

# ASTRONOMISCHE NACHRICHTEN.

N<sup>o</sup> 3684-85.

Band 154.

12-13.

## Definitive Orbit Elements of Comet 1898 VII.

By C. J. Merfield.

### 1. Introductory.

This comet was discovered by Mr. E. F. Coddington of the Lick observatory on the date 1898 June 11 in the constellation Scorpio, and then described as a bright nucleus of about the eighth magnitude surrounded by a nebulosity somewhat less than a minute of arc in diameter.

During the evening of 1898 June 9, Mr. Coddington made an exposure of two hours with the Crocker photographic telescope, for the purpose of obtaining a photograph\*) of the extensive nebulous region to the north of Antares, but it was not until two days later that the plate was developed, and the unknown object detected some two or three degrees north east of Antares. The comet appeared on the plate as a nebulous trail, from which the direction and rate of motion were inferred, so that with the twelve inch visual telescope the comet was easily found, and observed for position. This is the third comet that has been discovered by the aid of photography.

Mr. W. Pauly of Bukarest on the date 1898 June 14 independently discovered the object.

This comet was well observed in northern latitudes from the date of discovery until about the end of July, further observations being for a time precluded, owing to its large southern declination which was increasing daily. From southern observatories the comet could have been observed during the whole time of its visibility. About the first week of the month of September and until 1899 January

the comet was a circumpolar object for most of the southern observatories, several of which have published splendid series of observations. The largest series of observations are by Mr. J. Tebbutt of Windsor. The work of this astronomer extends over the period 1898 June 15 to 1899 Feb. 15, and comprises one hundred and two nights work, seven hundred and sixty eight comparisons being made, and one hundred and thirty seven stars of reference used. The provisional elements of this comet, published by the writer in A. N. 3546, depend almost entirely on the observations of Mr. Tebbutt who is to be congratulated not only on the general accuracy of the observations, but also on the careful manner in which the reductions have been prepared for publication.

The discussion of the orbit elements of the comet includes some four hundred observations by well known observatories of the northern and southern hemispheres. The observations for the most part were obtained between the dates 1898 June 11 and 1899 Feb. 15. Guided by an ephemeris, computed by the writer from the provisional elements, Mr. Coddington was able to secure four observations during August and September of the year 1899, and one on the date 1899 Dec. 6, this is the last observation made, the comet on this date was described as extremely faint, but had the weather conditions been favourable, further observations, about this date, would have been possible.

### 2. Provisional Elements and Calculation of Ephemerides.

The provisional elements were deduced from three normal places constructed for the dates 1898 June 18, 1898 Aug. 11, 1898 Oct. 4. These places are almost exactly represented by the elements found; see A. N. 3546. The final observation of the Lick observatory on the date 1899 Dec. 6 shews a correction to the ephemeris of only  $-1^s.54$  in right ascension and  $-31''.7$  in declination. As anticipated, the corrections to these provisional elements would be small, so that they have been adopted as the basis of the calculation and the data to be corrected. These elements are as follows.

#### Elements A.

$$\begin{array}{ll} T = 1898 \text{ Sept. } 14.052157 \text{ G. M. T.} & \log q = 0.2308280 \\ \omega = 233^\circ 15' 36''.51 & q = 1.7014844 \\ \Omega = 73 \ 59 \ 20.69 & \log e = 0.0003273 \\ i = 69 \ 55 \ 56.98 & e = 1.0007539 \end{array} \quad 1898.0$$

#### Equations for Co-ordinates 1898.0

$$\begin{array}{l} x = [9.6334169] r \sin(v + 13^\circ 21' 17''.79) \\ y = [9.9672364] r \sin(v + 341 \ 17 \ 19.63) \\ z = [9.9900458] r \sin(v + 256 \ 18 \ 10.82) \end{array}$$

\*) This photograph has been reproduced in the publications of the Astronomical society of the Pacific.

The elements  $\omega$ ,  $\Omega$ ,  $i$  referred to the ecliptic and mean equinox of the year 1898 have been reduced to the mean equinox of 1899 by applying the following quantities to these elements:

$$\begin{aligned}\Delta\omega &= + 0''.50 \\ \Delta\Omega &= + 50.09 \\ \Delta i &= + 0.08\end{aligned}$$

The equations for the co-ordinates will now become (1899.0):

$$\begin{aligned}x &= [9.6332832] r \sin(v + 13^\circ 22' 51''.17) \\ y &= [9.9672745] r \sin(v + 341^\circ 17' 31''.01) \\ z &= [9.9900374] r \sin(v + 256^\circ 18' 18''.67)\end{aligned}$$

The ephemeris, for comparing the observations between the dates 1898 June 10 and 1898 Oct. 11 has been computed from parabolic elements; see A. N. 3524:

# Elements B.

$$T = 1898 \text{ Sept. } 14.10411 \text{ G. M. T.}$$

$$\begin{aligned}\omega &= 233^\circ 18' 4''.50 \\ \Omega &= 73^\circ 59' 23''.14 \\ i &= 69^\circ 54' 46''.48\end{aligned} \quad \left. \vphantom{\begin{aligned}\omega \\ \Omega \\ i\end{aligned}} \right\} 1898.0$$

$$\log q = 0.2306440$$

Equations for Co-ordinates 1898.0.

$$\begin{aligned}x &= [9.6336495] r \sin(v + 13^\circ 25' 25''.22) \\ y &= [9.9672197] r \sin(v + 341^\circ 19' 21''.12) \\ z &= [9.9900158] r \sin(v + 256^\circ 20' 45''.17)\end{aligned}$$

The ephemeris for comparing the observations after the date 1898 Oct. 11, has been prepared from the provisional elements; only those positions necessary for an accurate interpolation for the dates of observation being tabulated. The adopted co-ordinates of the sun are those of the Nautical Almanac.

## Ephemeris (Elements B) for Greenwich Mean Noon.

1898	$\alpha$	$\delta$	$\log A$	Red. to app.	
				$\alpha$	$\delta$
June 10	16 <sup>h</sup> 30 <sup>m</sup> 31 <sup>s</sup> .54	24° 8' 37".9	0.04098	25° 05'	8".18
» 11	27 15.49	24 46 44.9	0.03922	2 726	8.38
» 12	23 56.64	25 24 51.9	0.03768	2 746	8.58
» 13	20 35 15	26 2 55.9	0.03635	2 767	8.79
» 14	17 11.25	26 40 53.6	0.03523	2 788	8.99
» 15	13 45.14	27 18 41.7	0.03431	2 808	9.21
» 16	10 17.06	27 56 17.2	0.03360	2 828	9.42
» 17	6 47.26	28 33 36.9	0.03310	2 848	9.64
» 18	16 3 15.97	29 10 37.9	0.03281	2 868	9.85
» 19	15 59 43.45	29 47 17.2	0.03273	2 888	10.07
» 20	56 9.97	30 23 32.1	0.03285	2 908	10.29
» 21	52 35.80	30 59 20.3	0.03317	2 927	10.52
» 22	49 1.20	31 34 39.4	0.03369	2 945	10.74
» 23	45 26.45	32 9 27.3	0.03440	2 963	10.96
» 24	41 51.82	32 43 42.1	0.03530	2 980	11.18
» 25	38 17.57	33 17 22.1	0.03638	2 997	11.40
» 26	34 43.96	33 50 25.8	0.03764	3 014	11.62
» 27	31 11.27	34 22 52.1	0.03906	3 031	11.84
» 28	27 39.74	34 54 40.0	0.04065	3 047	12.06
» 29	24 9.62	35 25 48.6	0.04239	3 062	12.28
» 30	20 41.16	35 56 17.5	0.04428	3 077	12.49
July 1	17 14.56	36 26 6.2	0.04631	3 091	12.70
» 2	13 50.05	36 55 14.6	0.04848	3 105	12.91
» 3	10 27.84	37 23 42.8	0.05077	3 119	13.11
» 4	7 8.12	37 51 30.9	0.05318	3 132	13.31
» 5	3 51.08	38 18 39.3	0.05570	3 144	13.51
» 6	15 0 36.90	38 45 8.5	0.05833	3 156	13.71
» 7	14 57 25.74	39 10 59.3	0.06106	3 168	13.91
» 8	54 17.74	39 36 12.4	0.06388	3 179	14.10
» 9	51 13.06	40 0 48.7	0.06678	3 190	14.28
» 10	48 11.83	40 24 49.2	0.06976	3 200	14.46
» 11	45 14.18	40 48 15.0	0.07281	3 210	14.64
» 12	42 20.21	41 11 7.2	0.07592	3 220	14.82
» 13	39 30.01	41 33 27.2	0.07909	3 230	14.99
» 14	36 43.65	41 55 16.4	0.08232	3 239	15.16
» 15	14 34 1.22	42 16 36.0	0.08559	3 248	15.32
July 16	14 <sup>h</sup> 31 <sup>m</sup> 22 <sup>s</sup> .77	42° 37' 27".4	0.08890	3° 256'	15".48
» 17	28 48.33	42 57 52.0	0.09224	3 264	15.63
» 18	26 17.96	43 17 51.3	0.09561	3 272	15.78
» 19	23 51.69	43 37 26.6	0.09901	3 280	15.93
» 20	21 29.51	43 56 39.3	0.10243	3 288	16.08
» 21	19 11.42	44 15 30.7	0.10586	3 296	16.22
» 22	16 57.41	44 34 2.3	0.10930	3 303	16.35
» 23	14 47.49	44 52 15.4	0.11275	3 310	16.49
» 24	12 41.64	45 10 11.4	0.11621	3 317	16.62
» 25	10 39.82	45 27 51.4	0.11966	3 324	16.75
» 26	8 41.99	45 45 16.6	0.12310	3 331	16.87
» 27	6 48.13	46 2 28.3	0.12654	3 338	16.99
» 28	4 58.18	46 19 27.6	0.12997	3 345	17.10
» 29	3 12.09	46 36 15.5	0.13338	3 352	17.22
» 30	14 1 29.81	46 52 53.1	0.13678	3 358	17.34
» 31	13 59 51.30	47 9 21.4	0.14016	3 365	17.44
Aug. 1	58 16.51	47 25 41.4	0.14352	3 371	17.54
» 2	56 45.41	47 41 54.0	0.14686	3 378	17.64
» 3	55 17.87	47 58 0.1	0.15017	3 384	17.74
» 4	53 53.85	48 14 0.5	0.15346	3 392	17.84
» 5	52 33.29	48 29 56.0	0.15672	3 399	17.93
» 6	51 16.17	48 45 47.5	0.15995	3 407	18.02
» 7	50 2.46	49 1 35.7	0.16315	3 414	18.11
» 8	48 52.10	49 17 21.4	0.16632	3 422	18.20
» 9	47 45.02	49 33 5.2	0.16945	3 429	18.29
» 10	46 41.15	49 48 48.0	0.17255	3 437	18.37
» 11	45 40.47	50 4 30.4	0.17562	3 444	18.45
» 12	44 42.91	50 20 13.0	0.17865	3 452	18.53
» 13	43 48.42	50 35 56.4	0.18164	3 460	18.61
» 14	42 56.94	50 51 41.3	0.18459	3 468	18.68
» 15	42 8.42	51 7 28.1	0.18751	3 476	18.75
» 16	41 22.79	51 23 17.4	0.19039	3 484	18.82
» 17	40 40.02	51 39 9.7	0.19322	3 493	18.89
» 18	40 0.06	51 55 5.6	0.19602	3 502	18.96
» 19	39 22.85	52 11 5.5	0.19877	3 511	19.02
» 20	13 38 48.33	52 27 9.7	0.20148	3 520	19.09

1898	$\alpha$	$\delta$	$\log A$	Red. to app.		1898	$\alpha$	$\delta$	$\log A$	Red. to app.	
				$\alpha$	$\delta$					$\alpha$	$\delta$
Aug. 21	13 <sup>h</sup> 38 <sup>m</sup> 16 <sup>s</sup> .46	52° 43' 18".8	0.20415	3 <sup>s</sup> 53.0	19 <sup>m</sup> 15	Sept. 17	13 <sup>h</sup> 38 <sup>m</sup> 34 <sup>s</sup> .89	60° 47' 35".2	0.26031	3 <sup>s</sup> 94.3	20 <sup>m</sup> 24
» 22	37 47.20	52 59 33.2	0.20678	3.540	19.21	» 18	39 6.24	61 7 50.4	0.26182	3.967	20.26
» 23	37 20.48	53 15 53.1	0.20936	3.550	19.27	» 19	39 39.82	61 28 17.3	0.26330	3.992	20.27
» 24	36 56.27	53 32 18.9	0.21191	3.560	19.33	» 20	40 15.65	61 48 56.2	0.26474	4.019	20.29
» 25	36 34.52	53 48 51.0	0.21441	3.571	19.38	» 21	40 53.76	62 9 47.2	0.26614	4.046	20.30
» 26	36 15.20	54 5 29.6	0.21686	3.582	19.43	» 22	41 34.18	62 30 50.3	0.26750	4.075	20.31
» 27	35 58.24	54 22 15.1	0.21928	3.594	19.48	» 23	42 16.94	62 52 5.7	0.26883	4.105	20.32
» 28	35 43.63	54 39 7.6	0.22165	3.606	19.53	» 24	43 2.09	63 13 33.4	0.27013	4.137	20.33
» 29	35 31.34	54 56 7.4	0.22397	3.618	19.58	» 25	43 49.70	63 35 13.6	0.27139	4.169	20.34
» 30	35 21.32	55 13 14.9	0.22625	3.630	19.63	» 26	44 39.81	63 57 6.3	0.27262	4.203	20.35
» 31	35 13.56	55 30 30.2	0.22850	3.643	19.67	» 27	45 32.48	64 19 11.6	0.27381	4.238	20.36
Sept. 1	35 8.03	55 47 53.5	0.23070	3.656	19.72	» 28	46 27.80	64 41 29.5	0.27496	4.276	20.36
» 2	35 4.72	56 5 25.2	0.23286	3.669	19.76	» 29	47 25.86	65 4 0.1	0.27609	4.316	20.36
» 3	35 3.61	56 23 5.4	0.23498	3.683	19.80	» 30	48 26.74	65 26 43.4	0.27719	4.359	20.36
» 4	35 4.68	56 40 54.4	0.23705	3.697	19.84	Oct. 1	49 30.56	65 49 39.6	0.27826	4.403	20.35
» 5	35 7.93	56 58 52.5	0.23908	3.712	19.88	» 2	50 37.43	66 12 48.7	0.27929	4.450	20.34
» 6	35 13.34	57 16 59.8	0.24107	3.728	19.92	» 3	51 47.47	66 36 10.8	0.28030	4.497	20.33
» 7	35 20.91	57 35 16.6	0.24302	3.744	19.95	» 4	53 0.82	66 59 45.9	0.28127	4.547	20.32
» 8	35 30.63	57 53 43.2	0.24493	3.761	19.99	» 5	54 17.64	67 23 34.1	0.28222	4.601	20.30
» 9	35 42.49	58 12 19.7	0.24680	3.778	20.02	» 6	55 38.09	67 47 35.4	0.28314	4.659	20.28
» 10	35 56.50	58 31 6.4	0.24863	3.796	20.05	» 7	57 2.35	68 11 49.8	0.28403	4.720	20.26
» 11	36 12.66	58 50 3.5	0.25041	3.815	20.08	» 8	13 58 30.61	68 36 17.3	0.28490	4.783	20.23
» 12	36 30.96	59 9 11.2	0.25216	3.834	20.11	» 9	14 0 3.10	69 0 57.8	0.28574	4.850	20.20
» 13	36 51.41	59 28 29.6	0.25387	3.854	20.14	» 10	1 40.05	69 25 51.5	0.28655	4.922	20.16
» 14	37 14.02	59 47 59.1	0.25554	3.875	20.17	» 11	3 21.73	69 50 58.1	0.28734	4.998	20.12
» 15	37 38.79	60 7 39.7	0.25717	3.897	20.19	» 12	5 8.43	70 16 17.6	0.28811	5.081	20.07
» 16	13 38 5.74	60 27 31.7	0.25876	3.920	20.21	» 13	14 7 0.47	70 41 49.9	0.28885	5.169	20.02

