4 59 49,63 *s*	Smyth
34*	—	———	Boston, N.A.	11 58 47,00 *m*	12 51 43,10 *m*	Paine
35	Sept. 11	(46) Aquarii	Edinburgh	11 17 10,00 *m*	.....	Hall
36	—	———	———	9,80 *m*	.....	Henderson
37	—	———	———	9,50 *m*	.....	Adie
38	—	———	Makerstown	22 43 42,70 *s*	.....	Dunlop
39*	—	———	Gottingen	23 55 18,69 *s*	.....	Harding
40	17	α Tauri	Boston, N.A.	21 19 32,20 *m*	.....	Paine
41	Oct. 9	67 Aquarii	Biggleswade	21 49 31,40 *s*	.....	Maclear
42*	—	———	Bedford	21 49 33,45 *s*	.....	Smyth
43*	—	———	Chislehurst	8 38 1,34 *m*	.....	Hussey
44	15	α Tauri	Dorpat	0 51 50,50 *s*	1 41 13,40 *s*	Struve
45	—	———	———	50,80 *s*	13,90 *s*	Preuss
46	—	———	———	50,70 *s*	13,20 *s*	Rosenius
47	—	———	———	50,50 *s*	13,20 *s*	Seuff
48*	—	———	South Kilworth	9 10 21,33 *m*	.....	Pearson
49*	—	———	———	.....	9 45 12,50 *m*	?
50	—	———	Biggleswade	22 49 3,50 *s*	23 25 2,70 *s*	Maclear
51*	—	———	Bedford	22 48 18,96 *s*	23 24 7,89 *s*	Smyth

25 Immersion doubtful to a second or two.

33 5-feet achromatic, $3\frac{3}{4}$ aperture, adjusted to moon; power 78.

34 Latitude 42° 21′ N. Longitude 71° 3′ 48″ W.

39 Reflecting telescope, by Schroeter, of 13 feet. Time very exact, and occultation well observed.

42 Telescope 5-feet focal length, aperture $3\frac{3}{4}$ inches, power 78, adjusted to the moon.

43 Latitude 51° 24′ 33″,3. Longitude $0^h\ 0^m\ 18^s,55$ East. 49-inch achromatic, 3·75 inch aperture, power 98, adjusted to the star.

48 Refractor $3\frac{3}{4}$ aperture, power 164. 49 Cassegrainian reflector, $6\frac{1}{4}$ aperture, power 74.

51 Achromatic telescope adjusted to the star, $3\frac{3}{4}$ aperture, 5-feet focal length, power 78.

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No.	Date.	Star.	Place.	Immersion.	Emersion.	Observer.
	1829.			h m s	h m s	
52	Oct. 15	α Tauri	Chislehurst	9 12 4,66 *m*	9 49 41,74 *m*	Hussey
53*	—	———	Greenwich Obs.	22 48 27,54 *s*	23 25 57,04 *s*	Pond
54*	—	———	———	28,24 *s*	57,24 *s*	T. Taylor
55*	—	———	———	27,69 *s*	57,04 *s*	Henry
56*	—	———	———	27,89 *s*	57,54 *s*	Richardson
57*	—	———	———	27,89 *s*	57,14 *s*	J. G. Taylor
58*	—	———	———	27,34 *s*	58,14 *s*	Rogerson
59*	—	———	Green. Hospital	9 11 56,30 *m*	.....	Riddle
60*	—	———	Lavender Hill	9 11 57,00 *m*	9 49 13,00 *m*	A. Baily
61*	—	———	Prince's Square	9 11 52,00 *m*	.....	Epps
62*	—	———	Campden Hill	22 47 47,68 *s*	23 25 4,00 *s*	Beaufort
63	—	———	———	49,18 *s*	3,80 *s*	Stratford
64	—	———	———	48,18 *s*	2,30 *s*	Wilson
65	—	———	———	.....	2,30 *s*	Lubbock
66*	—	———	Paris Obs.	22 50 27,00 *s*	23 34 35,00 *s*	Nicollet
67*	—	———	———	28,00 *s*	34,70 *s*	Bouvard
68*	—	———	———	27,30 *s*	35,40 *s*	Mathieu
69*	—	———	———	27,00 *s*	.....	Savary
70*	—	———	———	.....	35,00 *s*	South
71*	—	———	Paris	9 14 16,09 *m*	9 58 32,00 *m*	Francœur
72	—	———	Paris Ec. Mil.	9 14 17,00 *m*	9 58 12,00 *m*	Damoiseau
73*	—	———	Paris ?	9 14 15,50 *m*	.....	Gambart
74	16	130 Tauri	Biggleswade	.....	6 45 6,23 *s*	Maclear
75	Nov. 4	18 Aquarii	Makerstown	21 50 25,00 *s*	22 20 8,30 *s*	Dunlop

53 5-feet equatorial. 54 46-inch achromatic. 55 7-feet reflector.
56 30-inch achromatic. 57 10-feet reflector. 58 5-feet achromatic.
59 30-inch achromatic (Latitude 51° 28′ 52″, long. $0^s,8$ west), power 80, adjusted to the moon.
60 Achrom. telescope 5 feet, power 92, adjusted on the star. *Greenwich* mean time. Probable error of 1 sec.
61 30-inch achromatic telescope, 2 inches aperture, power 55.
62 6-inch object-glass, power 120, adjusted to the moon.
66 *This and the four following observations are given in times of the sidereal clock:* clock slow $21^s,54$.
66 Telescope of Lerebours, 6-inch aperture, power 150.
67 Telescope 4-inch aperture, power 60, for immersion. For emersion, telescope of Lerebours, power 80.
68 Telescope of Reichenbach's circle, power 70 or 80.
69 Telescope of equatorial, low power.
70 5-feet achromatic, by Lerebours.
71 Latitude 48° 40′ 50″, longitude $11^s,5$ east of the Observatory. Moderate telescope.
73 Telescope by Dollond, power 105.

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No.	Date.	Star.	Places.	Immersion.	Emersion.	Observer.
	1829.			h m s	h m s	
76	Nov. 5	(46) Aquarii	Edinburgh	20 10 11,80 *s*	.....	Henderson
77	—	Anon. 7^m	Makerstown	23 26 25,30 *s*	.....	Brisbane
78	11	α Tauri	Boston, N.A.	17 6 26,00 *m*	17 46 57,70 *m*	Paine
79	Dec. 5	(207) Piscium	Biggleswade	1 17 54,60 *s*	.....	Maclear
80	9	θ^1 Tauri	Dorpat	21 52 19,40 *s*	.....	Struve
81	—	———	———	20,30 *s*	.....	Preuss
82	—	———	———	20,60 *s*	.....	Seuff
83	—	———	———	5,50 *s*	.....	Rosenius
84	—	———	———	14,50 *s*	.....	Oberg
85	—	———	———	11,50 *s*	.....	Fuss
86	—	θ^2 Tauri	———	22 4 43,30 *s*	.....	Struve
87	—	———	———	34,40 *s*	.....	Preuss
88	—	———	———	17,60 *s*	.....	Rosenius
89	—	———	———	19,60 *s*	.....	Oberg
90	—	———	———	15,60 *s*	.....	Fuss
91	—	75 Tauri	———	22 5 43,10 *s*	.....	Preuss
92	—	(99) Tauri	———	22 38 30,60 *s*	23 35 0,00 *s*	Struve
93	—	(102) Tauri	———	22 43 52,70 *s*	.....	———
94	—	———	———	53,10 *s*	.....	Preuss
95	—	(113) Tauri	———	23 48 31,00 *s*	.....	Struve
96	—	α Tauri	———	1 3 40,40 *s*	2 7 56,40 *s*	———
97	—	———	———	40,70 *s*	7 59,80 *s*	Preuss
98	—	———	———	40,70 *s*	7 57,70 *s*	Seuff
99	—	———	———	40,80 *s*	8 5,20 *s*	Rosenius
100	—	———	———	40,80 *s*	8 3,20 *s*	Oberg
101	—	———	———	40,70 *s*	.....	Fuss
102*	—	———	Greenwich	5 44 2,50 *m*	6 39 37,50 *m*	Hewitt
103	—	———	Greenwich Obs.	.....	23 53 10,70 *s*	T. Taylor
104	—	———	———	.....	10,50 *s*	H. Taylor
105	—	———	———	.....	15,50 *s*	Henry
106	—	———	———	.....	15,30 *s*	Richardson
107	—	———	———	.....	11,70 *s*	Ellis
108	—	———	Gottingen	23 37 33,30 *s*	24 37 58,30 *s*	Harding
109	—		Altona	23 41 12,97 *s*	24 40 51,40 *s*	Schumacher

102 Common deck telescope, magnifying about 36 times. Each observation doubtful about 1 sec.

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No.	Date.	Star.	Place.	Immersion.	Emersion.	Observer.
	1829.			h m	h m	
110	Dec. 9	α Tauri	Altona	23 41 12,49 *s*	24 40 51,40 *s*	Seidelin
111	—	———	———	12,13 *s*	50,85 *s*	Nehus
112	—	———	———	12,07 *s*	.....	Nyegaard
113	—	———	———	12,39 *s*	52,62 *s*	Petersen
114	—	———	Makerstown	.....	23 46 49,70 *s*	Dunlop
115*	—	———	Ormskirk	5 36 20,25 *m*	.....	Dawes
	1830.					
116	Jan. 2	μ Piscium	Makerstown	1 29 1,30 *s*	2 39 11,50 *s*	Dunlop
117	5	75 Tauri	Cambridge	7 15 7,08 *s*	.....	Airy
118	—	———	Biggleswade	7 13 22,30 *s*	.....	Maclear
119	—	———	Bedford	7 12 18,88 *s*	.....	Smyth
120	—	———	Makerstown	7 0 4,10 *s*	.....	Dunlop
121	—	(99) Tauri	Cambridge	8 22 51,53 *s*	9 13 3,93 *s*	Airy
122	—	———	Biggleswade	8 21 32,30 *s*	9 11 28,73 *s*	Maclear
123	—	———	Bedford	8 20 31,18 *s*	.....	Smyth
124	—	———	Makerstown	8 2 53,10 *s*	8 59 43,00 *s*	Dunlop
125	—	(102) Tauri	Bedford	8 32 27,18 *s*	.....	Smyth
126	—	α Tauri	Cambridge	10 44 7,44 *s*	.....	Airy
127	—	———	Biggleswade	10 42 44,70 *s*	11 33 19,60 *s*	Maclear
128	—	———	Bedford	10 41 53,18 *s*	.....	Smyth
129	—	———	Boston, N.A.	10 14 50,50 *m*	11 12 19,00 *m*	Paine
130	Feb. 5	1 Cancri	Biggleswade	9 20 59,00 *s*	10 35 18,00 *s*	Maclear
131	8	48 Leonis	Makerstown	13 38 51,30 *s*	.....	Dunlop
132	Mar. 3	u Geminorum	Biggleswade	7 12 12,30 *s*	8 20 12,70 *s*	Maclear
133*	—	———	Cambridge Obs.	7 14 20,74 *s*	.....	Rothman
134	12	y Virginis	Biggleswade	.....	15 54 33,80 *s*	Maclear
135	—	k Virginis	———	17 19 32,20 *s*	.....	———
136	14	η Libræ	———	14 19 18,00 *s*	.....	———
137	28	70 Tauri	Dorpat	8 13 50,30 *s*	.....	Struve
138	—	Anon. 9^m	———	8 17 46,60 *s*	.....	———
139	—	71 Tauri	———	8 42 29,20 *s*	.....	———
140	—	———	Bedford	2 4 10,54 *s*	.....	Smyth
141	—	δ^1 Tauri	Dorpat	9 30 47,10 *s*	10 25 20,30 *s*	Struve
142	—	———	———	47,80 *s*	.....	Preuss

115 Latitude 53° 34′ 15″ N.

133 Bad observation: but probably not doubtful to more than 2 seconds.

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No.	Date.	Star.	Place.	Immersion.	Emersion.	Observer.
	1830.			h m s	h m s	
143	Mar. 28	θ^1 Tauri	Biggleswade	7 36 46,25 *s*	8 39 34,00 *s*	Maclear
144	—	———	Bedford	7 35 43,06 *s*	8 38 31,51 *s*	Smyth
145*	—	———	Campden Hill	7 38 2,65 *s*	.....	South
146*	—	———	———	2,45 *s*	.....	Babbage
147*	—	———	———	2,65 *s*	.....	Baily
148*	—	———	———	3,15 *s*	.....	Rothman
149	—	θ^2 Tauri	———	7 45 23,65 *s*	.....	South
150	—	———	———	23,45 *s*	.....	Babbage
151	—	———	———	23,45 *s*	.....	Baily
152	—	———	———	23,45 *s*	.....	Lubbock
153	—	———	Dorpat	9 31 29,10 *s*	.....	Struve
154	—	———	———	29,40 *s*	.....	Preuss
155	—	———	Biggleswade	7 43 39,00 *s*	8 35 57,50 *s*	Maclear
156	—	———	Bedford	7 42 33,56 *s*	8 34 55,16 *s*	Smyth
157*	—	Anon.	———	7 52 36,56 *s*	8 51 28,06 *s*	———
158	—	——	Biggleswade	7 53 37,60 *s*	.....	Maclear
159	—	——	Campden Hill	7 54 10,25 *s*	.....	South
160	—	——	———	10,45 *s*	.....	Baily
161	—	—— 10^m	Biggleswade	8 24 28,43 *s*	.....	Maclear
162	—	(99) Tauri	———	8 38 15,00 *s*	9 31 56,20 *s*	———
163	—	———	Bedford	8 37 15,56 *s*	9 30 54,06 *s*	Smyth
164	—	———	Cambridge Obs.	8 39 53,02 *s*	.....	Coddington
165	—	———	Dorpat	10 1 8,90 *s*	.....	Preuss
166	—	(102) Tauri	Biggleswade	8 41 37,50 *s*	.....	Maclear
167	—	85 Tauri	———	9 22 51,60 *s*	.....	———
168*	—	———	Cambridge Obs.	9 23 47,05 *s*	.....	Coddington
169	—	———	Campden Hill	9 26 26,41 *s*	.....	South
170	—	———	Dorpat	10 34 25,10 *s*	10 59 39,10 *s*	Struve
171	—	α Tauri	Boston, N.A.	5 6 8,60 *m*	6 19 50,90 *m*	Paine
172	—	Anon. 7^m	Dorpat	10 52 7,10 *s*	.....	Struve
173	29	111 Tauri	Biggleswade	.....	7 16 7,60 *s*	Maclear
174	—	117 Tauri	———	8 7 24,60 *s*	9 2 32,00 *s*	———
175	30	Anon. 10^m	———	10 7 46,60 *s*	.....	———

145 5-feet equatorial. 146 Fraunhofer's 6-feet achromatic. 147 42-inch achromatic, by Fraunhofer.
148 42-inch achromatic, by Tulley. 157 $R = 4^h\,19^m$, $D = +15°\,48'$. 168 Doubtful 1 second.

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No.	Date.	Star.	Place.	Immersion.	Emersion.	Observer.
	1830.			h m s	h m s	
176	Mar. 30	Anon. 9^m	Biggleswade	10 22 16,65 *s*	.....	Maclear
177	—	———	———	11 9 48,70 *s*	.....	———
178	Apr. 5	τ Leonis	———	8 6 14,60 *s*	9 24 16,00 *s*	———
179	—	———	Cambridge	8 8 7,27 *s*	.....	Airy
180	—	———	Campden Hill	8 6 13,00 *s*	9 20 3,50 *s*	Stratford
181	—	Anon. $9{\cdot}10^m$	Biggleswade	8 27 53,00 *s*	.....	Maclear
182	26	—— 10^m	———	11 58 15,20 *s*	.....	———
183	28	—— $9{\cdot}10^m$	———	14 8 43,40 *s*	.....	———
184	29	—— 8^m	———	10 57 54,40 *s*	.....	———
185	30	—— 8^m	———	13 4 40,90 *s*	.....	———
186	—	—— $8{\cdot}9^m$	———	14 17 46,40 *s*	.....	———
187	May 1	48 Leonis	———	.....	14 56 11,60 *s*	———
188	3	Anon. 9^m	———	14 31 0,20 *s*	.....	———
189	June 28	θ Virginis	Bedford	18 2 33,46 *s*	.....	Smyth
190*	July 15	α Tauri	Nantucket, N.A.	17 32 11,60 *m*	18 30 4,30 *m*	Paine
191	Oct. 5	γ Tauri	Bedford	23 14 22,37 *s*	23 50 35,37 *s*	Smyth
192	—	———	Makerstown	23 17 21,50 *s*	23 41 12,30 *s*	Dunlop
193	—	71 Tauri	Bedford	2 4 10,54 *s*	2 56 7,83 *s*	Smyth
194	—	———	Makerstown	.....	2 54 55,30 *s*	Dunlop
195	—	θ^1 Tauri	Bedford	3 12 4,82 *s*	4 24 26,31 *s*	Smyth
196	—	———	Makerstown	.....	4 13 42,00 *s*	Dunlop
197	—	θ^2 Tauri	Bedford	3 12 51,82 *s*	4 23 41,37 *s*	Smyth
198*	—	———	Makerstown	3 4 41,80 *s*	4 15 14,80 *s*	Dunlop
199	—	(99) Tauri	Bedford	4 25 38,31 *s*	5 25 49,30 *s*	Smyth
200	—	———	Makerstown	4 21 54,80 *s*	5 1 22,30 *s*	Dunlop
201	—	(102) Tauri	Bedford	4 27 20,31 *s*	.....	Smyth
202	—	85 Tauri	———	5 9 19,80 *s*	.....	———
203	—	———	Makerstown	4 50 19,30 *s*	.....	Dunlop
204	14	Venus	Cambridge	.....	7 5 54,53 *s*	Airy
205*	23	*d* Sagittarii	———	.....	20 47 42,88 *s*	——
206	31	μ Ceti	Bedford	21 39 7,13 *s*	23 8 7,10 *s*	Smyth

190 Lat. 41° 17′ N. Long. 70° 7′ 52″ W. 198 Imm. doubtful to 1ˢ or 2ˢ. 205 Pretty good obs.

Omitted to be inserted in their proper places.

	1829.					
207	Nov. 12	111 Tauri	Biggleswade	8 39 42,00 *s*	.....	Maclear
208	Dec. 10	130 Tauri	———	5 13 32,60 *s*	.....	———
	1830.					
209	Feb. 5	1 Cancri	Bedford	9 19 58,19 *s*	.....	Smyth

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Observed Eclipses of Jupiter's Satellites.

No.	Date.	Satellite.	Place.	Immersion.	Emersion.	Observer.
	1828.			h m s	h m s	
1	May 8	First	Campden Hill	.....	12 1 22,65 *s*	South E
2	27	Second	———	.....	13 22 45,85 *s*	——— E
3	31	First	———	.....	13 44 13,61 *s*	——— E
4	June 4	Third	———	13 4 56,28 *s*	15 9 22,28 *s*	——— E
	1829.					
5	March 14	Second	———	16 47 5,61 *s*	.....	——— E
6	—	———	———	16 46 56,11 *s*	.....	Stratford A
7	24	First	———	14 59 21,98 *s*	.....	——— *a*
8	—	———	———	14 59 19,98 *s*	.....	South E
9	May 18	———	———	15 17 20,67 *s*	.....	——— E
10	21	Third	———	14 43 35,86 *s*	.....	——— E
11	—	———	———	14 43 9,66 *s*	.....	Stratford A
12	June 29	Second	———	.....	16 39 14,71 *s*	South *a*
13	—	———	———	.....	16 39 14,21 *s*	Ashley E
14	July 31	———	———	.....	18 24 49,96 *s*	South E
15	August 8	Third	———	.....	18 14 51,32 *s*	Beaufort
16	—	———	———	.....	18 15 46,32 *s*	South E
	1830.					
17	July 8	First	Bedford	.....	18 41 36,89 *s*	Smyth
18	24	———	———	.....	18 3 28,38 *s*	———
19	25	Second	———	.....	17 11 42,29 *s*	———
20	—	Third	———	.....	20 59 51,15 *s*	———
21	31	First	———	.....	20 26 23,27 *s*	———
22	Aug. 16	———	———	.....	19 48 23,48 *s*	———
23	Sept. 1	———	———	.....	19 10 46,04 *s*	———

The observations at Camden Hill, marked E, were made with the 5-feet equatorial: those marked A, with a 5-feet achromatic telescope; and those marked *a*, with a 42-inch achromatic. The observation by Captain Beaufort, on Aug. 8, was made with an achromatic telescope having a 6-inch object-glass.

The observations at Bedford were made with the telescopes already described in Captain Smyth's paper.

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IV. *Extracts from the various Communications accompanying the preceding Observations, referring principally to the appearances of projection of Stars on the Moon's Disc, at the time of Occultation.**

THE attention of the Astronomical Society was particularly directed to the remarkable and anomalous appearances which at times accompany the occultations of the larger fixed stars, in an elaborate paper, by Sir JAMES SOUTH, "*On the Occultation of δ Piscium*, &c." in Vol. III. page 303 of the *Transactions*.

As one of the stars most remarkable for exhibiting projection (*Aldebaran*) was frequently occulted during 1829 and 1830, the Council took the opportunity of recommending the observation to a large circle of astronomers, and in this design they were most opportunely aided by two members of the Society, Messrs. HENDERSON and MACLEAR, who computed the times of occultation for several of the principal points in Europe. The results of this combined operation will be seen in the following pages.

Occultation of Aldebaran, July 25, 1829.

Dorpat.—"I observed the entry of the star into the bright limb as far as its apparent centre, when the disappearance took place instantaneously, without any previous loss of light. The moon was well defined, considering that it was so low, and the apparent diameter of the star was about 3″ or 4″: neither was there any projection at the dark side. The emersion was so immediate, that no appreciable time elapsed between the first appearance and the full splendour of the star." *Large refractor, by* FRAUNHOFER, *power* 214 *at immersion*, 140 *at emersion, adjusted on close double stars.*—*Professor* STRUVE.

Dorpat.—"I saw the star enter the moon for $2^s,4$; but when its centre touched the moon's edge, it disappeared instantaneously, without any

* The absolute times of immersion and emersion are tabulated in the preceding pages, so as to afford a synoptic view for computation. The present paper contains remarks upon the *appearances* at the time of occultation, arranged according to the dates of the observation.

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previous loss of light: consequently, I saw no projection. Emersion instantaneous." *Telescope, 5-feet achromatic by* TROUGHTON, *power* 92; *adjusted on the moon.*—*M.* PREUSS.

Aldebaran, August 22, 1829.

Paris, Royal Observatory.—" Immersion d'*Aldebaran* au bord éclairé de la lune; beau ciel, lune bien terminée. L'étoile a paru s'avancer sur le disque de la lune, et y rester pendant 2ˢ. Bonne observation, près d'une heure après le lever du soleil."—*M.* MATTHIEU.

" L'étoile a disparu d'une manière instantanée, en laissant dans l'œil l'impression d'une ombre à la place qu'elle semblait occuper sur le disque de la lune."—*M.* SAVARY.

" J'ai vu bien distinctement l'étoile sur le disque éclairé de la lune pendant environ 2ˢ; ensuite la disparition m'a paru instantanée. J'ai employé une petite lunette de LEREBOURS, qui termine les objets parfaitement."—*M.* ARAGO.