## Ephemeris (Elements A) for Greenwich Mean Noon.\*)

1898	$\alpha$	$\delta$	$\log A$	Red. to app.		1898	$\alpha$	$\delta$	$\log A$	Red. to app.	
				$\alpha$	$\delta$					$\alpha$	$\delta$
Oct. 11	14 <sup>h</sup> 3 <sup>m</sup> 21 <sup>s</sup> .63	69° 50' 33".7	0.28760	5 <sup>s</sup> 00	20 <sup>m</sup> 1	Oct. 31	15 <sup>h</sup> 7 <sup>m</sup> 48 <sup>s</sup> .71	78° 49' 12".5	0.29951	8 <sup>s</sup> 65	17 <sup>m</sup> 1
» 12	5 8.24	70 15 52.6	0.28836	5.08	20.1	Nov. 1.0	14 1.22	79 16 49.4	0.29997	9.07	16.7
» 13	7 0.19	70 41 24.3	0.28911	5.17	20.0	» 1.5	17 19.96	79 30 34.0	»	»	»
» 14	8 57.82	71 7 8.6	0.28984	5.26	20.0	» 2.0	20 47.72	79 44 15.4	0.30043	9.53	16.3
» 15	11 1.52	71 33 5.3	0.29054	5.36	19.9	» 2.5	24 25.08	79 57 53.0	»	»	»
» 16	13 11.73	71 59 14.3	0.29122	5.46	19.9	» 3.0	28 12.72	80 11 26.2	0.30089	10.05	15.7
» 17	15 28.94	72 25 35.2	0.29188	5.57	19.8	» 3.5	32 11.34	80 24 54.3	»	»	»
» 18	17 53.70	72 52 7.5	0.29252	5.69	19.7	» 4.0	36 21.63	80 38 16.5	0.30135	10.62	15.1
» 19	20 26.59	73 18 51.1	0.29314	5.82	19.6	» 4.5	40 44.34	80 51 32.1	»	»	»
» 20	23 8.31	73 45 45.4	0.29374	5.96	19.5	» 5.0	45 20.29	81 4 40.2	0.30180	11.26	14.4
» 21	25 59.62	74 12 49.7	0.29433	6.12	19.4	» 5.5	50 10.39	81 17 39.8	»	»	»
» 22	29 1.41	74 40 3.4	0.29490	6.28	19.2	» 6.0	15 55 15.57	81 30 29.8	0.30225	11.96	13.7
» 23	32 14.65	75 7 25.8	0.29546	6.46	19.1	» 6.5	16 0 36.84	81 43 9.1	»	»	»
» 24	35 40.48	75 34 55.9	0.29601	6.66	18.9	» 7.0	6 15.25	81 55 36.3	0.30270	12.74	12.7
» 25	39 20.18	76 2 32.7	0.29654	6.87	18.8	» 7.5	12 11.87	82 7 50.0	»	»	»
» 26	43 15.21	76 30 15.1	0.29706	7.10	18.6	» 8.0	18 27.82	82 19 48.8	0.30316	13.59	11.7
» 27	47 27.27	76 58 1.6	0.29756	7.35	18.3	» 8.5	25 4.26	82 31 30.9	»	»	»
» 28	51 58.25	77 25 50.6	0.29806	7.63	18.1	» 9.0	32 2.37	82 42 54.4	0.30361	14.51	10.5
» 29	14 56 50.38	77 53 40.3	0.29855	7.94	17.8	» 9.5	39 23.28	82 53 57.4	»	»	»
» 30	15 2 6.23	78 21 28.5	0.29903	8.28	17.5	» 10.0	16 47 8.13	83 4 37.6	0.30407	15.48	9.0

\*) The dates from Nov. 1—30 are given for noon and midnight.

1898	$\alpha$	$\delta$	$\log A$	Red. to app.	
				$\alpha$	$\delta$
Nov. 10.5	16 <sup>h</sup> 55 <sup>m</sup> 17 <sup>s</sup> .93	83° 14' 52".8		+	-
» 11.0	17 3 53.66	83 24 40.6	0.30453	16.48	7".4
» 11.5	12 56.11	83 33 58.2			
» 12.0	22 25.73	83 42 42.7	0.30500	17.47	5.6
» 12.5	32 22.69	83 50 51.3			
» 13.0	42 47.07	83 58 21.0	0.30547	18.38	3.5
» 13.5	17 53 38.26	84 5 8.6			
» 14.0	18 4 55.25	84 11 11.1	0.30595	19.12	1.2
» 14.5	16 36.42	84 16 25.5			+
» 15.0	28 39.56	84 20 48.9	0.30643	19.60	1.3
» 15.5	41 1.95	84 24 18.7			
» 16.0	18 53 40.18	84 26 52.5	0.30693	19.76	3.9
» 16.5	19 6 30.46	84 28 28.4			
» 17.0	19 28.48	84 29 5.0	0.30744	19.48	6.6
» 17.5	32 29.74	84 28 41.3			
» 18.0	45 29.57	84 27 17.0	0.30796	18.84	9.2
» 18.5	19 58 23.37	84 24 52.1			
» 19.0	20 11 6.80	84 21 27.2	0.30849	17.83	11.6
» 19.5	23 35.83	84 17 3.7			
» 20.0	35 46.96	84 11 43.3	0.30903	16.57	13.9
» 20.5	47 37.18	84 5 27.9			
» 21.0	20 59 4.13	83 58 19.8	0.30959	15.17	15.9
» 21.5	21 10 5.99	83 50 21.6			
» 22.0	20 21.55	83 41 35.9	0.31016	13.72	17.6
» 22.5	30 50.09	83 32 5.5			
» 23.0	40 31.37	83 21 53.1	0.31075	12.34	19.0
» 23.5	49 45.55	83 11 1.5			
» 24.0	21 58 33.05	82 59 33.1	0.31135	11.05	20.2
» 24.5	22 6 54.58	82 47 30.5			
» 25.0	14 51.00	82 34 56.3	0.31198	9.91	21.2
» 25.5	22 23.35	82 21 52.5			
» 26.0	29 32.71	82 8 21.2	0.31262	8.90	22.0
» 26.5	36 20.21	81 54 24.5			
» 27.0	42 47.03	81 40 4.1	0.31329	8.03	22.7
» 27.5	48 54.32	81 25 21.8			
» 28.0	22 54 43.23	81 10 19.0	0.31397	7.28	23.2
» 28.5	23 0 14.89	80 54 57.1			
» 29.0	5 30.31	80 39 17.6	0.31468	6.65	23.6
» 29.5	10 30.48	80 23 21.5			
» 30.0	15 16.38	80 7 10.0	0.31541	6.11	24.0
» 30.5	19 48.95	79 50 44.0			
Dec. 1	24 9.01	79 34 4.7	0.31617	5.65	24.3
» 2	32 14.72	79 0 8.8	0.31695	5.26	24.5
» 3	39 39.29	78 25 28.3	0.31776	4.94	24.7
» 4	46 27.74	77 50 8.5	0.31858	4.66	24.9
» 5	52 44.38	77 14 13.6	0.31945	4.43	25.0
» 6	23 58 32.99	76 37 47.6	0.32033	4.23	25.1
» 7	0 3 56.82	76 0 53.7	0.32125	4.06	25.2
» 8	8 58.65	75 23 34.9	0.32219	3.91	25.3
» 9	13 40.94	74 45 53.7	0.32317	3.78	25.4
» 10	18 5.81	74 7 52.3	0.32416	3.68	25.4
» 11	22 15.09	73 29 32.9	0.32520	3.59	25.5
» 12	26 10.40	72 50 57.3	0.32626	3.52	25.5
» 13	29 53.15	72 12 7.2	0.32735	3.46	25.6
» 14	0 33 24.59	71 33 4.3	0.32848	3.40	25.6
1898-99	$\alpha$	$\delta$	$\log A$	Red. to app.	
				$\alpha$	$\delta$
Dec. 15	0 <sup>h</sup> 36 <sup>m</sup> 45 <sup>s</sup> .80	70° 53' 50".0	0.32964	3.36	25".6
» 16	39 57.74	70 14 25.6	0.33083	3.32	25.7
» 17	43 1.24	69 34 52.5	0.33206	3.29	25.7
» 18	45 57.06	68 55 11.9	0.33332	3.26	25.7
» 19	48 45.88	68 15 24.9	0.33461	3.24	25.7
» 20	51 28.30	67 35 32.6	0.33593	3.23	25.7
» 21	54 4.80	66 55 36.1	0.33729	3.21	25.7
» 22	56 35.85	66 15 36.3	0.33868	3.20	25.8
» 23	0 59 1.94	65 35 34.1	0.34011	3.20	25.8
» 24	1 23.47	64 55 30.3	0.34157	3.19	25.8
» 25	3 40.74	64 15 25.9	0.34307	3.19	25.8
» 26	5 54.08	63 35 21.7	0.34459	3.18	25.8
» 27	8 3.78	62 55 18.5	0.34615	3.18	25.8
» 28	10 10.12	62 15 16.9	0.34775	3.19	25.8
» 29	12 13.32	61 35 17.8	0.34937	3.20	25.8
» 30	14 13.61	60 55 21.8	0.35103	3.20	25.8
» 31	16 11.19	60 15 29.7	0.35272	3.21	25.8
» 32	18 6.24	59 35 42.2	0.35445	3.22	25.8
» 33	1 19 58.92	58 55 59.8	0.35622	3.23	25.8
Jan. 1	1 18 8.55	59 35 23.3	0.35445	0.91	6.9
» 2	20 1.22	58 55 41.0	0.35622	0.91	7.0
» 3	21 51.71	58 16 4.4	0.35801	0.92	7.0
» 4	23 40.15	57 36 34.2	0.35983	0.93	7.1
» 5	25 26.67	56 57 11.1	0.36168	0.93	7.1
» 6	27 11.34	56 17 55.6	0.36356	0.94	7.2
» 7	28 54.39	55 38 48.3	0.36547	0.95	7.2
» 8	30 35.84	54 59 49.7	0.36741	0.96	7.3
» 9	32 15.81	54 21 0.3	0.36938	0.97	7.3
» 10	33 54.38	53 42 20.8	0.37138	0.97	7.4
» 11	35 31.64	53 3 51.6	0.37340	0.98	7.4
» 12	37 7.67	52 25 33.3	0.37546	0.99	7.5
» 13	38 42.54	51 47 26.4	0.37754	1.00	7.5
» 14	40 16.32	51 9 31.3	0.37964	1.01	7.6
» 15	41 49.05	50 31 48.5	0.38177	1.02	7.6
» 16	43 20.80	49 54 18.4	0.38392	1.03	7.7
» 17	44 51.62	49 17 1.4	0.38609	1.04	7.7
» 18	46 21.55	48 39 58.0	0.38829	1.05	7.8
» 19	47 50.63	48 3 8.6	0.39051	1.06	7.8
» 20	49 18.91	47 26 33.4	0.39275	1.06	7.9
» 21	50 46.42	46 50 12.7	0.39501	1.07	7.9
» 22	52 13.21	46 14 6.8	0.39729	1.08	8.0
» 23	53 39.30	45 38 16.1	0.39958	1.09	8.0
» 24	55 4.74	45 2 40.8	0.40189	1.10	8.0
» 25	56 29.54	44 27 21.0	0.40423	1.11	8.1
» 26	57 53.74	43 52 17.1	0.40658	1.12	8.1
» 27	1 59 17.37	43 17 29.2	0.40894	1.13	8.2
» 28	2 40.46	42 42 57.5	0.41130	1.14	8.2
» 29	2 3.02	42 8 42.3	0.41371	1.15	8.2
» 30	3 25.09	41 34 43.7	0.41612	1.16	8.3
» 31	4 46.69	41 1 1.7	0.41853	1.17	8.3
Feb. 1	6 7.84	40 27 36.6	0.42096	1.18	8.3
» 2	7 28.56	39 54 28.4	0.42339	1.19	8.4
» 3	8 48.87	39 21 37.3	0.42584	1.20	8.4
» 4	2 10 8.79	38 49 3.4	0.42829	1.20	8.4

1899	$\alpha$	$\delta$	$\log A$	Red. to app.	
				$\alpha$	$\delta$
Feb. 5	2 <sup>h</sup> 11 <sup>m</sup> 28 <sup>s</sup> 33	38° 16' 46" 8	0.43076	1 <sup>s</sup> 21	8" 5
» 6	12 47.52	37 44 47.6	0.43323	1.22	8.5
» 7	14 6.38	37 13 5.8	0.43571	1.23	8.5
» 8	15 24.91	36 41 41.6	0.43819	1.24	8.5
» 9	16 43.14	36 10 35.0	0.44068	1.25	8.6
» 10	18 1.07	35 39 46.0	0.44318	1.26	8.6
» 11	19 18.72	35 9 14.8	0.44567	1.27	8.6
» 12	20 36.09	34 39 1.4	0.44817	1.28	8.6
» 13	21 53.19	34 9 5.8	0.45067	1.28	8.7
» 14	23 10.03	33 39 28.0	0.45317	1.29	8.7
» 15	24 26.61	33 10 8.1	0.45567	1.30	8.7
» 16	25 42.95	32 41 6.0	0.45817	1.31	8.7
» 17	26 59.05	32 12 21.8	0.46067	1.32	8.7
» 18	28 14.91	31 43 55.2	0.46317	1.33	8.8
» 19	29 30.55	31 15 46.4	0.46566	1.33	8.8
» 20	2 30 45.96	30 47 55.2	0.46816	1.34	8.8
Aug. 8	5 13 53.05	0 55 35.0	0.66189	3.00	3.5

1899	$\alpha$	$\delta$	$\log A$	Red. to app.	
				$\alpha$	$\delta$
Aug. 9	5 <sup>h</sup> 14 <sup>m</sup> 19.43	0° 57' 8" 7	0.66153	3 <sup>s</sup> 00	3" 5
» 10	14 45.14	0 58 39.2	0.66116	3.01	3.5
» 11	15 10.16	1 0 6.5	0.66078	3.02	3.4
» 12	15 34.50	1 1 30.7	0.66039	3.03	3.4
» 13	15 58.14	1 2 51.8	0.65998	3.04	3.4
» 14	16 21.08	1 4 10.0	0.65956	3.04	3.4
» 15	5 16 43.31	1 5 25.2	0.65913	3.05	3.4
Sept. 1	5 21 6.36	1 20 15.1	0.65020	3.18	3.2
» 2	21 14.65	1 20 48.1	0.64960	3.19	3.2
» 3	21 22.09	1 21 19.4	0.64899	3.19	3.2
» 4	21 28.67	1 21 49.1	0.64837	3.20	3.2
» 5	21 34.39	1 22 17.2	0.64775	3.20	3.2
» 6	21 39.24	1 22 43.9	0.64712	3.21	3.2
» 7	21 43.22	1 23 9.2	0.64649	3.21	3.2
» 8	21 46.31	1 23 33.1	0.64584	3.22	3.2
» 9	21 48.52	1 23 55.8	0.64520	3.23	3.2
» 10	5 21 49.84	1 24 17.4	0.64456	3.24	3.2

### 3. Observations and Comparison Stars.

The observations of the comet have been taken from the usual sources, but in some cases they have been obtained from manuscript copies supplied by astronomers to whom I am indebted for their courtesy.

As previously mentioned these observations are very numerous and for the most part form good data; in only a few isolated instances was it necessary to reject them.

When investigating the Cordoba observations it was found that several of the differential measures were erroneous in sign; these were corrected and the values of  $\alpha$  or  $\delta$  altered accordingly; the two Cordoba observations dated 1898 Oct. 6 were rejected.

The following catalogues have been consulted for the positions of the comparison stars.

Argelander Oeltzen	Munich
Argentine General Catalogue	Paris
Armagh 1840-75	Radcliffe 1845-60-90
Astronomische Gesellschaft	Schjellerup
Cape 1840-50-60-80-90	St. Helena
Cordoba Zones	Taylor
Gilliss' Zones	Washington Zones
Melbourne 1870-80	Yarnall.

When the position of a star is given in two or more catalogues, the data of each has been combined and weighted according to the usually accepted value of their results. Systematic corrections have not been applied, such refinement being considered unnecessary for this particular discussion.

In forming the star list every care has been exercised. The reduction of the stars place, from the epoch of the catalogue to that desired, has been made by the formulae of Professor Hill adopting the constants of Peters and Struve. The apparent places of the stars have been obtained by applying reductions computed by the formulae and data of the Nautical Almanac.

In several cases the co-ordinates of the stars given in the list are not to be found in the catalogues mentioned, but are either the results of unpublished meridian observations or measures from well determined stars; these latter are denoted by a bracket containing two numbers, the lower of which is the datum star. A few of the star places that are given in the Cape Durchmusterung, also that of Cordoba have been included with a certain amount of diffidence, but the residuals of the observations depending on them are congruous; these residuals however have not been used in the formation of the normal places.

### Observations.

Observatory	1898	*	Com. — st. in $\alpha$	Parall.	Com. — st. in $\delta$	Parall.	$d\alpha$	$p$	$d\delta$	$p$
Lick	June 11.7157	224	+0 <sup>m</sup> 30 <sup>s</sup> 79	—0° 22	+0' 38" 7	+6" 8	—0° 26	3.4	—3" 4	2.8
»	» 11.7574	224	+0 22.27	—0.10	—0 53.7	+7.1	—0.35	3.0	—0.2	2.8
»	» 12.7225	225	—4 9.95	—0.19	—5 3.6	+7.0	—0.19	2.4	—5.0	2.1
Berkeley	» 12.8388	223	+0 11.89	+0.15	+5 21.5	+7.2	[—1.20]	0.0	[+37.7]	0.0
Lick	» 12.9320	223	—0 6.06	+0.38	+1 8.4	+6.2	—0.10	2.4	—3.7	2.1

Observatory	1898	*	Com. — st. in $\alpha$	Parall.	Com. — st. in $\delta$	Parall.	d $\alpha$	$\rho$	d $\delta$	$\rho$
Lick	June 13.7521	221	— 0 <sup>m</sup> 24 <sup>s</sup> 0.1	— 0 <sup>s</sup> 0.9	+ 2' 35".9	+ 7".2	+ 0 <sup>s</sup> 1.4	2.4	— 2".4	2.7
»	» 13.7814	—	—	—	—	+ 7.3	— 0.43	2.0	— 10.8	1.0
Rome	» 14.3697	220	— 2 20.08	— 0.10	— 0 12.2	+ 7.5	— 0.13	2.0	— 2.4	5.0
Arcetri	» 14.3787	217	+ 0 50.06	— 0.08	+ 3 53.4	+ 7.6	+ 0.19	1.0	— 3.8	1.4
»	» 14.3787	220	— 2 21.68	— 0.08	— 0 32.6	+ 7.6	+ 0.14	1.0	— 2.3	1.4
Algiers	» 14.4000	217	+ 0 45.65	— 0.10	+ 3 13.4	+ 7.2	+ 0.15	1.6	+ 4.2	0.7
Hamburg	» 14.4209	220	— 2 30.53	+ 0.02	— 2 13.9	+ 8.4	+ 0.08	1.0	— 7.3	0.5
Paris	» 14.4219	217	+ 0 40.88	— 0.03	+ 2 15.2	+ 7.9	— 0.04	2.0	— 3.6	1.2
Bethlehem	» 14.6719	217	— 0 11.17	+ 0.07	— 7 12.4	+ 7.5	— 0.44	2.0	— 4.7	1.0
Lick	» 14.7033	217	— 0 17.10	— 0.22	— 8 24.5	+ 7.0	— 0.17	2.4	— 6.1	2.1
»	» 14.7763	—	—	—	—	+ 7.3	— 0.27	2.0	— 2.5	1.0
Windsor	» 14.9265	222	— 4 54.64	— 0.28	+ 9 56.0	— 1.4	— 0.27	0.4	— 2.2	0.4
Rome	» 15.3532	219	— 4 15.92	— 0.13	+ 6 14.0	+ 7.5	— 0.32	1.0	— 6.1	2.0
Algiers	» 15.3831	218	— 2 54.08	— 0.13	+ 8 1.0	+ 7.3	— 0.18	1.6	+ 1.2	0.7
»	» 15.4017	218	— 2 57.96	— 0.08	+ 7 17.0	+ 7.3	— 0.16	2.0	— 1.8	0.9
Toulouse	» 15.4100	213	+ 0 20.94	— 0.06	+ 13 17.6	+ 7.7	+ 0.22	0.4	+ 5.4	0.3
Paris	» 15.4216	215	— 0 19.36	— 0.02	— 2 42.2	+ 7.9	[— 0.89]	0.0	[— 13.5]	0.0
Bordeaux	» 15.4227	206	+ 6 14.57	— 0.06	+ 5 0.8	+ 7.8	— 0.30	2.6	+ 0.1	3.0
Besançon	» 15.4249	213	+ 0 17.43	+ 0.02	+ 12 37.9	+ 7.9	— 0.13	3.4	— 0.7	0.9
Hamburg	» 15.4449	213	+ 0 13.02	+ 0.09	+ 11 51.4	+ 8.0	— 0.29	1.0	— 1.8	0.5
Besançon	» 15.4498	213	+ 0 12.25	+ 0.08	+ 11 44.1	+ 7.9	— 0.07	3.4	+ 1.7	0.9
»	» 15.4888	213	+ 0 3.81	+ 0.18	+ 10 14.8	+ 7.6	— 0.29	2.6	+ 0.2	0.6
Bethlehem	» 15.6206	213	— 0 23.33	— 0.07	+ 5 14.5	+ 7.6	— 0.24	2.0	— 2.7	1.0
Lick	» 15.6952	213	— 0 38.54	— 0.23	+ 2 23.6	+ 7.0	— 0.06	3.4	— 6.2	2.8
»	» 15.7712	—	—	—	—	+ 7.4	— 0.19	2.0	— 3.8	1.0
Windsor	» 15.8939	213	— 1 19.81	— 0.35	— 4 50.8	— 1.7	— 0.01	2.4	— 1.9	2.4
Sydney	» 15.9598	213	— 1 34.14	— 0.17	— 7 20.6	— 1.0	— 0.35	0.8	— 2.9	0.7
Algiers	» 16.3841	209	+ 1 14.97	— 0.12	— 11 12.9	+ 7.3	— 0.44	1.6	— 0.1	0.7
Bordeaux	» 16.3886	206	+ 2 56.60	— 0.14	— 1 46.8	+ 7.8	— 0.01	2.6	— 1.0	3.0
Algiers	» 16.4012	209	+ 1 11.31	— 0.08	— 11 52.9	+ 7.4	— 0.45	2.0	— 1.5	0.9
Paris	» 16.4254	211	+ 0 26.29	0.00	— 6 28.9	+ 8.0	— 0.06	1.6	— 1.5	0.8
Besançon	» 16.4496	205	+ 2 43.53	+ 0.10	— 4 6.8	+ 7.9	— 0.11	3.4	— 3.0	1.1
Gottingen	» 16.4756	205	— 0 48.83	+ 0.17	— 6 14.7	+ 7.8	[+ 0.64]	0.0	+ 4.7	0.5
Lick	» 16.7657	210	— 0 7.18	0.00	— 2 6.3	+ 7.4	— 0.28	3.4	— 2.5	2.8
»	» 16.7661	—	—	—	—	+ 7.4	— 0.17	2.0	— 3.2	1.0
»	» 16.7748	210	— 0 8.77	+ 0.03	— 2 25.9	+ 7.4	+ 0.09	2.4	— 1.6	2.7
Berkeley	» 16.8108	205	+ 1 27.30	+ 0.13	— 17 38.6	+ 7.4	— 0.45	1.0	— 6.9	0.5
Windsor	» 16.9416	214	— 5 0.14	— 0.21	— 9 45.0	— 1.0	— 0.11	1.6	+ 3.1	1.6
Algiers	» 17.3765	208	— 1 51.65	— 0.12	+ 0 4.5	+ 7.4	+ 0.23	2.0	+ 1.7	0.9
Bordeaux	» 17.3890	206	— 1 54.23	— 0.10	— 0 29.8	+ 7.8	+ 0.32	2.6	— 4.4	3.0
Algiers	» 17.4013	208	— 1 57.27	— 0.05	— 0 54.6	+ 7.4	— 0.09	2.0	— 2.0	0.9
Strassburg	» 17.4055	208	— 1 58.01	+ 0.01	— 1 5.7	+ 7.9	+ 0.11	2.0	— 3.6	2.9
Paris	» 17.4140	203	— 0 27.66	— 0.01	— 0 16.8	+ 8.0	— 0.23	2.0	— 2.3	1.2
Geneva	» 17.4144	208	— 2 0.03	+ 0.02	— 1 36.5	+ 7.9	— 0.02	0.4	[— 14.6]	0.0
Besançon	» 17.4312	208	— 2 3.87	+ 0.06	— 2 1.8	+ 7.9	— 0.27	3.4	— 4.3	0.2
Bamberg	» 17.4591	204	— 0 48.83	+ 0.16	— 6 14.7	+ 8.0	— 0.24	1.0	[+ 16.3]	0.0
Berkeley	» 17.7487	202	— 0 34.46	— 0.04	+ 7 14.7	+ 7.5	— 0.44	1.0	— 7.2	0.5
Lick	» 17.7609	—	—	—	—	+ 7.5	— 0.15	2.0	— 3.2	1.0
»	» 17.8100	201	— 0 8.44	+ 0.15	— 2 50.2	+ 7.5	— 0.18	2.6	— 2.2	2.3
»	» 17.8260	201	— 0 11.89	+ 0.20	— 3 30.8	+ 7.2	— 0.21	1.8	— 7.6	2.1
»	» 17.8317	201	— 0 14.39	+ 0.23	— 3 53.0	+ 7.1	— 0.18	2.6	— 2.9	2.3
Rome	» 18.3581	207	— 4 48.99	— 0.08	— 0 51.5	+ 7.7	+ 0.06	1.0	— 4.5	2.0
Munich	» 18.3779	200	— 0 58.10	— 0.03	+ 4 43.4	+ 8.0	+ 0.35	1.0	— 2.0	0.5
Arcetri	» 18.3792	200	— 0 58.58	— 0.03	+ 4 40.8	+ 7.8	+ 0.14	1.8	— 2.1	1.4
Toulouse	» 18.3845	198	+ 0 37.62	— 0.09	— 12 59.7	+ 7.8	+ 0.68	0.4	— 1.0	0.3
Algiers	» 18.3881	200	— 1 0.48	— 0.07	+ 4 21.9	+ 7.5	— 0.10	2.0	— 1.6	0.9

Observatory	1898	*	Com. — st. in $\alpha$	Parall.	Com. — st. in $\delta$	Parall.	$d\alpha$	$p$	$d\delta$	$p$
Bordeaux	June 18.3906	200	—1 <sup>m</sup> 0 <sup>s</sup> 86	—0 <sup>s</sup> 09	+ 4' 12 <sup>s</sup> 3	+7 <sup>s</sup> 9	+0 <sup>s</sup> 22	2.6	—5 <sup>s</sup> 3	3.0
Munich	» 18.4062	200	—1 4.15	—0.05	+ 3 42.1	+8.1	+0.28	1.0	—1.0	0.5
Algiers	» 18.4077	200	—1 4.86	—0.01	+ 3 39.3	+7.5	—0.07	2.0	—1.1	0.9
Padua	» 18.4252	200	—1 8.53	+0.11	+ 3 1.9	+7.8	+0.10	0.6	+0.4	1.5
Cordoba	» 18.4906	200	—1 22.48	—0.34	+ 0 43.2	—1.0	—0.41	1.2	—3.1	1.1
»	» 18.5217	200	—1 28.34	—0.25	— 0 9.9	—0.7	+0.44	1.2	[+12.6]	0.0
Lick	» 18.7420	197	—0 4.05	—0.04	— 5 2.0	+7.5	+0.16	2.6	—1.3	2.3
»	» 18.7498	197	—0 5.60	—0.01	— 5 22.1	+7.5	+0.32	1.8	—4.2	2.1
»	» 18.7557	—	—	—	—	+7.5	—0.57	2.0	—3.9	1.0
»	» 18.7586	199	—0 43.70	+0.01	+ 2 40.5	+7.5	+0.35	2.6	—6.0	2.3
Bordeaux	» 19.4023	194	+1 35.54	—0.04	— 3 19.4	+7.9	0.00	2.6	—4.7	3.0
Arcetri	» 19.4140	194	+1 33.12	+0.09	— 3 44.4	+7.8	+0.18	1.0	—4.4	1.4
»	» 19.4140	196	+1 2.23	+0.09	—11 15.1	+7.8	+0.44	1.0	—2.7	1.4
Lick	» 19.7300	195	+0 5.92	—0.07	+ 7 29.2	+7.5	+0.20	2.6	+0.4	2.3
Arcetri	» 20.3775	188	+1 19.04	0.00	+15 20.4	+7.9	+0.09	2.2	—5.2	1.4
Strassburg	» 20.3836	187	+2 26.47	—0.01	— 1 29.4	+8.0	—0.31	2.0	—0.7	2.9
»	» 20.3836	191	—0 34.25	—0.01	+ 0 15.5	+8.0	+0.05	2.0	—4.4	2.9
Rio	» 20.3911	188	+1 16.59	—0.45	+15 0.7	—0.2	—0.10	0.6	—7.0	0.3
Bordeaux	» 20.3971	193	—1 45.18	—0.04	+ 1 31.0	+7.9	+0.11	2.6	—2.2	3.0
Besançon	» 20.4039	193	—1 46.57	+0.03	+ 1 16.2	+8.8	+0.25	3.4	—1.5	1.1
Padua	» 20.4167	191	—0 41.37	+0.11	— 0 51.7	+7.9	[—0.84]	0.0	—0.2	3.0
»	» 20.4352	193	—1 53.42	+0.16	+ 0 10.4	+7.7	+0.23	0.6	—1.1	1.5
Washington	» 20.6477	188	+0 21.30	+0.16	+ 5 43.5	+7.6	+0.39	1.0	—1.8	0.5
Denver	» 20.7168	188	+0 6.17	+0.05	+ 3 13.2	+7.7	—0.04	1.6	—3.6	2.9
Lick	» 20.7454	—	—	—	—	+7.6	—0.12	2.0	—3.8	1.0
Denver	» 20.7549	183	+4 19.27	+0.17	— 3 38.0	+7.5	—0.19	2.6	—2.7	2.9
»	» 20.7711	193	—3 5.56	+0.21	— 1 52.6	+7.4	+0.10	2.6	—3.9	2.9
Lick	» 20.7768	188	—0 6.72	+0.10	+ 1 4.6	+7.5	—0.03	2.6	—4.4	2.3
Cape	» 21.3530	—	—	—	—	0.0	—0.25	2.6	—4.8	2.0
Arcetri	» 21.3730	186	—0 19.95	0.00	+13 16.5	+7.9	+0.07	2.6	—5.3	1.4
Padua	» 21.3858	189	—2 23.63	+0.04	— 4 52.3	+7.9	—0.09	0.6	—1.9	1.7
Strassburg	» 21.3901	189	—2 24.12	+0.06	— 5 5.4	+8.0	+0.35	0.8	—5.8	1.5
»	» 21.3901	190	—3 44.48	+0.06	+ 2 9.9	+8.0	+0.21	0.8	—6.1	1.5
Bordeaux	» 21.4012	189	—2 26.68	—0.03	— 5 26.3	+8.0	+0.10	2.6	—3.0	3.0
Windsor	» 21.9273	184	—0 33.11	—0.18	— 2 46.6	—0.5	—0.09	1.6	+0.2	1.6
Cape	» 22.3478	—	—	—	—	0.0	+0.07	2.6	—3.7	2.0
Rome	» 22.3579	185	—3 43.44	—0.02	— 7 3.2	+7.8	+0.15	1.8	—2.3	4.0
Arcetri	» 22.3670	181 <sup>a</sup>	+0 1.06	0.00	— 1 54.0	+7.9	+0.57	2.2	—1.9	2.0
Rio	» 22.3856	184	—2 11.77	—0.44	—18 25.5	—0.1	[—0.61]	0.0	[+19.9]	0.0
Padua	» 22.4025	181 <sup>a</sup>	—0 7.40	+0.10	— 3 6.8	+7.9	—0.16	1.0	—0.2	1.5
Washington	» 22.6686	182	—1 4.58	+0.18	+ 5 16.0	+7.5	+0.41	1.0	—6.1	0.5
Flowers	» 22.7082	182	—1 13.46	+0.29	+ 3 53.6	+7.0	+0.15	1.0	—6.5	0.5
Denver	» 22.7295	179	+1 7.75	+0.13	+ 7 37.6	+7.6	+0.18	2.6	—3.1	1.9
Lick	» 22.7350	—	—	—	—	+7.6	—0.39	2.0	—5.1	1.0
Denver	» 22.7491	182	—1 22.10	+0.18	+ 2 34.0	+7.5	+0.19	2.8	—0.5	2.9
»	» 22.7759	175	+3 29.45	+0.26	+12 46.6	+7.2	+0.05	3.2	—2.3	2.9
Lick	» 22.7783	181	—0 17.96	+0.13	+ 1 37.3	+7.5	+0.03	2.6	—3.7	2.3
Sydney	» 22.9401	179	+0 22.46	—0.12	+ 0 27.4	—0.3	—0.14	1.2	—3.8	1.2
»	» 22.9758	—	—	—	—	—0.2	—0.16	1.2	—5.8	0.4
Bordeaux	» 23.4053	178	—1 17.59	—0.03	— 0 49.3	+8.0	+0.05	2.6	—3.2	3.0
Rio	» 23.4477	178	—1 17.10	—0.24	— 2 11.7	—1.0	[—0.57]	0.0	[—11.9]	0.0
Flowers	» 23.6509	176	—0 11.42	+0.15	— 2 11.2	+7.5	+0.10	1.0	—3.2	0.5
Denver	» 23.6964	176	—0 21.06	+0.04	— 3 45.4	+7.7	+0.09	3.2	—3.9	2.3
Lick	» 23.6997	176	—0 21.88	—0.10	— 3 51.4	+7.6	—0.14	2.6	—3.3	2.3
»	» 23.7079	176	—0 23.63	—0.08	— 4 8.7	+7.6	—0.01	1.8	—3.3	2.1
Denver	» 23.7127	172	+1 36.97	+0.09	— 8 51.3	+7.7	[+1.39]	0.0	+4.9	2.9