At Geneva. *M.* GAUTIER " n'a pas vu l'étoile sur la lune."

M. GAMBART " a estimé qu'elle s'était projetée sur le disque de la lune environ 3ˢ."

M. BOUVARD " a estimé une ou deux secondes."

This occultation was seen at Boston, U. S., by *Mr. R. T.* PAINE, who has also witnessed several others invisible in Europe. In four cases, nothing particular was remarked, except that " when the immersion or emersion took place on the enlightened limb of the moon, the star usually became so tremulous, that there was an uncertainty of one or two seconds in the time of its taking place; but in the occultations of March 28 and July 15, 1830, at the emersion of the former and the immersions of the latter, the star did actually appear projected on the face of the moon for about 2ˢ, and the light of the star was, in both instances, very much more brilliant than usual, although the emersion of March 28th took place about sunset, and the immersion of July 15th while the sun was above the horizon." *Telescope* $3\frac{1}{2}$ *feet focal length, power* 60, *adjusted upon a star.*

At the immersion of *o Leonis,* September 1829, the star presented a very singular appearance. About 10ˢ before the disappearance, it spread out like a star viewed through a telescope not adjusted to distinct vision, and then faded away so gradually, that neither another gentleman, who

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was observing it at a place about $2\frac{1}{2}$ miles distant, nor himself, could observe the immersion with a precision greater than three or four seconds; but the emersion from behind the dark limb was instantaneous.

Aldebaran, October 15th, 1829.

Greenwich, Royal Observatory.—"The star appeared to me to hang on the limb of the moon, or rather within it, for about three seconds of time, and then suddenly disappeared."—*The* ASTRONOMER ROYAL, *with the* 5-*feet equatorial.*

"About eight seconds before the disappearance, the star appeared to come into contact with the moon's limb, and instantly recede therefrom with a libratory motion, and coming into contact again, appeared gradually to approach on the disc; and after being totally projected thereon for three seconds, disappeared altogether, leaving an indentation in the border."—*Mr.* TAYLOR, *sen., with the* 46-*inch achromatic.*

"The star approached steadily towards the moon's enlightened limb until the time of contact; it then appeared to hang on the edge of the moon for five or six seconds of time before it totally disappeared. Its lustre did not diminish materially; the colour of the star was ruby, that of the moon pale, somewhat resembling silver, but tarnished. Clouds of the cirri stratus order were passing swiftly before it."—*Mr.* HENRY, *with the* 7-*feet reflector.*

"Before the immersion the star appeared to be gradually projected on the moon's border. The greatest quantity of this projection I estimated to be about twice the diameter of the star; the quantity of projection afterwards decreased, when the star disappeared, seeming to make an indentation in the moon's border."—*Mr.* RICHARDSON, *with a* 30-*inch achromatic.*

"*Aldebaran* appeared in contact with the moon's limb seven or eight seconds before disappearing, and continued to approach the moon until within three seconds of disappearing, when it was totally included within the moon's limb. From this time up to the disappearance, the star appeared to advance on the disc a distance of about two diameters of the star, when it disappeared instantaneously. During the last three seconds, the red rays of the star were succeeded by those of a faint blue."—*Mr.* TAYLOR, *jun., with the* 10-*feet reflector.*

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"*Aldebaran* appeared to me to approach the moon's enlightened limb gradually, and to pass within the extreme edge to a short distance, where it vanished instantaneously, after seeming to be projected on the moon's disc two or three seconds."—*Mr.* ROGERSON, *with the* 5-*feet achromatic.*

In a letter which accompanied the observations at Greenwich, the Astronomer Royal adds:—"I formerly saw an occultation of this star by the unenlightened limb of the moon, during twilight, which is so favourable for seeing the whole surface of the moon; and the star continued so many seconds within the disc, that for a moment I began to doubt if I had not made a mistake as to which side of the moon the star was to pass. I think, in that case, three or four seconds must have elapsed between the first contact and the total disappearance."

Paris, Royal Observatory.—"Immersion d'α *Tauri* au bord éclairé de la lune. L'étoile m'a paru se projeter pendant environ $1^s,5$ sur le disque de la lune avant sa disparition complète, et la couleur de l'image ressemblait plutôt à celle de la lune qu'à celle de l'étoile, qui est rouge. Ciel entièrement dégagé de nuages depuis quelques instans; le bord de la lune un peu ondulant. *Lunette de* LEREBOURS, *de* 6 *pouces d'ouverture, grossissement environ* 150 *fois.*"—*M.* NICOLLET.

"Immersion d'*Aldebaran*. Le bord de la lune ondulant. Je n'ai pas vu l'image de l'étoile sur le disque de la lune. *Lunette de* 4 *pouces d'ouverture, grossissant environ* 60 *fois.*"—*M.* BOUVARD.

"J'ai bien vu l'étoile s'avancer sur le bord de la lune d'environ la moitié de son disque apparent, et y rester près de $1^s,5$, et disparaître instantanément. Ce phénomène n'était pas aussi prononcé que dans l'immersion observée le 22 d'Août dernier. L'étoile m'a paru moins de tems, et moins avancée sur le disque de la lune. *Lunette du cercle de* REICHENBACH, *qui grossit de* 70 *à* 80 *fois.*"—*M.* MATTHIEU.

"L'étoile a disparu d'une manière instantanée; elle a très-peu empiété sur le disque de la lune, seulement d'une partie de son image. *Lunette de l'équatorial, et un grossissement assez faible.*"—*M.* SAVARY.

This occultation was observed at the Royal Observatory of Paris by Sir JAMES SOUTH. "The star was extremely tremulous, as was also the moon's limb, at the moment of disappearance. I saw the star distinctly dichotomised by the moon's limb at the moment of its occultation. I could discover no hastened approach of the star towards the limb previous to its

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disappearance." *Telescope by* CAUCHOIX, 19 *feet focal length,* $11\frac{3}{4}$ *inches aperture, power* 360.

Nothing remarkable noted by any of the observers at the emersion.

The following observations were made at or near Paris :—

" A mesure que la lune s'est approchée de l'étoile, sa couleur rouge a perdu de sa teinte ; elle est bientôt devenue blanche, à-peu-près comme *Vénus.* Ma lunette étant médiocre, et grossissant peu ; j'attribue à cela un effet de lumière singulier, qui donnait à l'étoile une sorte de queue lumineuse, laquelle a augmenté de plus en plus à mesure que l'étoile approchait de la disparition. J'ai vu distinctement l'étoile se peindre sur le bord de la lune pendant environ 4^s, avec cette queue dont j'ai parlé. Quand j'ai cessé de la voir, elle était visiblement un peu éloignée du bord." —*M.* FRANCŒUR.

" J'ai en effet observé l'occultation avec une bonne lunette ; et si l'image de l'étoile n'a pas disparu à l'instant du contact, elle n'est pas restée visible pendant un tems appréciable. Je n'ai pas pu compter $0^s,5$; et certainement, pour moi, le bord du disque de la lune ne s'est pas détaché derrière l'étoile." —*M.* POUILLET.

" L'étoile m'a paru adhérente, et comme confondue avec le bord de la lune pendant environ une seconde, mais non projetée sur le disque de la lune."—*M.* DAMOISEAU.

" Lune voilée et étoiles faibles au moment de la disparition ; bords ondulants. On pouvait néanmoins juger qu'à $35^s,5$ l'étoile était sur le bord même, en sorte qu'elle semblait être entrée entièrement sur le disque à $37^s,5$, lorsqu'elle a disparu. Cette observation a été faite avec la lunette de DOLLOND, armée de l'oculaire grossissant 185 fois."—*M.* GAMBART.

" Le ciel avait été couvert et à la pluie pendant tous ces jours passés ; il était encore en cet état le jour que l'occultation devait avoir lieu. Ce ne fut que vers les sept heures du soir que le ciel s'est éclairci subitement, et que la lune s'est montrée dans tout son éclat ; cependant, des vapeurs toujours suspendues dans l'atmosphère rendaient ses bords très-ondulants et mal terminés, ce qui était indiqué par une scintillation très-vive des étoiles. La lune très peu élevée sur l'horizon, et l'étoile dans sa proximité, devaient en être encore plus affectées ; en effet, *Aldebaran* chatoyait de toutes les couleurs de l'Iris, dans lesquelles le rouge prédominait surtout. A l'approche de l'étoile de la lune, dont l'immersion se fit dans la partie éclairée, sa lumière,

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comme à l'ordinaire, avait beaucoup diminué; et à l'instant qu'elle touchait le bord de la lune, et qu'elle était sur le point de disparaître, les oscillations produites par les vapeurs l'ont fait aller et revenir alternativement sur ce bord, à-peu-près de la même manière qu'on le remarque aux passages de la polaire par les fils d'une lunette méridienne, ou sur le fil horizontal d'un instrument avec lequel on prendrait les hauteurs des étoiles près de l'horizon. Hormis ce sautillement de l'étoile sur le bord de la lune, qui n'a duré que quelques secondes, je ne me suis apperçu d'aucune apparition ou projection sur le disque lunaire; la disparition de l'étoile était instantanée. Selon toutes les apparences, l'état de l'atmosphère n'était nullement favorable à la reproduction du phénomène auquel on s'attendait, et sur lequel il n'y a plus de doute. Je crois que le phénomène en question n'aurait également pas eu lieu ce soir, quand même la lune aurait été très-élevée; car les étoiles, même au zénith, étincellaient et vibraient d'une manière extraordinaire. Je pense que les circonstances les plus propices et les conditions les plus favorables pour voir ce phénomène de l'inflexion, ou plutôt de la sensation impressive de la lumière, sont d'abord un état très-pur et très-calme de l'atmosphère, et ensuite l'immersion de l'étoile dans la partie obscure de la lune — fond sur lequel se projetera plus visiblement, pour ainsi dire, cette imprégnation momentanée et passagère de la lumière. Peut-être que la couleur rouge est la plus propre pour exciter une sensation et une empreinte plus vive et plus durable sur la rétine, ou le nerf optique de l'œil, que toute autre couleur; le rouge prédomine dans la lumière d'*Aldebaran*, et c'est précisément dans cette étoile que l'on a le plus souvent observé l'apparition de son fantôme. Je me suis servi à cet effet d'une excellente lunette vitro-cristalline de nouvelle invention, de M. Cauchoix, de 40 lignes de diamètre, et de 30 pouces de foyer, avec un grossissement linéaire de 114 fois."—*M. de Zach.*

Dorpat.—" I observed the immersion, which was instantaneous, and without projection on the bright disc: it could be observed with a certainty of $0^s,1$. The emersion was instantaneous, and was observed with great accuracy. *Great refractor, power* 140*; adjusted on the moon.*"—*Professor Struve.*

Campden Hill.—" I saw the star approach with a perfectly steady and equable motion. Five seconds after the bisection of the star by the moon's edge, during which time it continued to advance upon the limb until the

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whole apparent diameter was *inside* the lunar disc, the star instantaneously disappeared. As the star advanced upon the limb, the red rays seemed to vanish, and the blue to preponderate." *Telescope 6-inch object-glass; power* 120.—*Captain* BEAUFORT.

Campden Hill.—" I saw the star approach steadily, with a slight diminution of brilliancy, about thirty seconds previous to the contact. The external contact took place four seconds before the bisection of the star's disc, and three seconds afterwards the star suddenly disappeared. From the bisection of the star to its final disappearance, the path of its motion seemed deflected towards the moon's centre about fifteen seconds, and it was embedded in the moon's limb, with a dark line between the moon and star."—*Captain* WILSON.

" I saw the star most distinctly, and beautifully projected on the lunar disc; but I cannot well estimate the distance it was seen within the edge. I saw it, however, decidedly within the disc, and I should think at least the distance of one or two of its diameters. The time which the perfect projection lasted I cannot state, but it was long enough to allow me to mention the appearance to my son, who was observing at the same time, and to receive an answer." *Telescope 8-inch fluid object-glass.*—*Prof.* BARLOW.