Observatory	1898	*	Com. — st. in $\alpha$	Parall.	Com. — st. in $\delta$	Parall.	$d\alpha$	$p$	$d\delta$	$p$
Lick	June 23.7298	—	—	—	—	+7.6	-0.18	2.0	-2.0	1.0
Denver	» 23.7349	178	- 2 <sup>m</sup> 18.29	+0.16	-12' 7.4	+7.5	+0.29	3.2	-5.4	2.9
Windsor	» 23.8494	176	- 0 53.56	-0.38	- 8 49.4	-1.2	+0.01	3.0	-3.8	3.0
Sydney	» 23.9377	173	+ 0 38.98	-0.11	+ 7 33.0	-0.2	-0.27	1.2	+2.8	1.2
»	» 23.9706	—	—	—	—	-0.1	-0.03	1.2	+3.4	0.4
Rome	» 24.3517	169	- 0 7.20	-0.01	+ 2 23.0	+7.8	+0.47	2.0	-4.2	4.0
Arcetri	» 24.3945	169	- 0 16.51	+0.11	+ 0 56.3	+7.8	+0.44	1.0	-4.4	2.0
»	» 24.3945	170	- 0 43.26	+0.11	- 8 25.2	+7.8	+0.53	1.0	-1.2	1.4
»	» 24.3945	173	- 0 58.27	+0.11	- 8 6.6	+7.8	+0.65	1.0	-0.7	1.4
Denver	» 24.6995	164	+ 2 21.74	+0.07	- 2 34.4	+7.7	+0.25	3.2	-2.9	2.9
Lick	» 24.7106	166	+ 0 39.62	-0.05	+ 1 54.6	+7.6	+0.34	1.8	-2.1	2.1
Denver	» 24.7115	174	- 2 17.97	+0.10	+ 2 58.9	+7.7	+0.29	3.2	-2.3	2.9
Lick	» 24.7188	166	+ 0 37.62	-0.02	+ 1 38.5	+7.6	+0.12	2.6	-1.5	2.3
Denver	» 24.7241	166	+ 0 36.34	+0.14	+ 1 27.4	+7.6	+0.15	3.2	-2.0	2.3
Lick	» 24.7245	—	—	—	—	+7.6	-0.56	1.2	-8.2	0.5
Windsor	» 24.8683	174	- 2 51.60	-0.31	- 2 6.9	-0.7	-0.19	2.0	-1.3	2.0
»	» 24.8683	177	- 5 43.74	-0.31	+ 6 6.0	-0.7	-0.01	2.0	-0.7	2.0
Cape	» 25.3322	—	—	—	—	0.0	+0.24	2.6	-6.7	2.0
Rio	» 25.4876	177	- 7 54.42	-0.08	-13 46.5	-1.4	[+1.97]	0.0	[+37.4]	0.0
Lick	» 25.7194	—	—	—	—	+7.6	-0.29	0.6	-7.2	0.5
Denver	» 25.7339	161	+ 1 35.99	+0.19	+13 5.2	+7.5	+0.43	3.2	+0.6	2.9
»	» 25.7453	167	- 3 3.65	+0.22	+ 7 45.6	+7.4	+0.43	3.2	-2.3	2.9
»	» 25.7594	180	-10 10.09	+0.26	+ 6 6.9	+7.2	+0.34	3.2	+0.3	2.9
Lick	» 26.7014	159	- 0 44.43	-0.04	+ 4 37.3	+7.8	+0.37	3.2	-2.3	2.7
»	» 26.7121	159	- 0 46.84	-0.01	+ 4 17.4	+7.6	+0.21	1.6	-1.7	2.7
Windsor	» 26.8631	159	- 1 18.97	-0.30	- 0 26.7	-0.5	-0.07	1.6	-1.5	1.6
»	» 26.8631	160	- 1 44.65	-0.30	+ 1 0.9	-0.5	-0.06	1.6	-2.2	1.6
»	» 26.8631	163	- 4 31.69	-0.30	+ 4 34.7	-0.5	-0.08	1.6	-1.9	1.6
Sydney	» 26.9550	—	—	—	—	+0.1	+0.51	1.2	-0.4	0.4
Rome	» 27.3638	162	- 5 29.92	+0.08	- 1 2.8	+7.8	+0.27	1.0	-2.6	4.0
Arcetri	» 27.4302	158	+ 0 52.19	+0.25	- 9 52.4	+7.4	[+1.24]	0.0	+4.1	0.7
Lick	» 27.7090	—	—	—	—	+7.6	-0.06	2.0	-10.0	0.5
Denver	» 27.7255	156	+ 1 22.79	+0.19	+15 10.4	+7.5	+0.51	3.2	-2.7	2.9
»	» 27.7384	165	-10 0.62	+0.23	+ 0 16.0	+7.3	+0.53	3.2	-3.6	2.9
»	» 27.7583	168	- 9 15.17	+0.28	+10 10.2	+7.1	+0.52	3.2	-4.7	2.9
Windsor	» 27.8553	156	+ 0 55.40	-0.31	+11 12.1	-0.5	+0.05	2.0	-2.7	2.0
Arcetri	» 28.3954	154	+ 1 41.70	+0.17	+10 7.0	+7.7	+0.53	1.0	-7.0	1.4
»	» 28.3954	155	+ 0 53.95	+0.17	+ 4 41.3	+7.7	+0.64	1.0	-5.1	1.4
Lick	» 28.7038	—	—	—	—	+7.6	-0.08	0.6	[-14.0]	0.0
Denver	» 28.7568	154	+ 0 25.51	+0.30	- 1 0.5	+7.0	+0.33	3.2	-1.6	3.9
»	» 28.7682	155	- 0 22.76	+0.32	- 6 46.6	+6.9	+0.34	3.2	+0.6	3.9
Windsor	» 28.8454	151	+ 4 23.62	-0.32	+ 4 21.3	-0.5	+0.29	0.4	-1.0	0.4
»	» 28.8454	154	+ 0 7.32	-0.32	- 3 37.6	-0.5	+0.12	0.4	-1.4	0.4
Denver	» 30.6567	150	- 1 21.58	+0.03	- 1 44.6	+7.7	+0.21	3.2	-3.6	2.9
»	» 30.6673	149	- 1 10.79	+0.06	- 9 29.5	+7.6	+0.27	3.2	-2.2	2.9
»	» 30.6792	152	- 2 26.29	+0.10	+ 7 53.6	+7.6	+0.48	3.2	-3.8	2.9
Cape	July 1.3011	—	—	—	—	0.0	[-0.61]	0.0	-6.4	2.0
»	» 2.2960	—	—	—	—	+0.1	+0.36	2.6	-4.4	2.0
Windsor	» 2.8475	146	- 1 56.00	-0.26	- 7 13.8	+0.1	+0.49	1.6	-3.0	1.6
»	» 2.8475	147	- 4 21.39	-0.26	- 8 32.5	+0.1	+0.39	1.6	-4.1	1.6
»	» 2.8475	148	- 4 40.17	-0.26	- 3 17.4	+0.1	+0.46	1.6	-4.1	1.6
Rome	» 3.3549	144	+ 5 11.84	+0.15	+ 3 43.3	+7.6	+0.78	1.4	-3.1	4.0
Sydney	» 3.9695	145	- 0 11.10	+0.17	- 2 47.8	+0.4	+0.59	0.6	-9.3	0.4
Windsor	» 4.8713	143	+ 0 41.03	-0.15	+ 9 1.2	+0.5	+0.41	2.0	-4.0	2.0
Sydney	» 4.9141	—	—	—	—	+0.6	+0.59	1.2	-8.1	0.4
Denver	» 5.6784	143	- 1 56.41	+0.18	-12 31.7	+7.3	+0.56	1.6	-0.3	1.5



Observatory	1898	*	Com. — st. in $\alpha$	Parall.	Com. — st. in $\delta$	Parall.	$d\alpha$	$\rho$	$d\delta$	$\rho$
Windsor	July 5.8548	142	— 0 <sup>m</sup> 50 <sup>s</sup> 67	— 0 <sup>s</sup> 19	+ 1' 49".1	+ 0".5	+ 0 <sup>s</sup> 32	2.0	— 2".0	2.0
Sydney	» 5.9091	—	—	—	—	+ 0.7	+ 0.56	1.2	— 8.6	0.4
Cordoba	» 6.5761	140	— 1 45.95	+ 0.30	+ 6 2.6	+ 0.6	+ 1.02	1.4	[— 28.1]	0.0
Windsor	» 6.8646	136	+ 7 44.47	— 0.14	— 7 17.7	+ 0.6	+ 0.04	1.4	— 3.9	1.4
Sydney	» 6.9041	—	—	—	—	+ 0.7	+ 0.60	1.2	— 10.0	0.4
Windsor	» 7.8528	137	+ 2 39.51	— 0.16	— 2 40.5	+ 0.6	+ 0.35	2.0	+ 1.2	2.0
»	» 7.8528	139	— 0 57.49	— 0.16	— 1 39.5	+ 0.6	+ 0.17	2.0	+ 2.4	2.0
Cape	» 8.2660	—	—	—	—	+ 0.1	+ 0.32	2.6	— 1.1	2.0
Denver	» 8.6555	138	— 2 31.09	+ 0.15	+ 1 41.5	+ 7.3	+ 0.68	3.2	— 1.0	2.9
»	» 8.6727	134	+ 4 14.22	+ 0.20	+ 3 51.9	+ 7.1	+ 0.38	3.2	— 3.4	2.9
Windsor	» 9.8464	132	+ 3 12.89	— 0.14	+ 1 58.5	+ 0.8	— 0.14	1.6	— 5.2	1.6
Cordoba	» 10.6347	135	— 2 16.50	+ 0.53	+ 2 31.0	— 0.5	+ 0.55	0.6	— 7.1	0.6
Windsor	» 10.8559	135	— 2 54.45	— 0.10	— 2 23.0	+ 0.9	+ 1.06	1.6	[+ 9.4]	0.0
Sydney	» 10.9982	135	— 3 20.80	+ 0.36	— 5 50.2	— 0.1	+ 0.23	1.0	— 0.7	0.9
Cordoba	» 11.6691	129	+ 1 52.49	+ 0.59	+ 8 47.6	— 0.7	+ 1.33	1.4	+ 2.9	1.2
Windsor	» 11.9630	129	+ 1 0.95	+ 0.27	+ 2 0.1	+ 0.5	+ 0.82	2.4	— 3.3	2.4
Cordoba	» 12.5887	129	— 0 45.59	+ 0.41	— 12 22.3	+ 0.3	+ 0.85	1.4	[— 22.9]	0.0
Sydney	» 12.8750	—	—	—	—	+ 1.0	+ 0.14	1.2	— 3.0	0.4
»	» 12.9466	131	— 3 56.06	+ 0.24	— 6 47.8	+ 0.6	+ 0.48	1.2	— 1.3	1.0
Windsor	» 12.9557	130	— 1 55.60	+ 0.26	— 6 20.1	+ 0.7	+ 0.45	2.0	— 2.5	2.0
»	» 12.9557	131	— 3 57.78	+ 0.26	— 7 2.9	+ 0.7	+ 0.32	2.0	— 4.3	2.0
Sydney	» 12.9714	130	— 1 58.22	+ 0.31	— 6 37.5	+ 0.3	+ 0.52	0.8	+ 0.6	0.7
Cordoba	» 13.6409	128	— 1 51.71	+ 0.55	— 4 16.9	— 0.8	+ 1.02	1.6	+ 0.3	1.5
Lick	» 13.7033	127	+ 0 34.45	+ 0.23	— 1 42.5	+ 6.8	+ 0.55	2.6	— 3.2	2.3
Windsor	» 13.9710	122	+ 2 37.13	+ 0.32	— 8 10.5	+ 0.3	+ 0.51	2.0	— 4.5	2.0
Sydney	» 13.9774	122	+ 2 36.17	+ 0.34	— 8 20.1	+ 0.2	+ 0.63	1.2	— 5.8	1.0
Cordoba	» 14.5676	126	— 0 47.34	+ 0.37	— 6 18.6	+ 0.5	+ 0.61	1.6	+ 0.6	1.5
Lick	» 14.6923	123	— 0 9.30	+ 0.21	— 2 36.1	+ 6.8	+ 0.48	2.6	+ 1.9	2.3
Sydney	» 14.8657	—	—	—	—	+ 1.1	+ 0.87	1.2	— 3.2	0.4
»	» 14.9440	121	+ 0 9.80	+ 0.26	— 1 32.8	+ 0.6	+ 0.90	1.2	— 0.8	1.2
Windsor	» 14.9603	125	— 1 28.59	+ 0.30	+ 5 30.9	+ 0.4	+ 0.47	2.0	+ 2.4	2.0
Sydney	» 14.9665	125	— 1 29.71	+ 0.32	+ 5 21.1	+ 0.3	+ 0.36	1.2	+ 0.4	1.2
Cordoba	» 15.6285	120	+ 0 4.83	+ 0.53	+ 3 56.3	— 0.7	+ 1.01	1.6	+ 2.7	1.5
»	» 16.5479	119	— 1 6.60	+ 0.33	— 8 29.1	+ 0.8	+ 0.63	1.8	+ 0.4	1.7
»	» 17.6109	118	— 1 17.16	+ 0.50	— 3 38.7	— 0.4	+ 0.95	1.6	— 0.6	1.5
Windsor	» 17.9741	115	+ 2 42.52	+ 0.37	+ 7 19.0	+ 0.1	+ 0.52	2.0	+ 0.9	2.0
Cape	» 18.2190	—	—	—	—	+ 0.1	+ 0.45	2.6	— 3.2	2.0
Cordoba	» 18.5535	115	+ 1 17.69	+ 0.36	— 4 3.2	+ 0.6	+ 0.98	1.4	— 3.5	1.2
Lick	» 18.6931	116	+ 0 5.69	+ 0.27	— 7 40.3	+ 6.4	[+ 1.98]	0.0	+ 6.0	0.5
Windsor	» 18.9616	117 <sup>a</sup>	— 4 10.59	+ 0.35	— 1 40.0	+ 0.3	+ 0.43	2.0	+ 5.9	1.0
Cordoba	» 19.6230	113	+ 1 8.12	+ 0.52	+ 2 58.0	— 0.1	+ 0.99	1.4	+ 0.9	1.2
Lick	» 19.6934	113	—	—	+ 1 21.4	+ 6.3	—	—	— 8.5	1.0
»	» 19.7007	114	+ 0 33.88	+ 0.30	— 4 10.4	+ 6.2	+ 1.29	0.6	— 2.2	2.3
Windsor	» 19.9391	107	+ 3 26.87	+ 0.30	— 4 34.3	+ 0.6	+ 0.85	1.6	— 2.2	1.6
Cordoba	» 20.5300	112	— 0 38.97	+ 0.31	— 1 30.0	+ 0.9	+ 1.16	1.0	— 2.7	0.8
»	» 20.5491	112	— 0 41.60	+ 0.36	— 1 50.4	+ 0.6	+ 1.21	0.8	— 1.8	0.7
Windsor	» 20.9391	103	+ 3 45.89	+ 0.32	— 2 45.4	+ 0.5	+ 0.81	1.2	— 0.2	1.2
»	» 20.9391	117	— 5 52.98	+ 0.32	+ 7 0.2	+ 0.5	+ 0.62	1.2	— 0.6	1.2
Cordoba	» 21.6305	111	— 1 32.45	+ 0.53	+ 1 17.2	— 1.2	+ 0.97	1.4	— 2.7	1.2
Windsor	» 21.9490	100	+ 2 51.97	+ 0.35	+ 10 0.9	+ 0.3	+ 0.25	1.8	+ 0.5	1.8
Cordoba	» 22.6023	108	— 2 36.11	+ 0.49	— 0 28.3	— 0.6	+ 1.13	1.4	— 0.7	1.2
»	» 23.6348	102	— 2 2.99	+ 0.53	— 5 57.4	— 1.4	+ 0.81	1.4	— 2.1	1.2
Windsor	» 23.8936	106	— 4 21.08	+ 0.22	+ 3 47.0	+ 1.0	+ 0.57	2.0	+ 0.7	2.0
Cordoba	» 24.5309	96	— 0 14.38	+ 0.35	+ 6 29.0	+ 0.7	+ 0.73	1.0	— 5.5	1.0
»	» 24.5524	96	— 0 17.32	+ 0.29	+ 6 7.2	+ 1.0	+ 0.35	0.6	— 4.2	0.6
»	» 25.6218	99	— 3 32.56	+ 0.52	— 0 44.3	— 1.3	+ 0.99	1.0	+ 2.5	1.0