Mr. BARLOW, jun., with the 3-inch telescope, witnessed the same appearance.

" The star appeared to be in contact with the moon six seconds before the instantaneous disappearance. During this time the star made considerable progress on the moon's illuminated disc with a quick but irregular motion." *Telescope 30-inch focus, 2 inches aperture, power* 55.—*Mr.* EPPS.

" I saw no clinging to, or projection of, the star on the moon: the disappearance and re-appearance were instantaneous. The latter phenomenon put me in mind of a pin pushed through paper. The moon's edge was sharply defined."—*Mr.* CHARLES PERKINS.

" I did not perceive that the near approach of the moon's border affected the light, the colour, or the apparent motion of the star. It disappeared when about $\frac{4}{5}$ of its apparent disc was projected upon the face of the moon. Direction of the projection about $3^s,5$." *Telescope 45-inch focus, $2\frac{3}{4}$ aperture, power* 130; *adjusted to the star.*—*Mr.* SIMMS.

The star appeared round, but not quite a point. About $1^s,7$ after the centre had been in contact with the outer edge of the moon, the star, being

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then obviously within the moon's border, vanished instantaneously, without previously undergoing any diminution of brightness, or change of colour." *Telescope* 30-*inch achromatic, with a power of* 80; *adjusted on the moon.*—*Mr.* RIDDLE.

"I *did not see* the star projected on the face of the moon, or any appearance out of the usual course during the time that I was watching its progress. The re-appearance was instantaneous: the dark limb not visible." *Telescope adjusted to the star.*—*Mr.* FRANCIS BAILY.

"I saw *Aldebaran* unequivocally projected on the face of the moon during eight beats of the chronometer (1ˢ,2), when it suddenly disappeared. The re-appearance was as sudden; but the dark limb of the moon not being visible, it could not be ascertained whether the star was projected." 5-*feet achromatic by* TULLEY, *power* 92; *adjusted to the star.*—*Mr.* ARTHUR BAILY.

"Nothing remarkable occurred until the star came in contact with the moon's limb, where it appeared to hang for at least three seconds. It was then projected on the moon's disc, where it remained about two seconds, emitting a red faint light, and then disappeared. The dark limb of the moon at emersion not visible." *Telescope, a Gregorian reflector,* 30 *inches focus,* 5 *inches aperture, power* 120.—*Mr.* WROTTESLEY.

"The star appeared to indent the moon during 1ˢ,5 at immersion. The dark limb was not visible at the emersion." 49-*inch achromatic,* $3\frac{3}{4}$ *aperture, power* 98; *adjusted on the star.*—*Mr.* HUSSEY.

"Notwithstanding the haze and halo which surrounded the moon, *Aldebaran* was very distinct, and his fine red hue conspicuous. The star advanced without loss of splendour, change of colour, or altered motion, upon the moon's face to $\frac{1}{32}$ of her diameter, or about 1′, where it remained three seconds, and then instantly disappeared. The three seconds are counted from the instant the star began to move forward on the moon's face." *Wollaston telescope, power* 75.—*Mr.* MACLEAR.

Mr. BROMHEAD observed, at the same place, with an achromatic by DOLLOND, $3\frac{1}{2}$ feet focus, $2\frac{3}{4}$ inches aperture, power 40. His account agrees precisely with Mr. MACLEAR's.

"I saw *Aldebaran* approach the bright limb of the moon very steadily; but, from the haze, no alteration in the redness of its colour was perceptible. It kept the same steady line *to about* $\frac{3}{4}$ *of a minute inside the*

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lunar disc, where it remained, as precisely as I could estimate, two seconds and a quarter, when it suddenly vanished. In this there could be no mistake, because I clearly saw the bright line of the moon *outside* the star, as did also Dr. LEE, who was with me. The emersion took place without any thing remarkable: the dark limb not visible." *Telescope 5-feet achromatic, $3\frac{3}{4}$ aperture, power* 78; *adjusted on the star.—Captain* SMYTH.

"The star certainly appeared on the face or limb of the moon. Between the positions of external and internal contact there was no perceptible interval of time; for when I was expecting it to disappear, it seemed suddenly to leap, as it were, on the moon's limb. I should say, it dwelt on the limb a very small portion of time. No alteration in shape, colour, or brightness." *Nine-inch Newtonian reflector,* 112 *inches focus, power* 240; *aperture reduced to* 6 *inches.—Mr.* LASSELL.

"When the star had come in contact with the moon's limb, it remained hanging or lying upon it from $3^s,5$ to 4^s, and then instantly disappeared." *Refractor, $3\frac{3}{4}$ inches aperture, power* 164.—*Dr.* PEARSON.

Aldebaran, December 9, 1829.

Göttingen.—"I observed the occultation of Aldebaran of the 9th December, and the sky being perfectly clear, I have obtained the moments of immersion and emersion with extreme precision. The first creeping out of the star at the emersion was easily perceived, by the contrast of its red light with the white light of the moon's limb; and I think that the observation of the emersion is as accurate as that of the immersion. I devoted all my attention to the observation, with a view to the well-known phenomenon of the star's remaining visible some seconds on the moon's disc, which has been repeatedly observed in this star, and which I have myself seen several times. I remained both times, at the immersion and emersion, ten seconds before the telescope without turning my eyes, but nothing of the kind was seen. It appears to be beyond doubt, that this phenomenon arises from the telescopes, whose greater or less perfection is most likely the cause of it; and for this reason I am anxious to know whether any of FRAUNHOFER'S telescopes has this time presented the phenomenon, of which I am inclined to doubt. Perhaps *a certain distance of the star from the moon's limb* is requisite for producing the phenomenon,

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and, if so, it would not present itself in the same telescope at all times."*—*Professor* HARDING.

Professor STRUVE witnessed the passage of the moon through the Hyades, but saw no projection.

" Of all the occultations of *Aldebaran* in 1829, we have but obtained the last, on December 9; the rest were invisible, through the uncommonly bad weather. This last is very exactly observed. I add the result, and refer you for details to the *Astronomische Nachrichten.* We were five observers, all so distributed that none could hear or be troubled by the other. Each had his chronometer compared before and after with the transit clock. We saw nothing uncommon at this observation. To all, the immersion and emersion appeared instantaneous, except to Mr. PETERSON, who, at the emersion, believed that he saw the star adhere for a second to the bright limb of the moon. But it must be remarked, that his telescope was the least perfect, and shews the stars, not as small round discs, but with rays emerging."—*Professor* SCHUMACHER.

Commander HEWETT observed the occultation with a common deck-telescope, magnifying about 36 times. At the emersion he plainly perceived, for about half a second, an indistinctness, and a bluish tinge in the star; after which it suddenly brightened up, and came to its usual reddish colour. This appearance may perhaps arise from want of power in the telescope.

On March 28, 1830.

" We saw 99 *Tauri*, and PIAZZI IV. 102, upon the moon's disc. The telescopes used were 42-inch achromatics, $2\frac{1}{4}$ aperture. Mr. PERKINS with a power of 120, and Mr. HOLLAND with one of his own eye-pieces, the power of which he estimated to be 336. With this power the star was distinct, and the moon's dark limb well defined."—*Mr. C.* PERKINS *and Mr.* HOLLAND.

At Campden Hill Sir JAMES SOUTH saw a star ($\mathcal{R}$ 4^h 19^m 7^s; N. dec. 15° 46′) projected on the moon's disc a quantity equal to its diameter.

* It will be remarked, that Professor STRUVE has not seen any projection of *Aldebaran* with the Dorpat refractor. For the purpose of ascertaining whether this telescope gave a spurious addition to the moon's disc, micrometrical measures were taken of the distance between the star and the moon's limb before the immersion and after the emersion of the star; for an account of which see SCHUMACHER's *Astron. Nach.* No. 184.

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The same appearance was also seen by Lord ASHLEY with the 19-feet achromatic, but not by several other observers. θ^1 and θ^2 *Tauri* had been previously occulted without projection. The same evening, 85 *Tauri* seemed to Mr. ROTHMAN to hang on the moon's limb several seconds. To Lord ASHLEY this star was seen distinctly within the moon's limb, yet four other observers saw nothing remarkable.

Mr. DOLLOND is inclined to believe that the projection of *Aldebaran* "is an optical deception, depending upon the eye: it will, I believe, be found to depend upon which of the two objects the eye is most particularly directed to. I observed the occultation of the 21st of August, and directed my attention particularly to the limb of the moon, allowing the star to approach, when it gradually disappeared behind the moon, until one half of its apparent disc was hidden,—the last half disappearing instantaneously. I also had an observation of the emersion on the 9th of December. I allowed the star to pass from the moon about two seconds, when I directed my particular attention to the star; it then appeared to stop, and return towards the moon's limb."

The following Extract of a Letter from Mr. RUMKER to Sir JAMES SOUTH, is also connected with the subject of the preceding communications: —

"From the position of the moon's dark limb towards *Regulus* on 30th July, 1821, I concluded that she would eclipse the star before setting, and apprised Sir THOMAS BRISBANE of it, who made the observation, whilst I attended at the time. Nothing particular appears to have been noticed by him at the immersion of the star behind the dark limb, which was particularly conspicuous at the time; but, after the emersion, he was astonished to see *Regulus* upon the moon's disc; and being invited by him to look at the star through the glass, I certainly observed the star, according to my estimation, upwards of 2′ inside of the moon's enlightened limb, where it remained sufficiently long for Sir THOMAS and myself to exchange the telescope several times, and admire in turns the singular phenomenon.

"I must remark here, that on account of being afloat at the time, sailing along the coast of Cape Frio, which bore W.N.W. $\frac{1}{2}$ W., distant about five miles, Sir THOMAS BRISBANE could only make use of a comet-sweeper for the observation, which may have been influenced thereby. Moreover, it

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was broad daylight, the sun having just set; but as Professor WURM has deduced from the immersion and emersion respectively the following conjunctions,

	Mean time.	Conjunction.
Immersion	$6^h\ 2^m\ 52{,}4^s$	$4^h\ 18^m\ 10{,}08^s$
Emersion	6 12 59,7	4 18 5,74

(The star described a very small chord over the moon's disc.)

the observation cannot have been a bad one. Professor WURM deduces thence the longitude of Cape Frio, 41° 46′ W. from Greenwich. *Regulus* was visible to the naked eye before the observation.

" In Bode's *Jahrbuch* for 1822, I find the following observation, made by Professor BURG, in Vienna, in a letter from the observer to Professor BODE, related as follows: —

" ' 1819, April 13. Emersion of α m from the moon's dark limb at $12^h\ 3^m\ 22^s$ to 23^s apparent time.

" ' At $23^h\ 3^m\ 17^s{,}1$ apparent time, I observed the emersion of a star 6·7 mag., which, about 5″ after, suddenly appeared to me like a star of the first magnitude; and it is from this transition that I have dated the time of emersion. Perhaps *Antares* is a double star, and the first observed small one is so near the principal star, that both, viewed even through a good telescope, do not appear separated.'

" To this BODE remarks: ' *Antares* is no double star, and I explain the appearance observed by Professor BURG thus—that the star first appeared through the vapours of the moon's atmosphere at her dark limb, along which, however rare it may be, this atmosphere must have occupied a long track in the direction of the rays that entered the observer's eye from *Antares*, which, when clear thereof, suddenly appeared in its full splendour.'