Observatory	1898	*	Com. — st. in $\alpha$	Parall.	Com. — st. in $\delta$	Parall.	$d\alpha$	$p$	$d\delta$	$p$
Windsor	July 25 9522	98	— 4 <sup>m</sup> 4 <sup>s</sup> 53	+0 <sup>s</sup> 40	— 9' 0 <sup>"</sup> 1	+0 <sup>"</sup> 1	+0 <sup>s</sup> 85	2.0	+2 <sup>"</sup> 2	2.0
Cordoba	» 26.5378	92	+ 2 20.80	0.38	— 5 14.1	+0.5	+0.74	1.0	— 1.5	0.8
»	» 26.5378	94	— 1 37.49	0.38	+ 1 42.0	+0.5	+0.87	1.0	— 3.7	0.8
Windsor	» 26.9284	101	— 7 59.06	0.35	+10 37.5	+0.5	+0.24	0.8	+4.9	0.8
»	» 26.9284	104	— 9 31.49	0.35	+10 56.1	+0.5	+0.19	0.8	+3.9	0.8
»	» 26.9284	109	— 11 21.94	0.35	+ 2 54.3	+0.5	+0.23	0.8	+1.1	0.8
»	» 27 9490	90	+ 0 35.79	0.41	+ 7 17.3	+0.4	+1.27	2.0	— 0.2	2.0
»	» 27.9490	95	— 5 32.08	+0.41	+ 7 47.4	+0.4	+1.05	2.0	— 0.5	2.0
Cordoba	» 28.5240	90	— 0 25.93	+0.51	— 2 26.5	+0.6	+1.21	1.4	— 2.4	1.2
»	» 30.5637	84	+ 0 5.55	0.46	+ 4 1.2	— 0.3	+1.01	1.2	— 3.9	1.1
Windsor	» 30.9331	84	— 0 30.11	0.39	— 1 58.4	+0.2	+1.28	2.0	+1.2	2.0
»	» 30.9331	89	— 4 11.47	0.39	+ 9 8.6	+0.2	+1.36	2.0	+3.9	2.0
»	» 31.9556	89	— 5 48.71	0.44	— 7 37.0	— 0.3	+1.28	1.6	+0.6	1.6
Cordoba	Aug. 2.4834	77	+ 4 1.97	0.31	+ 8 16.9	+1.1	+1.37	0.8	— 4.9	1.2
Windsor	» 4.9225	71	+ 3 0.04	0.41	— 5 7.5	+0.1	+0.07	1.0	— 0.3	3.0
»	» 4.9225	74	+ 1 19.63	0.41	+ 2 40.5	+0.1	+0.04	1.0	— 0.5	3.0
»	» 5.9176	72	+ 0 59.66	0.40	— 7 33.7	+0.2	+0.97	0.2	+0.9	0.3
»	» 8.9278	51	+ 6 34.72	0.44	+ 5 8.0	— 0.2	+0.84	0.6	+1.4	1.8
»	» 8.9278	58	+ 4 12.27	0.44	+ 6 36.7	— 0.2	+0.74	0.6	+1.9	1.8
»	» 10.8953	78	— 6 57.67	0.39	— 10 21.9	+0.4	+0.03	0.4	+0.7	1.2
»	» 11.8876	67	— 1 22.28	+0.38	+ 6 39.9	+0.5	+1.85	0.6	+0.8	2.1
Cordoba	» 12.4864	57	+ 0 50.64	+0.40	+ 3 11.9	+0.6	+1.21	1.2	— 0.2	2.0
»	» 13.5178	45	+ 3 10.41	0.46	+11 6.2	— 0.1	+0.57	1.0	[— 12.8]	0.0
Windsor	» 13.9009	45	+ 2 51.47	0.42	+ 5 18.0	+0.1	+1.08	1.0	+2.1	3.0
Cordoba	» 15.5370	65	— 4 8.32	0.49	— 0 3.0	— 0.6	+0.89	0.8	—	—
»	» 16.4767	28	+ 3 37.40	0.40	+ 4 23.8	+0.6	+0.95	0.8	— 0.3	1.5
Windsor	» 16.9005	42	+ 1 9.32	0.43	+10 15.6	0.0	+0.79	1.0	+2.5	3.0
Cordoba	» 17.5018	31	+ 2 26.51	0.45	— 2 52.4	0.0	+0.97	0.8	— 1.5	1.3
»	» 17.5018	48	— 0 19.96	0.45	— 1 30.2	0.0	+1.03	0.8	+0.4	1.3
Windsor	» 18.8895	43	— 0 10.21	0.43	— 8 59.3	+0.1	+0.75	1.0	+4.4	3.0
»	» 19.8842	62	— 6 35.62	0.42	— 6 52.5	+0.2	+0.37	1.0	+3.0	3.0
»	» 19.8842	63	— 6 37.63	0.42	— 6 46.5	+0.2	+0.24	1.0	+3.0	3.0
Cordoba	» 20.4623	47	— 1 55.56	0.40	+11 54.3	+0.7	+1.56	0.8	+3.3	1.3
Windsor	» 20.8987	47	— 2 10.09	0.45	+ 4 48.4	— 0.2	+0.78	1.0	— 0.1	3.0
Cape	» 21.2282	36	— 0 30.43	0.38	+ 0 54.4	+0.5	+1.06	0.6	— 0.9	0.6
Cordoba	» 21.5441	13	+ 4 36.31	0.51	+ 4 53.1	— 1.1	+0.87	0.6	+1.6	1.2
»	» 21.5441	47	— 2 29.37	0.51	— 5 38.6	— 1.1	+0.88	0.6	+0.1	1.2
Windsor	» 21.9025	13	+ 4 26.29	0.46	— 0 56.1	— 0.3	+1.11	1.0	+2.4	3.0
Cape	» 22.2485	34	— 0 16.57	0.43	— 2 24.7	+0.1	[+0.44]	0.0	[— 3.2]	0.0
Cordoba	» 22.4875	13	+ 4 9.83	0.45	— 10 27.4	+0.1	+0.67	0.6	+4.3	1.2
Windsor	» 22.8870	32	— 0 30.87	0.44	— 0 54.4	0.0	+0.98	1.0	+3.2	3.0
Cape	» 23.2365	33	— 0 40.96	0.41	— 4 15.0	+0.3	+1.51	0.4	+2.0	0.7
Cordoba	» 25.4995	19	+ 1 13.73	0.48	+ 5 27.9	— 0.3	+1.16	1.0	— 2.4	1.7
Windsor	» 25.8961	19	+ 1 6.40	0.47	— 1 2.2	— 0.3	+1.26	1.0	+4.2	3.0
Cordoba	» 27.5294	12	+ 3 29.56	+0.51	— 0 41.5	— 1.1	+1.33	1.0	+1.8	1.7
Windsor	Sept. 5.8859	11	+ 3 5.40	+0.50	— 8 28.3	— 0.6	+1.06	1.0	+9.1	3.0
»	» 5.8859	26	— 1 38.19	0.50	— 10 10.5	— 0.6	+0.78	1.0	+7.9	3.0
Cape	» 6.2565	18	+ 0 11.39	0.50	+ 4 57.1	— 0.7	+1.36	0.6	+5.3	0.5
»	» 6.2565	22	— 0 31.94	0.50	— 1 18.9	— 0.7	+1.62	0.6	+3.5	0.5
Cordoba	» 6.4880	14	+ 1 37.22	0.52	— 1 12.3	— 0.6	+1.22	0.4	+7.4	0.7
»	» 6.4880	22	— 0 30.42	0.52	— 5 28.3	— 0.6	+1.12	0.4	+7.9	0.7
Windsor	» 6.9037	14	+ 1 40.46	0.52	— 8 50.1	— 1.0	+1.11	0.4	+5.9	1.2
Cordoba	» 7.4785	10	+ 3 44.36	0.52	+ 3 37.9	— 0.4	+0.94	0.6	+6.3	0.9
»	» 7.4785	37	— 3 24.62	0.52	— 0 4.2	— 0.4	+1.24	0.6	+7.3	0.9
Windsor	» 7.8873	9	+ 4 5.39	+0.51	+ 2 12.5	— 0.7	+0.69	0.8	+7.4	2.4

Observatory	1898	*	Com. — st. in $\alpha$	Parall.	Com. — st. in $\delta$	Parall.	$d\alpha$	$p$	$d\delta$	$p$
Windsor	Sept. 7.8873	37	$-3^m 21^s .06$	$+0^s .51$	$-7' 37'' .8$	$-0'' .7$	$+0^s .63$	0.8	$+6'' .5$	2.4
Cordoba	» 8.5151	9	$+4 12.94$	0.52	$-9 26.0$	1.3	$+1.21$	0.8	$+7.6$	1.3
»	» 9.4652	20	$+0 36.59$	0.51	$-4 37.4$	0.2	$+1.62$	1.0	$+5.5$	1.7
Windsor	» 9.8771	20	$+0 43.28$	0.52	$-12 14.4$	0.6	$[+2.36]$	0.0	$[+13.1]$	0.0
Cordoba	» 10.5030	16	$+1 43.06$	0.54	$+2 9.4$	1.1	$+0.24$	0.8	$+3.1$	1.3
»	» 10.5030	27	$-1 2.11$	0.54	$+2 50.2$	1.1	$+0.39$	0.8	$+4.1$	1.3
Windsor	» 10.8838	16	$+1 50.19$	0.52	$-5 4.3$	0.7	$+1.01$	1.0	$+3.7$	3.0
»	» 10.8838	27	$-0 55.18$	0.52	$-4 22.0$	0.7	$+0.95$	1.0	$+6.2$	3.0
Cordoba	» 11.4752	15	$+2 26.44$	0.53	$-8 14.7$	0.5	$[+2.16]$	0.0	$+13.0$	0.9
Windsor	» 11.8804	52	$-5 14.34$	0.53	$-7 32.0$	0.7	$+0.66$	0.8	$+7.6$	2.1
Cordoba	» 12.4842	17	$+1 53.61$	0.54	$-3 23.2$	0.8	$+1.36$	0.8	$+5.4$	1.3
»	» 12.4842	29	$-0 55.00$	0.54	$+3 37.3$	0.8	$+0.85$	0.8	$+4.2$	1.3
Windsor	» 12.8814	55	$-5 37.35$	0.53	$-1 10.3$	0.8	$+1.19$	0.8	$+6.1$	2.1
Cape	» 13.2456	29	$-0 38.11$	0.53	$-11 6.0$	0.7	$+1.44$	1.0	$+6.3$	1.4
Cordoba	» 13.4778	16 <sup>a</sup>	$+2 34.30$	0.54	$-6 4.2$	0.7	$+0.95$	0.6	$+6.6$	0.9
»	» 13.4778	44	$-2 57.84$	$+0.54$	$-2 17.4$	$-0.7$	$+1.02$	0.6	$+6.5$	0.9
Cape	» 14.2266	25	$+0 37.22$	$+0.52$	$+2 54.9$	$-0.3$	$+1.17$	0.4	$+6.4$	1.0
»	» 14.2449	25	$+0 37.28$	0.53	$+2 32.0$	0.7	$+0.79$	0.8	$+4.6$	1.4
Windsor	» 14.8848	54	$-4 37.16$	0.54	$+9 33.1$	0.9	$+0.03$	0.4	$+13.9$	1.0
Cape	» 15.2332	30	$-0 2.22$	0.53	$-1 23.2$	0.5	$[+0.90]$	0.0	$[+12.3]$	0.0
»	» 15.2337	30	$-0 2.34$	0.53	$-1 30.6$	0.5	$[+0.77]$	0.0	$[+5.4]$	0.0
»	» 15.2512	35	$-0 26.24$	0.54	$+6 43.9$	0.9	$+0.07$	0.8	$+7.5$	1.0
Windsor	» 15.8810	50	$-3 3.70$	0.54	$-7 0.8$	0.9	$+1.08$	1.0	$+8.6$	3.0
»	» 15.8810	54	$-4 9.47$	0.54	$-10 20.1$	0.9	$+1.10$	1.0	$+7.0$	3.0
Cordoba	» 16.5048	24	$+2 2.83$	0.56	$+1 16.5$	1.4	$+0.69$	0.6	$+7.5$	1.0
»	» 16.5048	46	$-1 50.30$	0.56	$+6 1.2$	1.4	$+0.55$	0.6	$+8.8$	1.0
Cape	» 17.2378	39	$-0 42.54$	0.54	$-1 54.2$	0.7	$+1.42$	0.4	$+10.6$	1.0
»	» 17.2378	39	$-0 43.19$	0.54	$-1 48.7$	0.7	$+0.77$	0.8	$+16.1$	2.1
Windsor	» 17.8701	21	$+3 22.15$	0.55	$+8 21.5$	0.7	$+0.39$	0.6	$+9.7$	1.8
»	» 17.8701	23	$+2 48.82$	0.55	$+6 39.4$	0.7	$+0.56$	0.6	$+8.5$	1.8
Cape	» 19.2407	41	$+0 18.75$	0.55	$+0 24.3$	0.8	$+0.57$	0.6	$+8.5$	0.7
Windsor	» 19.8792	38	$+1 0.83$	0.56	$+10 13.6$	1.0	$+0.49$	0.8	$+11.7$	2.1
»	» 19.8792	56	$-2 36.26$	0.56	$-0 8.7$	1.0	$+0.20$	0.8	$+11.8$	2.1
Cape	» 20.2430	38	$+1 15.24$	0.56	$+2 38.2$	0.9	$+1.40$	0.6	$+9.6$	0.7
Cordoba	» 20.4890	38	$+1 24.28$	0.58	$-2 33.2$	1.2	$+1.14$	0.6	$+5.3$	1.0
»	» 20.4890	56	$-2 12.52$	0.58	$-12 53.5$	1.2	$+1.13$	0.6	$+7.4$	1.0
»	» 21.4787	40	$+1 46.13$	0.58	$+4 19.2$	1.0	$+0.48$	0.6	$+12.0$	1.0
»	» 21.4787	64	$-4 28.45$	0.58	$-6 35.6$	1.0	$+0.15$	0.6	$+14.0$	1.0
Windsor	» 22.8803	60	$-3 1.86$	$+0.58$	$+1 45.7$	$-1.1$	$+1.27$	1.0	$+10.9$	3.0
Cordoba	» 24.4850	49	$+2 45.02$	$+0.60$	$-2 40.2$	$-1.2$	$+0.90$	0.6	$+11.2$	1.0
»	» 24.4850	66	$-2 26.77$	0.60	$-1 47.7$	1.2	$+0.72$	0.6	$+12.8$	1.0
»	» 25.4737	53	$+2 6.38$	0.61	$-11 12.8$	1.0	$+1.16$	0.6	$+6.2$	1.0
»	» 25.4737	61	$-1 6.60$	0.61	$-7 34.9$	1.0	$+0.81$	0.6	$+6.6$	1.0
»	» 26.5148	59	$+1 12.01$	0.59	$-7 0.1$	2.0	$+1.06$	0.8	$+10.6$	1.2
»	» 26.5171	67 <sup>a</sup>	$-1 41.66$	0.59	$-8 44.4$	2.0	$+0.95$	0.6	$+13.4$	0.9
Windsor	» 29.8796	73	$-2 31.28$	0.62	$-5 36.0$	1.3	$[+1.93]$	0.0	$+15.5$	1.2
»	Oct. 2.8803	68	$+4 43.94$	0.65	$-9 7.0$	1.4	$+0.18$	0.4	$+22.4$	0.9
»	» 2.8803	69	$+4 40.97$	0.65	$-9 25.0$	1.4	$+0.32$	0.4	$+19.7$	0.9
Cordoba	» 3.4962	79	$-1 50.86$	0.64	$-6 26.8$	1.8	$+1.15$	0.8	$+12.3$	1.2
Windsor	» 4.8845	75	$+2 43.04$	0.66	$+0 6.5$	1.5	$+0.37$	0.8	$+17.8$	2.4
»	» 4.8845	76	$+2 23.98$	0.66	$+0 32.3$	1.5	$+0.24$	0.8	$+18.4$	2.4
Cordoba	» 5.4903	70	$+5 21.33$	0.67	$-4 39.8$	1.7	$+0.32$	0.4	$+16.0$	0.5
»	» 5.4903	83	$-4 39.37$	0.67	$+4 28.2$	1.7	$+0.51$	0.4	$+15.9$	0.5
Windsor	» 5.8946	83	$-4 6.96$	0.66	$-5 10.9$	1.8	$+0.05$	0.6	$+20.6$	1.5
»	» 5.8946	85	$-5 17.77$	$+0.66$	$-5 26.0$	$-1.8$	$+0.31$	0.6	$+19.5$	1.5

Observatory	1898	*	Com. — st. in $\alpha$	Parall.	Com. — st. in $\delta$	Parall.	dz	$\rho$	d $\delta$	$\rho$
Cordoba	Oct. 6.5173	79 <sup>a</sup>	+0 <sup>m</sup> 57 <sup>s</sup> 18	+0 <sup>s</sup> 64	+ 0' 56 <sup>9</sup>	-2 <sup>3</sup>	—	—	—	—
»	» 6.5173	82	-2 2.53	0.64	+ 3 15.7	-2.3	—	—	—	—
Cape	» 7.2359	81	-0 4.55	0.68	- 0 58.5	-1.4	+0 <sup>s</sup> 70	0.4	[+8 <sup>5</sup> ]	0.0
Cordoba	» 8.5197	—	+4 26.35	—	- 5 22.3	—	—	—	—	—
»	» 9.4986	80	+4 25.92	0.70	+ 9 49.6	-1.9	-0.12	0.6	+17.2	0.9
»	» 9.4986	87	-1 43.62	0.70	+ 1 8.3	-1.9	+0.57	0.6	+19.1	0.9
Windsor	» 9.8905	87	-1 4.44	0.70	- 8 32.5	-1.8	[+1.35]	0.0	+25.0	1.5
Cape	» 10.2481	86	+0 46.62	0.71	- 6 28.1	-1.5	+0.53	0.4	+17.9	0.7
Cordoba	» 10.4974	88	-0 58.11	+0.71	+ 3 32.6	-1.9	+0.33	0.8	+16.1	1.2
Cape	» 12.2554	93	-1 22.06	+0.72	+ 8 41.8	-1.7	+1.97	0.8	- 4.8	1.4
Windsor	» 14.8929	91	+6 19.08	0.76	+ 8 17.9	-1.9	-1.09	0.8	- 1.0	1.2
Cordoba	» 16.4966	103 <sup>a</sup>	-1 36.96	0.79	- 2 56.1	-2.0	+0.21	1.0	+ 0.8	0.9
»	» 16.4966	95 <sup>a</sup>	+3 3.92	0.79	- 4 28.3	-2.0	+0.02	1.0	+ 0.8	0.9
»	» 17.4905	97	+3 52.98	0.81	+ 1 32.0	-1.9	+0.79	0.8	+ 4.8	0.7
»	» 17.4905	110	-1 52.20	0.81	+ 5 2.6	-1.9	+0.51	0.8	+ 6.4	0.7
Windsor	» 17.8902	110	-0 53.89	0.81	- 5 43.7	-1.8	+0.34	2.0	- 2.3	3.0
Cordoba	» 18.5137	105	+2 26.77	0.78	-11 36.5	-2.4	+1.53	1.2	- 5.8	1.0
Cape	» 28.3110	133	+5 34.50	0.89	- 3 9.7	-2.8	-0.50	0.8	- 5.5	1.0
»	» 28.3117	133	+5 35.83	0.89	- 3 10.0	-2.8	+0.63	0.6	- 4.8	0.7
Windsor	» 30.9138	141	+5 37.25	+1.13	- 1 47.3	-2.1	-2.43	0.8	+ 2.9	1.2
»	Nov. 1.9169	153	-3 37.35	+1.23	- 4 22.9	-2.1	+4.60	0.4	- 0.8	0.6
»	» 4.9162	171	+3 25.12	1.45	+ 6 3.2	-1.8	-4.38	1.0	- 1.9	1.5
»	» 9.8962	227	-1 34.70	2.01	- 0 51.1	-0.7	-1.66	0.6	- 1.2	0.9
»	» 13.9399	228	-9 27.57	+2.39	+ 7 3.7	-0.6	-2.82	0.6	- 1.2	0.9
»	» 30.9344	230	-2 40.71	+0.68	- 6 5.8	+2.6	-2.82	1.0	- 0.8	1.5
»	Dec. 1.9490	229	+8 26.14	0.72	+ 6 26.8	+2.4	[-4.68]	0.0	+ 0.5	1.5
Cordoba	» 3.6159	231	+3 35.40	1.00	+ 4 36.4	+1.4	-2.19	1.4	- 4.9	1.2
»	» 5.5927	232	-3 13.48	0.80	+ 2 23.2	+1.8	-1.02	1.2	- 9.3	1.0
Windsor	» 7.9415	2	-0 37.16	0.45	+ 3 13.0	+2.4	-1.68	1.6	- 6.0	2.4
»	» 7.9938	2	-1 21.63	0.69	+ 5 15.9	+1.7	-1.22	1.6	- 1.4	2.4
»	» 8.9459	1	+9 44.66	0.45	+ 0 36.8	+2.3	-1.27	0.8	- 4.2	1.2
»	» 9.9596	3	+4 54.07	0.49	+ 5 28.6	+2.1	-0.89	1.6	- 0.2	2.4
»	» 10.9674	4	+4 3.18	0.51	+ 5 17.7	+2.0	-0.59	1.2	+ 2.1	1.8
Cordoba	» 11.5817	5	+3 58.92	0.57	+ 3 55.5	+1.8	-0.94	1.6	- 9.3	1.3
Windsor	» 12.9559	6	-1 48.30	+0.43	- 7 27.2	+2.0	-0.99	1.6	[+16.5]	0.0
»	» 28.9482	7	+1 59.07	+0.28	- 4 17.6	+1.3	+0.25	1.6	- 8.3	0.8
»	» 31.9361	233	-0 16.88	0.24	+ 1 28.5	+1.3	+0.18	2.4	- 5.6	1.2
»	1899									
»	Jan. 3.9487	235	-6 50.07	0.26	- 7 22.3	+0.9	+0.58	2.0	-12.1	3.0
»	» 5.9463	234	-0 26.38	0.25	+ 9 28.9	+0.9	+0.43	2.2	- 1.6	3.3
»	» 6.9406	237	-2 59.45	0.24	+ 4 40.6	+0.9	+0.31	1.4	- 7.0	2.1
»	» 6.9406	239	-7 10.55	0.24	- 1 9.9	+0.9	+0.54	1.2	- 2.9	1.8
»	» 8.9597	241	-6 23.79	0.26	- 7 36.8	+0.5	+0.27	2.6	- 7.4	3.0
»	» 11.9702	238	+3 10.49	0.27	- 5 47.6	+0.3	+0.59	1.4	- 6.3	2.1
»	» 11.9702	246	-6 16.09	0.27	- 8 11.5	+0.3	+0.76	1.8	- 7.8	2.5
»	» 12.9361	236	+8 9.21	0.22	-11 24.9	+0.6	+0.67	0.8	- 4.6	1.2
»	» 13.9558	242	+0 26.08	0.25	- 2 5.5	+0.3	+0.89	2.2	- 8.6	3.3
»	» 13.9558	244	-1 55.50	0.25	+ 8 14.7	+0.3	+1.04	3.2	- 7.1	4.0
»	» 14.9639	240	-4 7.20	0.25	- 0 9.6	+0.2	+1.21	3.2	-10.7	4.0
»	» 14.9639	245	-1 1.26	0.25	+ 2 30.6	+0.2	+1.08	1.6	- 8.3	2.4
»	» 14.9639	247	-5 12.76	+0.25	+ 9 19.3	+0.2	+1.38	2.0	-10.2	3.0
»	» 29.9412	—	+1 47.31	+0.20	+ 3 7.6	-0.3	—	—	—	—
»	» 31.9487	248	+7 8.66	0.21	+ 6 32.0	-0.4	+0.19	1.6	-13.1	2.4
»	» 31.9487	249	+6 57.91	0.21	+ 7 23.2	-0.4	+0.37	1.6	-12.4	2.4
»	Feb. 1.9482	251	+5 22.86	+0.21	+ 5 10.3	-0.5	+0.25	2.0	- 9.6	3.0

Observatory	1899	*	Com. — st. in $\alpha$	Parall.	Com. — st. in $\delta$	Parall.	$d\alpha$	$p$	$d\delta$	$p$
Windsor	Feb. 2.9448	255	$-6^m 31^s 56.8$	$+0^s 20$	$+3' 12.7$	$-0'' 5$	$+0^s 44$	1.8	$-9'' 0$	2.5
»	» 2.9448	258	$-7 48.41$	$+0.20$	$+6 27.6$	$-0.5$	$+0.10$	1.4	$-6.9$	2.1
»	» 5.9397	259	$-7 11.84$	$+0.20$	$+0 38.8$	$-0.5$	$+0.72$	1.4	$-14.2$	2.1
»	» 5.9397	260	$-7 32.63$	$+0.20$	$+2 24.7$	$-0.5$	$+1.08$	1.8	$-12.5$	2.5
Lick	» 6.6190	254	$+0 4.42$	$+0.11$	$+6 12.9$	$+2.9$	$-0.07$	3.2	$-17.7$	2.4
»	» 8.6119	256	$+0 18.85$	$+0.10$	$-0 28.2$	$+2.9$	$-0.46$	3.2	$-16.6$	1.6
Windsor	» 8.9326	261	$-4 6.46$	$+0.19$	$+7 51.1$	$-0.6$	$+1.14$	1.6	$-8.5$	2.4
»	» 9.9251	257	$+1 42.14$	$+0.18$	$-7 28.6$	$-0.4$	$+0.41$	2.2	$-9.9$	3.3
Lick	» 11.6193	262	$-0 41.23$	$+0.11$	$+4 24.1$	$+2.7$	$-0.83$	3.2	$-11.5$	2.4
Windsor	» 12.9631	266	$-1 55.39$	$+0.20$	$+5 34.6$	$-1.0$	$+1.23$	2.0	$-19.9$	3.0
Lick	» 13.6196	265	$-0 13.75$	$+0.12$	$-5 56.4$	$+2.7$	$-0.05$	3.6	$-12.0$	2.6
Windsor	» 13.9233	268	$-2 52.87$	$+0.18$	$-8 5.3$	$-0.7$	$+1.07$	2.0	$-4.5$	3.0
»	» 14.9173	269	$-3 31.78$	$+0.17$	$-9 26.8$	$-0.6$	$+0.96$	1.2	$-19.0$	2.4
Lick	» 15.6213	267	$+0 41.02$	$+0.11$	$+2 14.6$	$+2.6$	$-0.47$	3.6	$-19.8$	2.4
»	Aug. 10.9604	275	$+0 5.53$	$-0.10$	$+3 33.3$	$+1.1$	$-0.89$	3.2	$-26.8$	2.4
»	» 11.9725	277	$+0 4.19$	$-0.09$	$+2 46.7$	$+1.1$	$-0.97$	2.4	$-27.5$	1.8
»	Sept. 1.9368	279	$+0 4.92$	$-0.08$	$-0 48.6$	$+1.2$	$-1.00$	4.0	$-30.2$	3.0
»	» 7.9780	280	$-0 21.37$	$-0.06$	$-1 47.1$	$+1.2$	$-1.48$	3.2	$-32.0$	2.4
»	Dec 6.8402	274	$+0 5.82$	$+0.03$	$-1 35.2$	$+1.1$	$-1.54$	4.0	$-31.7$	3.0

Note. The residuals between the dates 1898 Nov. 1 — Dec. 13 have not been used, with the exception of those in declination between the dates 1898 Nov. 30—1898 Dec. 13 inclusive.