" It is perhaps presumptuous to venture an explanation of a phenomenon so maturely examined by you. But you will not scrupulously criticise an hypothesis imparted by me to you. You know I forgot to take with me your interesting memoir when I left Campden Hill last; so that I cannot peruse it now. But I think the phenomenon has principally been observed upon the bright limb. Had now, in the above instance of *Antares*, that limb of the moon behind which the star emerged been enlightened, the moon's atmosphere would also have been enlightened, and have become visible to us, appearing a continuation of the moon's limb, but sufficiently

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transparent for us to have seen the star through it; so that, after observing its emersion, we still should have seen it within what we considered to be the moon's disc. Thus was it in the instance of *Regulus*, observed by Sir THOMAS BRISBANE and myself; and the long duration on that occasion was owing to the oblique direction in which the star traversed the annulus of the atmosphere.

"Astronomers have always deduced a smaller moon's diameter from eclipses of the sun than from meridian observations of the moon, and ascribe this to the inflexion, which is a confirmation of my hypothesis. We observe the contact of the moon's atmosphere with the wire, whilst we observe the encroachment of the moon's opaque body upon the sun.

"This phenomenon has principally been observed with the brighter stars, because the rays of the smaller ones could not pierce the atmosphere, and also do not always disappear suddenly at their immersions at the bright limb."

On the subject of inflexion, see the remarks of Don JOSE JOACHIM DE FERRER, in page 583.

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REPORT OF THE COUNCIL OF THE SOCIETY

TO THE

TENTH ANNUAL GENERAL MEETING,

FEBRUARY 12, 1830.

YOUR Council have the pleasure to announce in this, the Tenth Annual, Report, the increasing prosperity, efficiency, and consideration of the Astronomical Society.

The following abstract of the receipts and expenditure during the preceding year, will shew the present state of the funds of the Society; viz.: —

Receipts.	£.	*s.*	*d.*
Balance of last year	335	3	3
Arrears, February 1829:—			
Resident members	62	15	0
Non-resident members	33	12	0
Contributions for 1829-30:—			
8 admission fees	11	11	0
Resident members	161	14	0
3 non-resident members	25	4	0
1 non-resident fee	4	4	0
1 composition	21	0	0
1 year's dividend on 800*l.* cons.	24	0	0
1 year's ditto on 857*l.* 13*s.* 8*d.* new 4 per cents	34	6	0
By sale of the memoirs	45	2	0
	£758	11	3

Expenditure.	£.	*s.*	*d.*
Printer's bill for Vol. III. Part II.	270	14	7
Robinson's bill, last year	22	5	0
Repairs of instruments	15	12	0
Lithographer's bills	8	0	0
Engraver's bills	2	13	6
1 year's rent to Michaelmas ...	52	10	0
Commission to collector	17	10	0
Sundry disbursements for porterage, postage, &c. including an arrear due to the former Secretary	38	3	9
Balance	331	2	5
	£758	11	3

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And the assets and present property of the Society are as follow; viz.: —

Assets of the Society.

	£.	s.	d.
Balance in the hands of the Treasurer	286	2	5
Due from Messrs. Baldwin and Co. booksellers, about	50	0	0
Due from Messrs. Priestley and Weale, booksellers, about	70	0	0
Arrears, February 1830: —			
2 contributions of four years' standing	16	16	0
3 ——— three ditto	18	18	0
10 ——— two ditto	42	0	0
8 ——— the past year	16	16	0
1 change of residence	4	4	0
5 non-resident members	42	0	0
	£546	16	5
800*l.* stock in the 3 per cent consols.. } valued at about	1600	0	0
857*l.* 13*s.* 8*d.* ditto in new 4 per cents }			
Books unsold, now in hand			
Various astronomical instruments			
Eleven silver medals unappropriated			
From the above, however, are to be deducted —			
The printer's bill for Vol. IV. Part I. now in progress			
——— sundries	24	5	8
Cost of three gold medals omitted to be carried to account	30	7	6
A few sundries, estimated at about	20	0	0

Agreeably to the fundamental Rules of the Society, no bills above the amount of five pounds can be paid by the Treasurer, without having been previously examined and approved of by the Council; and the annual accounts are afterwards again examined, prior to the General Meeting, by a Committee appointed for that purpose. All the documents are deposited with the Secretary, and may be inspected by any member of the Society.

The progress and present state of the Society with regard to the number of its members and associates, may be seen from the following abstract, continued from the Report of last year; viz.: —

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	Compounded.	Resident.	Non-resident.	Honorary.	Total Members.	Associates.	Grand Total.
February 1829	40	92	99	1	232	32	264
Since elected	1	9	9	–	19	2	21
Since lost	–	6	2	–	8	–	8
February 1830	41	95	106	–	243	34	277

Amongst the deaths, the Society have to regret the loss of Mr. EDGEWORTH, a gentleman of the highest promise and attainment, and worthy of a name dear to science and to literature.

The exquisite transit circle by TROUGHTON, of two feet diameter, presented by Dr. LEE, is now in the possession of Captain SMYTH, after receiving from the hands of its maker some important additions and improvements. Upon these much time was necessarily expended, and since the instrument was placed in the Bedford Observatory, the weather has not allowed Captain SMYTH to prosecute the delicate researches in which he is engaged. The Society will have remarked with satisfaction the excellent observations of occulted stars by this active astronomer, and by Mr. MACLEAR, to whom Dr. WOLLASTON's telescope was intrusted. The transit clock presented by Lieutenant BEAUFOY, and now in the possession of Mr. HERSCHEL, has been lent to the Rev. MICHAEL WARD, and will be forwarded to him by the first opportunity. The Beaufoy circle has been safely received, but too recently to have allowed Mr. WARD to furnish the observations which may be expected from his zeal and attainments.

A library has been formed, of considerable extent and value, from the contributions of individuals and scientific bodies. The want of any means of consulting this has long been felt; but the Council have the gratification of stating, that Professor DE MORGAN has offered his valuable services to arrange and catalogue the books and manuscripts belonging to the Society, a task which is now nearly completed. It is well known that the Council have long been endeavouring to procure more convenient apartments for

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the use of the Society, such as would be better adapted to their increasing demands, and under a more permanent tenure than those which they now hold. It is to be regretted that so desirable an object has not hitherto been attained.

Upon the increasing attention paid to our noble science, it is scarcely possible to speak in terms too flattering. In addition to the increased activity of public observatories, the exertions of private individuals are by no means slackened in this race of improvement. A magnificent achromatic object-glass, the masterpiece of CAUCHOIX, and of the largest dimensions, having $11\frac{3}{4}$ inches clear aperture, and 19 feet focal length, has been purchased by our spirited President. The task of mounting this gigantic telescope equatorially, has been undertaken by the most celebrated of our modern artists, and we may hope to see this active astronomer speedily engaged in pursuing, with unequalled means and unabated ardour, the path of discovery in which he is already so advantageously known.*

Your Council trust, that they have not been backward in promoting, to the utmost of their power, every attempt to advance the interests of the science of Astronomy.

Before the departure of Captain Ross on his Arctic expedition, that enterprising officer proposed to make any scientific observations, for which his situation might be considered favourable, should he unfortunately be

* [Although this telescope was placed on a temporary stand, at the President's Observatory at Kensington, on January 29, the weather did not permit of any trial of its powers *previously* to the anniversary. It may now, therefore, be interesting to state, that the first night on which an opportunity was afforded, viz. the 13th of February, Mr. HERSCHEL discovered a *sixth* star in the trapezium in the nebula of *Orion*, a few degrees south following of, and about five or six seconds distant from, the star denominated A in that trapezium, in Mr. SOUTH's observations of the double stars. Its brightness is about one-third of that of the fifth star, discovered by M. STRUVE, which is as distinctly seen as the companion to Polaris is in a five-feet achromatic. It was immediately after detected by Mr. SOUTH, and has since been seen by Mr. BAILY, Mr. TROUGHTON, Mr. SHARPE, and others, and repeatedly by myself. *Saturn*, with his Belts, Double Ring, and Seven Satellites, is beautifully defined, with powers of 130, 280, and 350. The object-glass is not in very perfect adjustment; it was placed in its cell, as now used, by mere accident, and, in consequence of unfavourable weather, it has not been deemed prudent hitherto to attempt any alteration. — W. S. S. *Sec.*]

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detained upon his perilous route. An application was made by him to the Lords of the Admiralty, and supported by your Council, for a loan of the requisite instruments, which was received by their Lordships in a most gratifying manner. Captain Ross was amply supplied with the proper instruments; and, at the request of the Council, a list of moon-culminating stars, for the months of January, February, March, and April, 1831, was prepared for him by Mr. HENDERSON, the Astronomer Royal having undertaken that the corresponding observations should be made at Greenwich.

The numerous and excellent observations of *Aldebaran*, during the preceding year, which have been already communicated, are a satisfactory proof of the increased interest felt for the science, and of the importance attached to the views and wishes of the Society. In some instances the star disappeared instantaneously after the bisection of its disc by the moon's limb, while in others the projection lasted nearly six seconds. It does not appear that a sensible diminution of brightness was perceived previous to immersion. When a sufficient number of well-attested appearances has been collected, it may be possible to account for the anomalies which have hitherto been so perplexing. The attention of astronomers towards this interesting phenomenon is earnestly requested during the present year. Neither should the predicted occultations of other stars be neglected by observers. It is from them that the most accurate determinations of longitude are, in the generality of cases, to be obtained; and the tedious difficulties with which they were embarrassed, have been in a great measure removed. The Council have distributed from time to time monthly notices of the principal lunar occultations, for the meridian of Greenwich, computed by Mr. HENDERSON, to whom this branch of astronomy is under peculiar obligations. It is to be regretted that the avocations of this gentleman will not allow him to continue these useful lists much longer. Fortunately, this loss is greatly diminished by a recent memoir due to our excellent Associate Professor BESSEL, and inserted in *Encke's Ephemeris* for 1831, which gives a short and simple method of transferring to another meridian the time and circumstances of an occultation already computed for Berlin, along with the quantities required for the calculation. These subsidiary quantities have been prepared for the first six months of the present year by Professor TROEGER of Dantzic, and inserted in the *Astronomische Nachrichten*, an

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early copy of which was transmitted to the Society by the accomplished editor. This has been printed for distribution, in the hope that the zeal of Mr. HENDERSON will find worthy successors. To mark their sense of obligation to this gentleman, and as a small tribute of respect, the Council have unanimously agreed, "That it be recommended to the general meeting to present to Mr. HENDERSON a copy of the Memoirs, handsomely bound, for the very valuable assistance which he has rendered to the cause of Astronomy in his various computations presented to the Society."* The numerous communications that have from time to time been received from Germany, and the valuable astronomical works that are constantly issuing from the press of that country, render an acquaintance with the German language almost essential to the prosecution of the science. The difficulty which the Council would otherwise have experienced has been greatly removed by the cordial and very valuable assistance of a gentleman deeply versed in every branch of the science, who has, on all occasions, been ready in favouring the Council with translations of such papers as they have from time to time required. To mark their sense also of this obligation, and as a small tribute of respect, they have agreed, "That it be recommended to the general meeting to present to Dr. TIARKS a copy of the Memoirs, handsomely bound, for his kind and ready assistance at all times in translating various foreign papers for the use of the members, and for other valuable services rendered to the Society."*

A simple and ingenious method of determining the mass of the moon, by observing the R. A. of the bright limb of *Venus*, has been proposed by Professor AIRY, with a request that the Society would use their influence in obtaining for it an extensive circulation. Copies have, accordingly, been forwarded to every public and private observatory in Europe, with a strong recommendation for its adoption.

The fluctuating use of symbols in mathematical investigations more frequently occasions mistake and misapprehension than the inherent difficulty of the subject matter; and it is to be lamented that so little care is taken

* [The recommendation of the Council in each of these instances was unanimously approved of, and adopted by, the Members at the General Meeting. — *Sec.*]

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by the generality of authors to be consistent with each other, or even with themselves. An attempt has been made by Mr. LUBBOCK, under the auspices of the Society, to introduce a system of notation depending upon fixed rules. This paper is now in the press, and will be submitted before publication to the geometers of this and other countries. In this way, it seems probable that a considerable degree of accordance may be obtained, which it is hoped may be strengthened and confirmed by the sanction and practice of the Society.