## Comparison Stars.

*	$\alpha$ 1898.0	$\delta$ 1898.0	*	$\alpha$ 1898.0	$\delta$ 1898.0	*	$\alpha$ 1898.0	$\delta$ 1898.0
1	$0^h 3^m 38^s 37$	$-74^\circ 48' 21''.1$	29	$13^h 37^m 37^s 91$	$-59^\circ 21' 57''.7$	58	$13^h 43^m 38^s 45$	$-49^\circ 38' 21''.3$
2	$0 9 15.20$	$75 28 49.2$	30	$[13 37 49.60]$	$[-60 10 36.0]$	59	$13 43 57.72$	$64 1 11.5$
3	$0 12 58.65$	$74 14 37.2$	31	$13 37 54.62$	$51 44 8.6$	60	$13 45 16.69$	$62 51 2.6$
4	$0 18 1.62$	$73 35 47.1$	32	$13 37 55.95$	$53 12 55.9$	61	$13 45 22.48$	$63 37 48.3$
5	$0 20 31.91$	$73 10 55.6$	33	$13 37 57.77$	$53 15 20.5$	62	$13 45 28.73$	$52 18 13.5$
6	$0 31 29.31$	$72 5 49.8$	34	$[13 37 58.05]$	$[-53 1 6.2]$	63	$13 45 30.58$	$52 18 19.7$
7	$1 10 7.37$	$61 32 55.8$	35	$13 38 13.25$	$60 19 8.8$	64	$13 45 42.96$	$62 12 56.0$
8	$13 15 59.43$	$72 9 18.7$	36	$13 38 41.77$	$52 47 47.7$	65	$13 45 53.08$	$51 19 3.4$
9	$13 31 26.11$	$57 53 36.6$	37	$13 38 52.38$	$57 43 47.0$	66	$13 45 54.25$	$63 21 57.4$
10	$13 31 43.22$	$57 47 30.2$	38	$13 39 12.67$	$61 56 23.0$	67	$13 46 13.68$	$50 24 56.5$
11	$13 32 9.57$	$57 6 11.2$	39	$13 39 27.76$	$60 50 13.2$	67 <sup>a</sup>	$13 46 51.35$	$63 59 27.3$
12	$13 32 22.87$	$54 30 18.1$	40	$13 39 28.82$	$62 23 53.0$	68	$13 46 57.59$	$66 23 51.0$
13	$13 33 25.49$	$52 56 50.0$	41	$13 39 31.82$	$61 33 25.4$	69	$13 47 0.70$	$66 23 35.7$
14	$13 33 42.03$	$57 24 27.4$	42	$13 39 36.15$	$51 47 38.5$	70	$13 49 38.21$	$67 30 20.4$
15	$13 33 58.26$	$58 50 34.0$	43	$13 39 38.38$	$52 0 7.6$	71	$13 49 39.49$	$48 23 24.2$
16	$13 34 22.95$	$58 42 36.7$	44	$13 40 2.26$	$59 35 17.3$	72	$13 50 23.80$	$48 36 44.3$
16 <sup>a</sup>	$13 34 30.13$	$59 31 30.6$	45	$13 40 11.91$	$50 55 14.4$	73	$13 50 54.61$	$65 18 2.9$
17	$13 34 49.82$	$59 14 51.6$	46	$13 40 12.37$	$60 43 24.2$	74	$13 51 19.84$	$48 31 12.4$
18	$13 35 5.96$	$57 26 25.0$	47	$13 40 31.07$	$52 46 19.8$	75	$13 51 28.44$	$67 20 34.2$
19	$13 35 12.81$	$54 2 30.8$	48	$13 40 41.11$	$51 45 28.8$	76	$13 51 47.36$	$67 21 0.4$
20	$13 35 15.14$	$58 16 13.8$	49	$13 40 42.72$	$63 21 6.7$	77	$13 52 2.09$	$47 57 54.6$
21	$13 35 42.05$	$61 13 18.9$	50	$13 41 8.77$	$60 17 54.3$	78	$13 52 44.57$	$49 52 19.4$
22	$13 35 49.54$	$57 20 10.8$	51	$13 41 16.14$	$49 36 53.1$	79	$13 54 17.83$	$66 41 1.6$
23	$13 36 15.54$	$61 11 38.1$	52	$13 41 45.03$	$58 59 7.7$	79 <sup>a</sup>	$13 55 28.65$	$67 44 7.4$
24	$13 36 19.71$	$60 38 40.9$	53	$13 42 9.90$	$63 34 10.9$	80	$13 56 27.73$	$69 22 50.5$
25	$13 36 44.98$	$59 55 8.9$	54	$13 42 14.54$	$60 14 36.6$	81	$13 57 30.68$	$68 16 25.3$
26	$13 36 52.80$	$57 4 30.0$	55	$13 42 28.82$	$59 24 49.2$	82	$13 58 28.27$	$67 46 26.5$
27	$13 37 8.22$	$58 43 16.4$	56	$13 42 49.40$	$61 46 0.5$	83	$13 59 38.92$	$67 39 28.1$
28	$13 37 26.16$	$-51 35 6.1$	57	$13 43 27.02$	$-50 30 53.8$	84	$14 0 28.97$	$-47 6 5.1$

*	$\alpha$ 1898.0	$\delta$ 1898.0	*	$\alpha$ 1898.0	$\delta$ 1898.0	*	$\alpha$ 1898.0	$\delta$ 1898.0
85	14 <sup>h</sup> 0 <sup>m</sup> 49 <sup>s</sup> .97	-67° 39' 14".1	137	14 <sup>h</sup> 52 <sup>m</sup> 5 <sup>s</sup> .40	-39° 29' 41".1	193	15 <sup>h</sup> 56 <sup>m</sup> 28 <sup>s</sup> .95	-30° 39' 24".5
86	14 1 21.56	69 25 15.8	138	14 54 47.08	39 54 4.3	194	15 56 40.79	29 58 43.2
87	14 2 37.77	69 14 7.1	139	14 55 42.18	39 30 41.2	[195]	15 57 0.65	30 21 18.3
88	14 3 31.40	69 41 32.7	140	15 0 32.13	39 6 28.5	[192]		
89	14 4 10.35	47 17 9.4	141	15 1 44.04	78 44 56.4	196	15 57 11.94	29 31 10.8
90	14 4 28.82	46 25 42.6	142	15 1 55.14	38 43 2.5	197	16 0 41.24	29 32 53.9
91	14 4 31.13	71 38 34.8	143	15 3 34.85	38 24 8.5	198	16 1 16.15	29 11 50.5
92	14 5 19.86	45 49 9.7	144	15 4 4.47	37 37 24.4	199	16 1 17.50	29 41 17.4
93	14 7 3.40	70 31 3.9	145	15 7 24.68	37 47 53.7	200	16 2 52.86	29 29 20.3
94	14 9 18.23	45 56 8.1	146	15 12 54.24	37 12 5.7	201	16 4 2.94	29 0 52.2
95	14 10 36.39	46 26 13.2	147	15 15 19.51	37 10 48.3	202	16 4 41.85	29 8 46.4
95 <sup>a</sup>	14 11 18.45	72 7 46.8	148	15 15 38.35	37 16 3.4	[203]	16 5 45.99	28 48 47.6
96	14 11 51.14	45 26 0.0	149	15 19 32.97	36 6 48.3	[204]	16 5 57.46	28 44 11.4
97	14 12 50.29	72 39 59.9	150	15 19 45.91	36 14 15.6	205	16 5 57.79	28 9 5.7
98	14 12 52.35	45 35 13.9	151	15 20 17.86	35 25 16.5	206	16 6 1.19	27 39 40.6
99	14 12 59.03	45 37 43.9	152	15 20 46.17	36 24 33.9	207	16 6 47.70	29 23 4.5
100	14 14 11.89	44 42 55.6	153	15 24 0.35	79 37 33.5	208	16 7 18.45	28 47 41.2
101	14 14 56.01	46 11 37.0	154	15 24 33.95	35 17 18.4	209	16 7 39.99	27 59 29.4
102	14 15 30.23	44 57 32.7	155	15 25 19.81	35 11 50.2	[210]	16 7 42.06	28 22 52.8
103	14 15 34.10	44 11 26.5	156	15 27 14.03	35 1 13.2	[214]		
103 <sup>a</sup>	14 15 59.43	72 9 18.7	158	15 28 47.73	34 26 41.2	[211]	16 8 20.27	28 5 47.9
104	14 16 28.36	46 11 56.6	159	15 32 58.29	34 17 55.3	[205]		
105	14 16 49.53	72 54 16.8	160	15 33 23.98	34 19 23.6	212	16 11 57.03	27 46 30.8
106	14 17 16.09	45 11 54.0	161	15 34 3.77	33 54 46.6	213	16 11 57.95	27 47 23.9
107	14 18 11.47	43 50 47.0	162	15 35 23.05	34 33 31.6	214	16 11 58.38	28 21 33.4
108	14 18 15.20	44 44 23.5	163	15 36 10.98	34 22 57.5	215	[16 12 34.70]	[-27 32 9.0]
109	14 18 18.83	46 3 57.8	164	15 36 59.08	33 4 48.3	216	16 15 2.23	26 54 47.3
110	14 18 35.08	72 43 28.7	165	15 38 34.62	34 46 45.2	217	16 15 2.23	26 59 14.4
111	14 19 19.07	44 28 21.5	166	15 38 39.02	33 9 38.7	218	16 15 18.22	27 41 11.7
112	14 20 55.32	44 5 4.1	167	15 38 40.88	33 49 52.7	219	16 16 46.14	27 38 22.9
113	14 21 14.65	43 52 13.3	168	15 38 44.90	34 57 17.9	220	16 18 13.91	26 54 47.2
113 <sup>a</sup>	14 21 33.62	73 10 7.2	169	15 40 42.80	52 58 5.3	221	16 18 24.81	26 34 11.3
114	14 21 38.41	43 46 43.5	170	15 41 9.64	32 48 40.6	222	16 18 53.56	27 25 48.4
115	14 23 39.05	43 24 27.8	171	15 41 10.47	81 8 29.3	223	16 20 53.10	26 1 35.3
116	14 24 31.79	43 23 37.7	172	15 41 15.49	32 25 10.3	224	16 24 21.16	25 14 47.2
117	14 25 12.65	44 21 12.8	173	15 41 24.77	32 48 58.7	225	16 25 39.79	25 47 27.7
117 <sup>a</sup>	14 28 7.49	43 34 45.5	174	15 41 36.19	33 10 45.5	227	16 47 10.72	83 1 29.8
118	14 28 33.14	43 6 18.3	175	15 42 43.59	32 14 31.9	228	18 13 5.03	84 17 23.4
119	14 31 4.07	42 40 2.3	176	15 43 16.79	32 29 41.8	229	23 23 18.01	79 8 3.1
120	14 32 16.30	42 33 27.9	177	15 44 28.48	33 18 58.0	230	23 26 11.52	79 29 55.2
121	14 34 0.51	42 13 43.2	178	15 45 5.80	32 22 40.3	231	23 40 14.74	78 8 9.2
122	14 34 10.93	41 46 22.5	179	15 45 15.51	32 7 47.8	232	23 59 24.38	-76 54 54.3
[123]	14 34 59.80	42 7 23.6	180	15 45 44.14	33 48 39.7		$\alpha$ 1899.0	$\delta$ 1899.0
[124]	14 35 7.59	42 0 57.3	[181]	15 46 30.59	32 3 29.7	233	1 <sup>h</sup> 18 <sup>m</sup> 17 <sup>s</sup> .65	-59° 39' 13".0
125	14 35 35.79	42 21 4.1	[182]			234	1 27 32.02	56 29 15.1
126	14 35 57.98	42 0 57.1	181 <sup>a</sup>	15 47 40.57	31 45 39.1	235	1 30 24.62	57 31 8.2
[127]	14 36 57.90	41 47 8.1	182	15 47 41.09	32 3 22.6	236	1 30 27.68	51 38 14.8
[122]			183	15 49 7.36	30 47 2.8	237	1 31 47.56	55 45 37.9
128	14 39 34.51	41 43 1.5	184	15 49 48.66	31 29 13.3	238	1 33 54.52	52 20 42.9
129	14 41 24.95	41 12 10.5	185	15 51 26.61	31 40 11.6	239	1 35 58.85	55 39 43.3
130	14 41 32.61	41 26 1.3	186	15 51 34.45	31 25 58.2	240	1 37 39.43	50 32 53.6
131	14 43 34.64	41 25 20.4	187	15 52 19.79	30 35 53.1	241	1 38 35.34	54 14 47.3
132	14 45 25.82	40 23 4.5	188	15 53 28.87	30 52 34.3	242	1 39 46.66	51 8 57.3
133	14 47 56.99	77 31 21.5	189	15 53 35.18	31 8 13.5	243	1 40 44.78	49 59 45.0
134	14 47 58.32	39 56 41.6	190	15 54 55.40	31 15 29.2	244	1 42 8.38	51 19 16.0
135	14 48 34.42	40 42 13.1	191	15 55 20.85	30 37 41.9	245	1 42 47.73	50 35 31.4
136	14 50 6.34	-39 0 8.4	192	15 56 21.48	-30 22 50.6	246	1 43 21.21	-52 18 20.4

*	$\alpha$ 1899.0	$\delta$ 1899.0	*	$\alpha$ 1899.0	$\delta$ 1899.0	*	$\alpha$ 1899.0	$\delta$ 1899.0
247	1 <sup>h</sup> 46 <sup>m</sup> 59.50	-50° 42' 21".9	260	2 <sup>h</sup> 20 <sup>m</sup> 16.56	-37° 49' 2".9	272	2 <sup>h</sup> 38 <sup>m</sup> 46.05	-27° 46' 4".6
248	1 58 55.31	40 35 47.2	261	2 20 45.66	36 20 22.9	273	4 31 24.63	+ 3 18 56.6
249	1 59 6.24	40 36 37.7	262	2 20 47.36	34 54 52.0	[274]	4 31 49.83	3 20 32.6
250	2 1 37.84	41 39 10.9	263	2 20 48.97	35 1 33.1	[275]	5 15 3.57	0 55 56.0
251	2 2 1.88	40 1 13.6	264	2 21 18.46	33 38 4.3	[276]	5 15 13.50	0 52 30.7
253	2 13 8.05	37 36 10.2	265	2 22 54.86	33 44 44.9	[277]	5 15 29.47	0 58 7.1
254	2 13 32.12	37 31 25.5	266	2 23 45.21	34 15 49.2	[278]	5 15 40.41	0 54 52.5
255	2 15 16.62	39 26 29.9	267	2 24 32.95	32 54 25.1	[279]	5 21 8.55	1 20 56.0
256	2 15 53.79	36 22 12.6	268	2 25 57.76	33 33 26.3	[280]	5 22 6.35	1 24 39.1
257	2 16 13.74	35 34 28.5	269	2 27 53.31	33 3 8.8	[281]	5 23 1.81	1 29 45.0
258	2 16 33.00	39 29 42.7	270	2 33 45.21	34 15 49.2	282	5 23 5.39	+ 1 17 28.7
259	2 19 55.41	-37 47 18.7	271	2 37 44.16	-27 47 32.4			

Note. The co-ordinates of the DM-stars are enclosed within brackets.

#### 4. Residuals and Weights.

The observed positions of the comet have been deduced in the usual manner, viz, by reducing the mean place of the comparison star to its apparent position for the date, and applying the observed quantities given in the fourth and sixth columns together with the corrections for parallax tabulated in the fifth and seventh columns of the table of observations. The observed quantity comet minus star is assumed to have been corrected for refraction and other determinate corrections if not otherwise stated.

The initial meridian adopted being that of Greenwich, the observed local mean times have firstly been reduced to Greenwich mean time, and secondly corrected for the aberration time. With this reduced time as argument, the right ascension and declination of the comet have been interpolated from the ephemeris, using third differences; the result is then corrected by the quantities appended to the ephemerides and subtracted from the observed right ascension and declination, the residuals thus derived are tabulated in the eighth and tenth column.

Combining a number of these residuals in right ascension and declination at suitable intervals and plotting them on section paper it was found that they could be represented by curves of the second degree, between the extreme dates of the ephemeris (Elements B). Forming equations of condition for each co-ordinate, and reducing by least squares, the following formulae were obtained:

$$\left. \begin{aligned} n_{\alpha} &= +1^{\circ}052 + [7.72591] \tau - [6.46338] \tau^2 \\ n_{\delta} &= +0''.40 + [9.23045] \tau + [7.31940] \tau^2 \end{aligned} \right\} \quad (a)$$

in which

$$\tau = t - T \quad T = 221 = 1898 \text{ Aug. 10}$$

and  $t$  denotes the day of the year 1898 for which the value of  $n_{\alpha}$  or  $n_{\delta}$  is desired.