The paper upon the Constant of Aberration, by Mr. WM. RICHARDSON, to which such marked attention was drawn in the Report of last year, has subsequently been published in the Memoirs of the Society, and fully justified the high expectations excited. The immense labour bestowed upon this important investigation, the clearness with which it is developed, and the number of observations on which it is founded, must command the admiration of all astronomers. Your Council have unanimously awarded to Mr. RICHARDSON the gold medal for the determination of this fundamental constant.

A gold medal has also been voted to Professor ENCKE for the superb *Ephemeris of Berlin*. It would be superfluous to dwell here upon the merits of this well-known work, which, far outstripping all rivalry, must be considered as the only ephemeris on a level with the present wants of the science — the manual and standard of practical astronomy wherever it may be cultivated.

The President will deliver the medals at the close of this meeting in the accustomed form.

Your Council trust that this exposition of the resources and progress of the Society will be satisfactory to the members at large; but it is not to be forgotten, that much remains to be done, and that more labourers are demanded. It is not sufficient to thank or to admire those who have toiled in the good cause — the necessity of imitation must be strongly felt and inculcated. There is scarcely any instrument which may not be usefully employed, or any acquirements which may not perform good service.

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Phenomena may be predicted, preliminary computations furnished, reductions prepared, with little more knowledge than that of common arithmetic; occultations, eclipses, moon-culminating stars, planets, may be observed, and portions of the heavens examined and surveyed, with instruments of moderate price and of inferior dimensions. Indeed, in the present state of astronomy, the class of *differential observations* embraces far the greater portion of celestial phenomena even for the best instruments; and by the publication of the *Berlin Ephemeris*, computation is almost wholly reduced to simple interpolation. At no distant period it may be possible for the Council to provide skeleton forms, not merely for registering observations, but for their reduction and for all ordinary calculations.

It would also be highly desirable to collect and publish annually, in a condensed form, observations presented to them by British and foreign astronomers, and not printed elsewhere — a repository and digest of the services of amateur observers. The Council confidently rely upon the energy and activity of the members, and of all friends to astronomical science, for the accomplishment of this important object. Thus, not only will a large mass of valuable information be rescued from oblivion, and preserved in a shape the best adapted to comparison and use, but a deeper interest will be felt by the contributor, and a stronger motive offered for that care and method, without which computation is rendered useless, and instruments degenerate into toys.

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AN ADDRESS

DELIVERED AT

THE ANNUAL GENERAL MEETING

OF

THE ASTRONOMICAL SOCIETY OF LONDON,

ON FEBRUARY 12, 1830,

ON PRESENTING THE HONORARY MEDALS

TO

MR. WILLIAM RICHARDSON AND PROFESSOR ENCKE,

BY

J. SOUTH, Esq. F.R.S. L. & E. M.R.I.A. F.L.S.

AND PRESIDENT OF THE SOCIETY.

GENTLEMEN,

ERE we proceed to the distribution of our honorary rewards, I cannot but congratulate you on the general state of astronomical affairs: whether we turn to the north or to the south, to the east or to the west, the astronomical horizon presents a more promising aspect than it has done for many years; and what is peculiarly gratifying to us is, that amidst the general endeavours to advance astronomical knowledge, our own country this year stands indeed conspicuous. Since our last anniversary, the observations of Professor AIRY have done honour to the University of Cambridge; those of Dr. ROBINSON have rewarded the munificence of the Primate of Ireland; and others made at Paramatta, in the observatory founded by Sir THOMAS BRISBANE, and which (thanks principally to the exertions of members of this Society) is now become an observatory in the service of the British government, give us an earnest of the value of those observations of Sir THOMAS, now in the course of reduction by Mr. RICHARDSON, as also of the importance of others, which, on the authority of the government,

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we are henceforth regularly to receive from Paramatta. Again, within these few days has arrived a first series of standard transit observations, made by Mr. Fallows at the Cape Observatory. They are, as yet, unpublished. Knowing him, however, intimately as I do, and having witnessed his early astronomical career, I may be permitted to felicitate you on their arrival, confident that whatever comes from him will be honourable to his country, for it will be worthy of himself. But that these observatories have rendered to us their first fruits, is not all: others are in a state fast approaching to practical utility; and when another year shall glide away, he who shall have the honour to fill the chair I now so unworthily occupy, will have, I hope, to applaud the activity of the observatories of Brussels and Cadiz, of Cracow and of Edinburgh, of Geneva and Madras.*

While exulting, however, in the accession of these new observatories, let us not forget honourably to notice, that from the Royal Observatory of Greenwich has issued, but a few weeks since, a *Catalogue of* 720 *Stars;* — a valuable treasure, and for which the astronomical world is indebted to this Society, as well as to the Astronomer Royal; inasmuch as the stars it embraces have been selected from, and reduced by, the *Society's Catalogue.* On examining the important facts resulting from this first series, and which the Astronomer Royal has exhibited by actual comparison with our own work, let us hope, now that his fundamental catalogue has reached a degree of accuracy probably unexampled in astronomical history, he will persevere in the task; assured as he may be, that no one thing would tend more to the credit of the Observatory, and to his own glory, than that his name should be attached to a large catalogue of stars, called, as in the good old times of Flamsteed, "*The British Catalogue.*"

The Royal Observatory of Paris is also an object of increasing interest; a splendid equatorial by Gambey has been added to its previous collection; and the transit instrument by the same distinguished artist, so long and so

* This is not literally a new observatory; the instruments, however, now about to be sent thither, are so far superior to those already there, that it may almost be regarded as a new establishment. The same applies to the Geneva observatory, but with greater force; for not only are superior instruments ordered for it, but a new building is being prepared for their reception.

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anxiously looked for by our *confrères* of Paris, is at length placed on its piers; whilst the Observatory, *properly* so called, is about to be remodelled and rendered more convenient for astronomical labour. We hail the recommencement of the observations as an era which will be worthy of the country of CASSINI,* of LA CAILLE, and of LA LANDE;—of LA GRANGE, LEGENDRE, and LA PLACE. The sentiments of the late distinguished Secretary of the Institute, that "*Ce n'est pas le tout que de fonder un observatoire et de doter l'astronome, il faudrait faire un fonds annuel pour l'impression, et imposer à l'astronome l'obligation de n'être jamais en retard d'une année,*"† being adopted by the astronomers of Paris, we shall not have to regret that observations, made with such instruments and by such men, shall be available only to those who reside within the walls of the observatory. We have this year set our Parisian friends a splendid example, and doubtless they will follow it.

As to the improvement of the achromatic telescope, since our last anniversary, much cannot be said. The theory of Mr. ROGERS has not, as far as I know, been put to the test of practice, in a manner at all commensurate with its merits; whilst Mr. BARLOW's achromatic, of eight inches aperture and eleven feet focal length, owing to imperfections in the material of its exterior lens, does not define close sidereal objects so neatly as might be wished, but is, nevertheless, applicable to many useful purposes; and there is a hope that the labours of a sister society, although hitherto unsuccessful in furnishing us with the mode of making good *flint* glass, will shortly put us in possession of at least a succedaneum for it.

Some of the members‡ of the Society, regretting that the late Board of Longitude was not remodelled instead of being dissolved, had, during the last spring, several interviews with His Majesty's ministers on the subject

* CASSINI was an Italian professor; he was, however, called to Paris by COLBERT, whose comprehensive mind felt that not only military success, but scientific reputation could confer glory on his country. Not only did he place the observatory of Paris under the care of CASSINI, but men of all countries who had distinguished themselves by their scientific acquirements were invited by that illustrious patron of science to reside in Paris. He was also the founder of the Académie des Sciences, and of the Observatory of Paris.

† Hist. de l'Astron. au XVIIIème siècle; par Delambre, p. 115.

‡ Lord ASHLEY, Mr. FRANCIS BAILY, Captain BEAUFORT, and the President.

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of a new one. A plan for the constitution and regulation of a new Board was shewn to the First Lord of the Admiralty; and was *only* not introduced to the consideration of Parliament at the instance of the projectors of it, in consequence of a wish expressed by Lord Melville, that a bill drawn up in its spirit should be presented to the Legislature by the Admiralty officers. The question which at that time, and during the remainder of the session, so completely engrossed the attention of the government, being now disposed of, let us hope, that the pledge then given will be remembered, and that on our next anniversary we shall have to thank the government for having given us a Board of Longitude, which shall be worthy of the first maritime nation in the world.

As connected in some measure with astronomy, we see the geodetic operations in Ireland carried on with vigour, under the superintendence of Colonel Colby; whilst for triangulating our Indian empire (thanks to the scientific spirit of the Directors of the East India Company), such a battery of field apparatus is nearly prepared by Troughton and Simms, as, in even less able hands than those of Captain Everest, could scarcely fail to immortalise him who should have the happiness of using it.

Again, we have the pendulum investigations of our associate, Professor Bessel, shewing that the corrections employed by British philosophers for the reduction to a vacuum are far from accurate; and, to come nearer home, our ever active member, Mr. Francis Baily, has demonstrated that certain imperfections and discordances exist in the apparatus employed by previous experimenters, which point out the absolute necessity of fresh inquiries being instituted, ere we can pretend to be possessed of accurate estimations either of measure or of weight.*

But our Society was not founded solely for the investigation of astronomical refinements — practical utility was to go hand in hand with it: geography was to be improved; and hydrography, so essential to the well-being of our maritime country, was not to be neglected. To advance our knowledge of the former since our last anniversary, British intrepidity,

* A standard measure, on a new construction, has been ordered by the Council, since the delivery of this address, and is now in course of completion by Troughton and Simms.

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undaunted by previous defeat, has left our shores, and is now struggling in the Victory to achieve that, which the perseverance of a PARRY, backed by the exchequer of Great Britain, was forced, after repeated trials, to abandon in despair. And the no less interesting part of the history is, that the expense of the attempt (which God grant may be successful!) has been defrayed by the princely liberality of an English gentleman, whose modesty withholds his name from the public.

Again, as to hydrography: scientific surveys are gradually spreading to every quarter of the globe, under the influence of the noble Lord who has lately enrolled his name in this Society. But little does it matter if coasts are well surveyed, rocks detected, shoals discovered, and currents ascertained, if the results are not digested so as to be practically useful to the seaman. It gives me pleasure, therefore, to announce, that since we last met, an appointment has been made by the Admiralty, which has given universal satisfaction; for it assures us, that the day is not far distant, when an Englishman shall visit the hydrographic department of the *Depôt de la Marine* of a neighbouring state, without feelings humiliated by the comparative inferiority of the corresponding establishment of his own country.

Proceed we now to the distribution of our medals. By the minutes read at the table, you have been informed that "one of them has been decreed to Mr. RICHARDSON for his investigation and determination of the constant of aberration, from observations made at Greenwich with the two mural circles; the other to Professor ENCKE, for his *Berlin Ephemeris*."

Three hundred years have now elapsed since COPERNICUS proposed to the world that system which bears his name; and if we except the labours of TYCHO BRAHE, who, besides a catalogue of 800 stars, made attempts to determine the altitude of the pole-star at different seasons of the year, little was done by practical observation to support or refute the ideas of COPERNICUS till the time of GALILEO. Observations of the eclipses of *Jupiter's* satellites induced him to propose them as a means of determining differences of longitude, whilst his discovery of the phases of *Venus* removed a serious objection to the truth of the Copernican system,

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and which Copernicus himself predicted would be removed, though he had not the means of doing so himself. About the year 1665, Huygens, by his invention of the pendulum clock, gave to astronomical observations an accuracy hitherto unknown; and Cassini, by means of the excellent glasses of Campani, accumulated a vast mass of observations of the eclipses of *Jupiter's* satellites, and deduced from them tables whereby astronomers could predict their occurrence.

Notwithstanding the powerful arguments advanced in its favour, the Copernican hypothesis was not generally embraced; for in the year 1669, nearly a century and a half subsequent to its promulgation by Copernicus, even the celebrated Hook, to use his own words, "would not absolutely declare for it."* To settle the matter, therefore, this extraordinary man, feeling that the instruments of Tycho, although magnificent beyond all others, were, from the nature of their construction, and from their being unprovided with telescopic sights, incompetent to detect minute alterations of sidereal positions, and knowing that the laws which governed refraction were so little understood† as to render all observations in which that element was materially involved, liable to errors greater probably than the quantities he was in search of, invented the zenith sector. It was erected at Gresham College, and consisted of a telescope 36 feet long, a divided arc, and a plumb-line. The star selected for observation, and with reference to which, indeed, his instrument was entirely constructed, was one which passed within two or three minutes of the zenith of Gresham College, was visible in the day-time throughout the year, and was γ *Draconis:* by observing its zenith distance when the earth was in opposite points of her orbit, he found (as he erroneously concluded) a sensible parallax, amounting to about 20 seconds, and, consequently, determined that the Copernican system was the true one.‡

In the mean time, the eclipses of *Jupiter's* satellites, thanks to the facilities of predicting them afforded by Cassini's tables, had been

* An Attempt to prove the Motion of the Earth, from Observations made by Robert Hook, F.R.S., pp. 5 and 7.

† Idem, pp. 10 and 11.

‡ Idem, p. 25.

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assiduously observed; and in the year 1675, the discordances found between the predicted and the observed eclipses enabled the celebrated ROEMER to demonstrate that light was not instantaneously propagated, and that the discordances between the tables and the observations might be considered as the measure of its velocity.

The year of ROEMER's discovery was further marked by another epoch in astronomical history, namely, the foundation of the Royal Observatory. FLAMSTEED, with his mural quadrant, detected a change of place in the pole-star, amounting to 35, 40, or 45 seconds, attributed it to parallax, and regarded it as confirmatory of HOOK's discovery. Indeed, the observations of HOOK, as well as of those who preceded him, although nominally in search of parallax, had for their object little else than the confirmation or verification of the Copernican system; and this arrived at, there seems to have been but little disposition to repeat them.

Hence it was that the brilliant discoveries of NEWTON having placed the accuracy of the Copernican system beyond all possibility of doubt, the investigation of parallax was not resumed till the latter end of November, in the year 1725, at which time MOLYNEUX erected his 24-feet zenith sector, by GRAHAM, in his observatory at Kew.* "On the 3d of December, *γ Draconis* was, for the first time, observed as it passed near the zenith, and its situation carefully taken with the instrument; and again, on the 5th, 11th, and 12th, when, no material change in the star's place having been detected, further observations seemed needless, since it was a time of the year when no sensible alteration of parallax could soon be expected." BRADLEY, however, being on a visit to his friend MOLYNEUX, was "tempted by curiosity to repeat the observation on the 17th, and perceived the star pass a little more southerly than when it had been observed before:" suspecting that the apparent change of place might be owing to erroneous observation, it was observed again on the 20th, and he found the star still farther south than in the preceding observations. This sensible alteration surprised himself and MOLYNEUX, inasmuch as it was the con-

* Philosophical Transactions, vol. xxxv. p. 639.

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trary way from which it would have been, had it proceeded from an annual parallax of the star; but being incapable of accounting for it by want of exactness in the observations, and having no notion of any other cause from which such apparent motion could proceed, they suspected that some change in the materials of the instrument itself might have occasioned it. Under this apprehension they remained some time, but being at length fully convinced, by repeated trials, of the great exactness of the instrument, and finding, by the gradual increase of the star's distance from the pole, that there must be some regular cause which produced it, they examined nicely at the time of each observation how much it was; and about the beginning of March 1726, the star was found to be 20″ more southerly than at the time of the first observation. It now, indeed, seemed to have arrived at its utmost limit southward; for in several observations made about this time, no sensible difference could be detected in its situation. By the middle of April it appeared to be returning towards the north, and about the beginning of June it passed at the same distance from the zenith as it had done in December, when it was first observed. From the quick change in the star's declination about this time (it increasing a second in three days) they concluded that it would now proceed northward, as it before had gone southward of its present situation; and it happened as was conjectured; for it continued to move northward till September following, when it again became stationary, being then near 20″ more northerly than in June, and no less than 39″ more northerly than it had been in March. From September it returned towards the south, till it arrived, in December, at the very same situation it had been at that time twelve months, allowing for the difference of declination "on account of the precession of the equinox."

Such is a brief history of the Kew observations; commenced, indeed, for the determination of sensible parallax, but which, as subsequently in the hands of Herschel, led to a very different result. In reading it, we are at a loss whether most to admire the mode in which the observations were conducted, or the modest unassuming manner in which they are recorded: no possible source of error is allowed to pass without the most rigid examination — no theory suffered to embarrass the observers in their

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observations; the slightest anomaly became the subject of suspicion, till in presumed anomaly was found the most perfect regularity.

That observations so conducted, leading to results so unexpected, could be abandoned till the law which governed them should be unfolded, was impossible. But BRADLEY rejected all inquiries into the cause till the effects were accurately determined; and feeling that the apparent motion was obtained by observations only of one year—by one instrument—and by one star,—he erected at Wanstead, aided by his friend GRAHAM, on the 19th of August, 1727, his zenith sector of $12\frac{1}{2}$ feet focus, formed, indeed, upon the same general plan of MOLYNEUX's, but furnished with a divided arc of $6\frac{1}{4}$ degrees on each side of the zenith point, for the purpose of enabling him to ascertain, by direct observation, whether other stars than γ *Draconis* would be similarly affected. The instrument's situation, when adjusted, "might be securely depended upon to half a second," and its telescope could be directed to "not less than 12 stars, bright enough to be seen in the day-time" throughout the year: the same changes were observed as had been previously detected with MOLYNEUX's instrument. Inflexible, however, in his resolution not to generalise till sufficient means were collected to lead him to a "probably just conclusion," the year of probation was suffered to be completed before "the observations were examined and compared:" *then* it was that he satisfied himself of the general laws of the phenomena; and *then*, and not *till then*, did he endeavour to find out their cause. Convinced that the apparent motion of the stars which he had observed was not owing to nutation—persuaded that a change in the direction of the plumb-line with which the instrument was rectified was insufficient to have occasioned it—and having appealed unsuccessfully to refraction,—he perceived "that if light was propagated in time, the apparent place of a fixed object would not be the same when the eye is at rest as when it is moving in any other direction than that of the line passing through the eye and the object; and that when the eye is moving in different directions, the apparent place of the object would be different." He therefore announced his discovery in these words: "That all the phenomena proceeded from the progressive motion of light and the earth's annual motion in its orbit," or, as he afterwards called it, aberration of light.

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But he who determined its existence determined also its constant, and fixed it at 20″; giving us, therefore, the interval of time in which light travels from the sun to the earth, as eight minutes and seven seconds, differing from that deduced by Roemer nearly three minutes of time, a circumstance not at all to the discredit of Roemer, considering the imperfect knowledge of the theory of *Jupiter's* satellites at the time he made his important discovery.

The observations, however, which led Bradley to the discovery of aberration, and to the determination of its constant, being as yet unpublished, have given rise to insinuations certainly ungenerous, and probably unjust. Impelled by more honourable feelings, our illustrious associate Bessel, alluding to the observations of γ *Draconis* made by Bradley when the sector was removed to Greenwich, says,* "*Cæterùm Bradleii observationes Wansteadianæ liberari possunt à sectoris mutabilitate, quum sæpiùs, eodem tempore, observatæ sint stellæ, in quibus aberrationi contraria fuerunt signa: quâ de causâ, et propter observationum præstantiam, optabile esset reperire ipsa Bradleii autographa.*" It will, therefore, be highly grateful to him, and to astronomers in general, to be informed from this chair, that the manuscripts of the Wanstead observations are found!—that, to the honour of the University of Oxford, twenty-three sheets of them are already printed; and that the volume will be presented to the public with as little delay as possible, under the superintendence of Professor Rigaud.

Till within these few years, the constant, as determined by Bradley, was universally employed in all our astronomical reductions; recently, however, astronomers have re-investigated it. Delambre, from the eclipses of *Jupiter's* satellites, regards it as 20″,25. Bessel, from Bradley's observations made at the Royal Observatory, after he was appointed Astronomer Royal, has deduced for the constant 20″,68. Lindenau, by comparisons of Bradley's, Maskelyne's, Bessel's, and Pond's observations of *Polaris*, has obtained for it 20″,61. Brinkley, from his own observations, considers it as 20″,37. Whilst Struve, by his observations, draws almost the same inference, namely 20″,35.

* Fundamenta Astronomiæ, p. 124.

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Such were the results most entitled to our confidence, when Mr. RICHARDSON, in the hours allotted to him for repose or recreation, undertook those labours which form the subject of our present consideration, and of which the following is a brief outline. A second mural circle by JONES, after the model of that of TROUGHTON's, having been erected at the Royal Observatory, in the April of 1825, corresponding observations with the two instruments were carried on simultaneously; they were confined, indeed, to a few stars, but every precaution to render them as accurate as possible was adopted. Thus, the index error of each instrument was ascertained by observing the same star alternately, by direct vision and reflection; each pair, therefore, giving to its respective instrument one horizontal point perfectly independent of astronomical tables, the final accuracy of the determination of the index error being directly as the number of pairs observed. Throughout the observations, the place of each star was arrived at by reference to the six microscopes of each circle; care also being taken to equalise, as nearly as possible, the temperature of the observatory with that of the external air, so that errors to any extent, arising from partial expansions or erroneous divisions of the instrument, were effectually excluded.

From such unexceptionable data, fourteen stars were selected by Mr. RICHARDSON as the fittest for his purpose, being those the least affected by refraction, and the most affected by aberration, so that the errors of observation might have the minimum influence upon the results. Upwards of 4,000 observations he separately discussed, and in no instance was the actual aberration of each observed star less than 14″; and the conclusion to which he has arrived is, from TROUGHTON's circle, that the Constant of Aberration is 20″,505; whilst by JONES's it is 20″,502, the one differing from the other but three-thousandths of a second.

HOOK, in searching for parallax, was misled by his instrument. BRADLEY, in detecting it, was unsuccessful, but discovered aberration. HOOK's instrument was the work of his own hands; BRADLEY's was the work of GRAHAM. Sensible that much of his astronomical glory was referable to the accuracy of his instrument, the amateur astronomer of Wanstead was ever ready to acknowledge it; and when we consider that one hundred

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years' improvement in astronomical manipulations can alter the constant of aberration as determined by him but one half second,* we are almost led to exclaim "*quando ullum inveniemus parem?*"

Our Graham is amongst us; to him we are indebted for the instruments with which results thus important have been obtained, and also for the mode of using them, through which the maximum of accuracy has been acquired. One of them was made with his own hands, the other under his direction; and it is not too much to say, that the disciple has shewn himself worthy of his master. The benefits which Edward Troughton has conferred on science are too well known to need enumeration. His Majesty the King of Denmark, not insensible to the importance of science, and feeling that for much of the accuracy to which astronomy and navigation have arrived, we are indebted to the genius of our revered member, has recently acknowledged his gratitude to him, by the presentation of his gold medal, inscribed with the word "Merito." Never was inscription more appropriate. May he live long to enjoy this token of respect! alike honourable to himself and to the princely feelings of its royal donor.

On looking over the constant as determined by each star, nothing definitive, as Mr. Richardson justly observes, can be concluded, as to whether light emitted from different stars is propagated to us with different degrees of velocity: the idea is not irrational, but its validity future astronomers must determine.

(*The President then, addressing Mr. Richardson, continued thus:*—)

Mr. Richardson,—Brought up to an employment little allied to astronomy—residing in a part of the country remote from the metropolis—cut off from the society of scientific men, which operates so powerfully in stimulating to scientific exertions,—we see you quitting the place of your birth,—leaving the roof of your respected parents,—and presenting yourself in this great city, known only to a single individual; abandoning every sordid pursuit to follow that which, however noble, too often leads, in this

* It is not impossible that much of this discordance will disappear when the Wanstead Observations shall be reduced with modern precision.

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country, to neglect and poverty—we find you, in August 1822, at the Royal Observatory as an assistant. Here you soon distinguished yourself by your punctuality—your attention—and your zeal; accustomed to the business of an observatory,* you required to be instructed only in the established routine of that to which you were appointed. Soon did you gain the confidence of the Astronomer Royal; and whether he wished to establish the place of a star in the heavens, or of a spot on the earth, to no one could he intrust the one or the other with more confidence than to you, whom he emphatically styled "his right hand." Attached to astronomy, but unable to maintain your family upon the *miserable* pittance allowed you by the government, we see you observing all day and computing all night. As an assistant of the Royal Observatory, I have only to say,—Go on as you have begun. But if a trust higher in the scale of importance awaits you, remember, sir, that you have *now* a character to maintain; for your name, but a few years since confined to the narrow limits of a country village, is now known throughout Europe; and that too by your own exertions. Receive this medal, sir, as a pledge of our esteem—as, indeed, the highest honour we have to offer. May it stimulate you to fresh exertions in the cause of your favourite science; and on your return from India to your native home, may the Astronomer of Madras be as honourably distinguished as is this day the Assistant of the Royal Observatory.

(*The President then resumed his address to the Members, as follows:*—)

The second medal has been adjudged to Professor ENCKE, for the *Berlin Ephemeris* which bears his name. Experience has long shewn, that an astronomical ephemeris is almost as necessary an appendage to an observatory as are the instruments themselves; accordingly we find that some one, more or less perfect, has been in the hands of every astronomer, since astronomy has been pursued in a systematic manner. The first which appears in this country at all deserving the name of an astronomical ephemeris was that of VINCENT WING, and was used by FLAMSTEED: it, however, was very imperfect, and FLAMSTEED, whilst at Derby, transmitted to the Royal Society supplements to it, containing notices of phenomena not inserted in WING's *Ephemeris*, and which were published from time to

* The President's.

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time in the *Philosophical Transactions*. La Caille, about the year 1755, proposed one upon a larger scale; but in 1767, on the recommendation of Dr. Maskelyne, the Board of Longitude of Great Britain published the *Nautical Almanac and Astronomical Ephemeris*, Dr. Maskelyne himself taking the superintendence of it. Its object was evidently twofold, since it contained, even when first published, much information not wanted by the astronomer, and still *more* not required by the seaman. The *Connoissance des Tems* also was published much in the same style, and was, as well as the *Nautical Almanac*, a manual not only for the seaman, but also for the astronomer. The *Berlin Ephemeris* was purely astronomical, but, like the *Connoissance des Tems*, contained, in the shape of additions, much valuable astronomical information, inserted by its highly respected editor, the much-lamented Bode. But the *Connoissance des Tems*, compared with the *Nautical Almanac*, had so fallen into disrepute, that, in the year 1795, Gregoire, now Bishop of Blois, in the name of the Committees of Marine, of Finance, and of Public Instruction, proposed to the National Convention the establishment of a Board of Longitude, in imitation of the British Board, and to which should be confided the publication of the *Connoissance des Tems*. From that time to the present it has been published with greater regularity, and in general about the same time as the *Nautical Almanac;* for, from some cause or other, the latter has not appeared so many years in advance as in the times of Maskelyne. Considering that the work is sometimes wanted for long voyages of discovery, its publication 3 or 4 years in advance, instead of $2\frac{1}{4}$ years, as at present, would certainly be desirable. From the time of Maskelyne's editing the *Nautical Almanac* till his decease, it gained the approbation of his countrymen and the eulogies of foreign astronomers. La Lande, speaking of it, says, "*On a fait à Bologne, à Vienne, à Berlin, à Milan; mais le 'Nautical Almanac' de Londres est l'éphéméride la plus parfaite qu'il y ait jamais eu.*"

On the death of Maskelyne, the superintendence of it passed into the hands of "irresponsible" persons, and the character which it had so long sustained was lost. Compared with corresponding productions of other countries, it was not only inaccurate but incomplete. Astronomical knowledge was progressive; but the *Nautical Almanac* remained not only stationary, but retrograded. To restore it to its former rank, a new Board of Longitude was formed, and the superintendence of the Almanac was

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confided to the Secretary of the Board. To retrieve the character of a work which, from holding the highest rank in the ephemerides of Europe, had descended below mediocrity, was no easy task; but it is due to the memory of that eminent person to acknowledge, that the first volumes published under his superintendence did much to restore its character for accuracy. Other ephemerides, however, having, in an astronomical point of view, got the start of it, sustained their superiority; and there is scarcely an observatory in the country upon whose desks have not been found, for several years past, the ephemerides of France, of Berlin, and of Milan. As a small addition, a supplement has been recently published; this, however, does not get into circulation till its year is actually commenced, and therefore is comparatively of little use. Under these circumstances, so injurious to the astronomical character of the country, many have been the discussions relative to the *Nautical Almanac*, and the individual who has the honour to address you has not been unconcerned in them. His animadversions may have been occasionally severe, but he hopes never unjust;—they were intended to convince, not unnecessarily to wound. For the individual with whom he had the misfortune to differ, he entertained the highest respect; and by no one even of his scientific friends was his premature removal more keenly felt than by him, who never differed from him but with regret. His acquirements were of no common order; and whatever may be our opinions of his superintendence of the *Nautical Almanac*, all suffrages will unite in pronouncing him an ornament to his country.

Since the decease of Dr. Young, the superintendence of the Almanac has been transferred to the Astronomer Royal, and the volume for 1832 has just been published under his direction. No important alteration distinguishes it from its predecessors. Almost on the same day appeared the corresponding volume of the *Connoissance des Tems*. The former gives us no notice of improvements contemplated for future volumes; the latter promises some important additions. I have, however, the satisfaction of announcing to the Society the following message from the First Lord of the Admiralty, transmitted to me through the Hydrographer; namely, "that the Admiralty has actually ordered some additions to the Almanac for 1833, and has it in contemplation to order further additions to that for

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1834." What these additions are, it has not been thought proper to divulge, at least to me; let us therefore hope that they will be worthy of the country, and that ere long the *Nautical Almanac and Astronomical Ephemeris of Great Britain,* rising like a phœnix from its ashes, shall be as much superior to Encke's, as Encke's is now superior to it. That, however, will be no easy task: Encke, whose name stands already in the list of those to whom our medal has been *before* adjudged, is no ordinary rival. Well knowing what is wanted in an observatory — skilled in practice — profound in theory — and living under a government by which science is *eminently* encouraged—he has given to us an ephemeris which is invaluable. To enter into its individual merits would far exceed the time allowed me; suffice it to say, that for every purpose of astronomical investigation, its materials are sterling, and its arrangement excellent. With it, an observatory scarcely wants a single book; without it, every one.

(*The President then, addressing Mr. Baily, said:* —)

Mr. Baily, — To no one can I confide this medal with more propriety than to you; for no one, more than you, knows the importance of our associate's labours. Transmit it to him as a second badge of our regard; and tell him, that for his Ephemeris we are under obligations to him, which we never can repay.

ERRATA.

Page 4, line 9, *for* (cotan $\lambda \mp \alpha$) *read* (cotan $\lambda \mp$ cotan α).
Page, 460, line 1, *for* $9^h\ 8^m$ *read* $21^h\ 8^m$.
For the Errata in Mr. Lubbock's paper on Halley's Comet, see page 516.

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PRESENTS

RECEIVED BY

THE ASTRONOMICAL SOCIETY OF LONDON,

NOVEMBER, 1829—DECEMBER, 1830.

1829.	Presents.	Donors.
Nov. 13.	Illustrations of the Atmospherical Origin of Epidemic Diseases, and of its Relation to their Predisponent Constitutional Causes; exemplified by Historical Notices and Cases; and on the Two-fold Means of Prevention, &c. To which are appended, Popular Rules for the Maintenance of Health. By T. Forster. Chelmsford, 1829. Second edition. 8vo.	T. Forster, Esq.
	Formulas Nuevas para calcular la Aberracion de los Planetas en Longitud y Latitud. Por D. Josef Sanchez Cerquero. 8vo.	M. Bauza.
	Report of the Proceedings of the Second General Meeting of the Subscribers to the Oriental Translation Fund; with the Prospectus, Report of the Committee, and Regulations. London, 1829. 8vo.	The Royal Asiatic Society.
	Asiatic Researches; or, the Transactions of the Society instituted in Bengal, for inquiring into the History and Antiquities, the Arts and Sciences, and Literature of Asia. Vol. XVI. Calcutta, 1828. 4to.	———
	Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin, aus dem Jahre 1825. Nebst der Geschichte der Akademie in diesem Zeitraum. Berlin, 1828. 4to.	Berlin Academy.
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	Transactions of the American Philosophical Society, held at Philadelphia, for promoting Useful Knowledge. Vol. III. New Series. Philadelphia, 1830. 4to.	American Phil. Society.

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*** *A new election of Officers and Council was made on the acceptance of the Charter on the 6th of April*, 1831, *which will be given in the next Volume.*

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The Gold Medal.—For his invention of an Engine for computing and printing Mathematical Tables.

Professor JOHANN FRIEDRICH ENCKE.

The Gold Medal.—For his investigations relative to the Comet which bears his name.

CHARLES RUMKER, Esq.

The Silver Medal.—For his re-discovery of ENCKE's Comet in 1822.

M. JEAN LOUIS PONS.

The Silver Medal.—For his discovery of two Comets in 1822.

1826.

Feb. 7. J. F. W. HERSCHEL, Esq. and JAMES SOUTH, Esq.

The Gold Medal, each.—For their important researches on the subject of Multiple Stars.

Feb. 10. Professor STRUVE.

The Gold Medal.—For his important researches on the subject of Multiple Stars.

1827.

Feb. 2. FRANCIS BAILY, Esq.

The Gold Medal.—For his "New Tables for determining the places of 2881 Stars."

WILLIAM SAMUEL STRATFORD, Esq.

The Silver Medal.—For his superintendence of the computation of "New Tables for determining the places of 2881 Stars."

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Feb. 5. Colonel MARK BEAUFOY.

The Silver Medal.—For his valuable collection of Observations, particularly those of the Eclipses of Jupiter's Satellites.

1828.

Jan. 11. Sir THOMAS MACDOUGALL BRISBANE, K.C.B.

The Gold Medal.—For his establishment of an Observatory, and for an important series of Observations made at Paramatta.

JAMES DUNLOP, Esq.

The Gold Medal.—For his Observations of the Nebulæ of the Southern Hemisphere.

Feb. 4. Miss CAROLINE HERSCHEL.

The Gold Medal.—For her recent reduction, to Jan. 1800, of the Nebulæ discovered by Sir WILLIAM HERSCHEL.

1829.

Jan. 9. Rev. WILLIAM PEARSON.

The Gold Medal.—For his work, entitled, "An Introduction to Practical Astronomy."

Professor BESSEL.

The Gold Medal.—For his Zone Observations.

Professor SCHUMACHER.

The Gold Medal.—For the publication of his various Astronomical Tables, and the "Astronomische Nachrichten."

1830.

Jan. 8. Mr. WILLIAM RICHARDSON.

The Gold Medal.—For his investigation of the Constant of Aberration.

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The Gold Medal.—For the New Berlin Ephemeris.

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