The series of observations from each observatory was then examined for the purpose of deducing the weights. From a manuscript table, the values of  $n_{\alpha}$  and  $n_{\delta}$  were interpolated for the times of observation, these were subtracted from the corresponding residuals in right ascension and declination respectively, new quantities were thus obtained and denoted by  $n'$ , which were assumed to represent approximately the errors of observation and from which the weights in  $\alpha$  and  $\delta$  were obtained thus:

$$\varepsilon_1^2 = \frac{[mn n]}{\mu} \quad p = \frac{m \varepsilon^2}{\varepsilon_1^2}$$

in which  $m$  denotes the number of comparisons and  $\mu$  the number of observations. The adopted units of weights being that for which the mean errors are

$$\varepsilon_{\alpha} = 0''.28 \quad \varepsilon_{\delta} = 3''.0$$

#### 5. Formation of Normal Places.

The observations combined to form a normal place are denoted, in the table of observations, by a line ruled across the columns.

The date of the normal place has been obtained thus

$$t' = \frac{[p t]}{[p]}$$

and from formulae (a) the value of  $n_{\alpha}$   $n_{\delta}$  have been found corresponding to this date, which is taken to the nearest half day.

The definitive position of the comet has then been derived by applying to the ephemeris place the quantity

$$\begin{aligned} d\alpha &= n_{\alpha} + \frac{[p(n - n_{\alpha})]}{[p]} \\ p_{\alpha} &= [p] \end{aligned} \quad (b)$$

and similarly in the case of the declination.

In the appended tables the right ascension  $\alpha_o$  and the declination  $\delta_o$  have been deduced as explained. The values of  $\alpha_c$   $\delta_c$  being computed with the elements A, the

co-ordinates of the sun have been taken from the American Ephemeris.

The normals prepared from the corrections to the ephemeris (Elements A), have been found by simply taking the summation of the weighted residuals and dividing by the sum of the weights. One exception is to be noted, namely, the observations of right ascension on the dates

included in the 13<sup>th</sup> normal. This normal has been prepared from equation (b) by using

$$\eta_{\alpha} = +0.62 + [8.8633]\tau + [7.5052]\tau^2$$

$T = 1899 \text{ Jan. } 9.5$  and  $\tau$  will have the same significance as previously.

#### Normals. Right Ascension.

No.	Date	$\alpha_o$ 1898.0	$\alpha_c$ 1898.0	15 Cos $\delta$ $d\alpha$	$p_{\alpha}$
1	1898 June 15.0	16 <sup>h</sup> 13 <sup>m</sup> 44 <sup>s</sup> .994	16 <sup>h</sup> 13 <sup>m</sup> 45 <sup>s</sup> .111	— 1".56	85.8
2	" 20.0	15 56 9.966	15 56 9.977	— 0.14	112.0
3	" 25.0	15 38 17.744	15 38 17.661	+ 1.04	86.6
4	July 5.0	15 3 51.523	15 3 51.321	+ 2.38	71.0
5	" 20.0	14 21 30.244	14 21 29.951	+ 3.16	59.0
6	Aug. 4.0	13 53 54.890	13 53 54.374	+ 5.16	13.4
7	" 19.0	13 39 23.800	13 39 23.503	+ 2.73	20.0
8	Sept. 9.5	13 35 50.246	13 35 49.886	+ 2.83	18.0
9	" 18.0	13 39 6.992	13 39 6.811	+ 1.31	14.2
10	Oct. 3.0	13 51 48.049	13 51 47.738	+ 1.85	11.8
11	" 18.0	14 17 53.938	14 17 53.516	+ 1.86	10.6
12	1899 Jan. 9.5	1 33 3.528	1 33 2.941	+ 5.17	29.6
13	Feb. 8.0	2 15 22.593	2 15 22.407	+ 2.24	37.4
14	Aug. 11.5	5 15 18.396	5 15 19.300	— 13.56	5.6
15	Sept. 4.5	5 21 27.321	5 21 28.527	— 18.09	7.2
16	Dec. 6.8*	4 31 53.893	4 31 55.441	— 23.18	4.0

#### Declination.

No.	Date	$\delta_o$ 1898.0	$\delta_c$ 1898.0	$d\delta$	$p_{\delta}$
17	1898 June 15.0	— 27° 18' 44".25	— 27° 18' 43".71	— 0".54	65.5
18	" 20.0	— 30 23 35.16	— 30 23 34.33	— 0.83	104.1
19	" 25.0	— 33 17 24.47	— 33 17 24.37	— 0.10	86.7
20	July 5.0	— 38 18 42.30	— 38 18 41.07	— 1.23	66.0
21	" 20.0	— 43 56 39.91	— 43 56 39.98	+ 0.07	56.8
22	Aug. 4.0	— 48 14 0.42	— 48 13 59.35	— 1.07	22.3
23	" 19.0	— 52 11 3.83	— 52 11 1.98	— 1.85	42.7
24	Sept. 9.5	— 58 21 35.19	— 58 21 32.62	— 2.57	38.7
25	" 18.0	— 61 7 40.74	— 61 7 38.12	— 2.62	31.7
26	Oct. 3.0	— 66 35 54.60	— 66 35 51.52	— 3.08	24.3
27	" 18.0	— 72 52 8.82	— 72 52 7.81	— 1.01	12.7
28	Dec. 8.0	— 75 23 37.73	— 75 23 35.22	— 2.51	16.7
29	1899 Jan. 9.5	— 54 2 5.28	— 54 1 57.83	— 7.45	37.7
30	Feb. 8.0	— 36 42 10.85	— 36 41 58.22	— 12.63	42.5
31	Aug. 11.5	+ 1 0 18.01	+ 1 0 45.32	— 27.31	4.2
32	Sept. 4.5	+ 1 21 28.99	+ 1 22 0.18	— 31.19	5.4
33	Dec. 6.8*	+ 3 18 53.37	+ 3 19 25.11	— 31.74	3.0

\* 1899 Dec. 6.8402083.

#### 6. Perturbations.

The actions of Venus, Earth, Mars, Jupiter, and Saturn, have been considered in the determination of the perturbations of the comet, the adopted values of the masses of these bodies being those that are given in the preface to the 1898 Nautical Almanac.

The perturbations in right ascension and declination were obtained indirectly. The first procedure was to determine the variation of the co-ordinates of the comet due to the actions of the foregoing disturbing bodies, the ecliptic being taken as the fundamental plane of reference, the



equinox adopted being that of 1898.0. The variations of  $x y z$  were then summed and changed into those referred to the equator by the following

$$\begin{aligned} dx_1 &= dx \\ dy_1 &= \cos \varepsilon dy - \sin \varepsilon dz \\ dz_1 &= \sin \varepsilon dy + \cos \varepsilon dz. \end{aligned}$$

The perturbations of  $\alpha$  and  $\delta$  were then deduced from the following equations

$$\begin{aligned} \cos \delta d\alpha &= -\frac{\sin \alpha}{\Delta \sin 1''} dx_1 + \frac{\cos \alpha}{\Delta \sin 1''} dy_1 \\ d\delta &= -\frac{\cos \alpha \sin \delta}{\Delta \sin 1''} dx_1 - \frac{\sin \alpha \sin \delta}{\Delta \sin 1''} dy_1 + \frac{\cos \delta}{\Delta \sin 1''} dz_1. \end{aligned}$$

The values of  $\cos \delta d\alpha$  and  $d\delta$  are shewn in the appended table, together with the summation of  $dx_1$ ,  $dy_1$ ,  $dz_1$ , which are in units of the seventh decimal place.

As it is desired to find the undisturbed orbit, the

values of  $\cos \delta d\alpha$  and  $d\delta$ , for the date of the normal place, are to be subtracted from the respective residuals shewn in the table of normals, the results obtained will form the absolute terms for the equations of condition.

#### Perturbations Equator and Equinox 1898.0.

1898-99	$[dx_1]$	$[dy_1]$	$[dz_1]$	$\cos \delta d\alpha$	$d\delta$	1899	$[dx_1]$	$[dy_1]$	$[dz_1]$	$\cos \delta d\alpha$	$d\delta$
June 1	- 2.0	+ 8.6	+ 4.5	-0.08	+0.03	March 28	- 69.8	+ 332.6	+1699.9	+1.58	+ 9.75
» 21	0.0	0.0	0.0	0.00	0.00	April 17	+ 9.3	314.7	1906.3	+0.94	+10.17
July 11	- 1.6	+ 8.5	+ 5.6	-0.13	+0.02	May 7	106.3	307.6	2118.9	+0.32	+10.58
» 31	5.3	33.9	25.3	-0.48	+0.12	» 27	220.2	312.4	2336.5	-0.31	+11.06
Aug. 20	12.9	74.6	62.0	-0.95	+0.29	June 16	348.0	330.4	2558.3	-0.95	+11.67
Sept. 9	25.6	129.6	118.9	-1.50	+0.44	July 6	491.1	360.9	2783.5	-1.64	+12.44
» 29	44.1	193.0	198.9	-2.10	+0.44	» 26	649.4	403.8	3011.0	-2.41	+13.40
Oct. 19	69.8	259.2	305.4	-2.65	0.00	Aug. 15	825.8	460.3	3241.3	-3.28	+14.60
Nov. 8	100.7	320.2	435.2	-2.34	-1.91	Sept. 4	1022.5	532.1	3473.9	-4.26	+16.02
» 28	136.5	366.6	586.0	+3.14	-1.42	» 24	1240.4	640.4	3718.5	-5.31	+17.65
Dec. 18	167.3	396.5	752.5	+4.04	+1.83	Oct. 14	1480.6	733.4	3952.1	-6.38	+19.23
Jan. 7	183.6	405.3	929.9	+3.95	+4.54	Nov. 3	1740.9	869.2	4200.0	-7.24	+20.61
» 27	184.2	399.3	1113.6	+3.52	+6.73	» 23	2019.7	1031.3	4455.4	-7.69	+21.41
Feb. 16	166.7	380.8	1303.9	+2.91	+8.24	Dec. 13	+2314.8	+1220.0	+4718.7	-7.70	+21.42
March 8	-129.2	+356.4	+1499.2	+2.24	+9.17						

#### 7. Differential formulæ and Least square solution for Definitive Elements.

If  $\theta$  represent any co-ordinate of the comet computed from assumed orbit elements then in this discussion

$$\theta = f(\omega' \Omega' i' T q e).$$

The equations of condition will therefore take the form

$$\begin{aligned} \cos \delta d\alpha &= \cos \delta \frac{\partial \alpha}{\partial \omega'} d\omega' + \cos \delta \frac{\partial \alpha}{\partial \Omega'} d\Omega' + \dots \cos \delta \frac{\partial \alpha}{\partial e} de \\ d\delta &= \frac{\partial \delta}{\partial \omega'} d\omega' + \frac{\partial \delta}{\partial \Omega'} d\Omega' + \dots \frac{\partial \delta}{\partial e} de. \end{aligned}$$

The elements (A)  $\omega \Omega i$ , referred to the ecliptic, were transformed into quantities having the same significance but referred to the equator as the fundamental plane and are as follows:

$$\left. \begin{aligned} \omega' &= 256^\circ 18' 10.81 \\ \Omega' &= 67 \ 29 \ 9.37 \\ i' &= 77 \ 46 \ 46.70 \end{aligned} \right\} 1898.0$$

The numerical values of the differential coefficients in the foregoing equations have then been determined by suitable formulæ.

The solution of the equations will give the corrections to the elements referred to the equator. These are changed into those required by simple formulæ.

An approximate check on the calculation of the coefficients was obtained by plotting them on section paper; to further check them suitable variations were given to the several elements to be corrected; introducing these variations into the equations the values of  $\cos \delta d\alpha$  and  $d\delta$  were obtained, and with the new elements these quantities were found directly, the agreement being satisfactory.



The reduction from the preliminary to the normal equations has been made by the method of least squares, using an arithmomètre to obtain the several sums, these being completely verified by the usual controls. In the determination of the final equations Zech's Additions- und Subtractions-Logarithmen tables have been employed.

The numerical quantities in the normal, also those in the elimination equations, are the logarithms of the coefficients.

The notation of these equations are

$$\begin{aligned} x &= d\omega' & t &= 10^3 dT \\ y &= d\Omega' & u &= 10^5 dq \\ z &= di' & w &= 10^5 de \end{aligned}$$

From the elimination equations the following quantities were deduced, and found to satisfy the normal equations.

$$\begin{aligned} \log x &= 1.2911078_n & d\omega' &= -19.55 \\ \log y &= 0.0358327_n & d\Omega' &= -1.09 \\ \log z &= 0.5993392 & di' &= +3.98 \\ \log t &= 0.9004428_n & dT &= -0.0079514 \\ \log u &= 1.0800332 & dq &= +0.000120236 \\ \log w &= 1.4467607 & de &= +0.000279744 \end{aligned}$$

To determine  $d\omega$   $d\Omega$   $di$  the following formulae have been used:

$$\begin{aligned} d\omega_0 &= [9.06770] d\Omega' - [9.15530] di' = -0.70 \\ d\Omega &= [9.98113] d\Omega' - [9.61984] di' = -2.70 \\ di &= [9.58269] d\Omega' + [9.96389] di' = +3.24 \\ d\omega &= d\omega' - d\omega_0 = -18.85 \end{aligned}$$

Applying  $d\omega$   $d\Omega$   $di$  to the Elements (A) together with the values of  $dT$   $dq$   $de$  already found, the following elements of the orbit result.

#### Elements.

Epoch of Osculation 1898 June 21.

$$\begin{aligned} T &= 1898 \text{ Sept. } 14.0442056 \text{ G. M. T.} \\ \omega &= 233^\circ 15' 17.66 \\ \Omega &= 73^\circ 59' 17.99 \\ i &= 69^\circ 56' 0.22 \\ q &= 1.701604636 \\ \log q &= 0.2308587 \\ e &= 1.001033644 \\ \log e &= 0.0004487 \\ \log p &= 0.5321131 \end{aligned} \quad 1898.0$$

Equations for Co-ordinates.

$$\begin{aligned} 1898.0 \quad \left\{ \begin{aligned} x &= [9.6334131] r \sin(v + 13^\circ 20' 49.56) \\ y &= [9.9672352] r \sin(v + 341^\circ 17' 1.42) \\ z &= [9.9900478] r \sin(v + 256^\circ 17' 51.25) \end{aligned} \right. \end{aligned}$$

#### Residuals.

Right Ascension						Declination					
No.	cos $\delta$ $d\alpha$		No.	cos $\delta$ $d\alpha$		No.	$d\delta$		No.	$d\delta$	
	Equations	Elements		Equations	Elements		Equations	Elements		Equations	Elements
1	-0.03	-0.09	9	+0.60	+0.60	17	+0.45	+0.45	25	+0.02	+0.06
2	+0.06	+0.11	10	+1.93	+1.92	18	-0.30	-0.22	26	-0.41	-0.38
3	+0.03	+0.01	11	+2.62	+2.64	19	+0.12	+0.07	27	+1.61	+1.65
4	-0.44	-0.50	12	+2.07	+2.06	20	-1.11	-1.08	28	+1.28	+1.30
5	-0.66	-0.68	13	+0.10	+0.06	21	+0.86	+0.84	29	+0.68	+0.72
6	+1.72	+1.65	14	+3.74	+3.71	22	+0.52	+0.54	30	-0.31	-0.30
7	+0.16	+0.16	15	+2.96	+2.98	23	+0.30	+0.32	31	-2.01	-1.83
8	+1.62	+1.62	16	-1.71	-1.72	24	-0.01	0.00	32	-3.77	-3.72
									33	+2.33	+2.34

$$[p v v] = 884.05$$

$$[v v] = 78.46$$

To determine the weights of the unknown quantities of the normal equations, the order of elimination has been reversed, by so doing the quantities for the purpose were obtained, and the values of the unknowns derived by the first elimination were completely verified.

#### Weights and Probable Errors.

$$\begin{aligned} \log p_x &= 1.43543 & r(d\omega) &= \pm 0.74 \\ \log p_y &= 2.39569 & r(d\Omega) &= \pm 0.24 \\ \log p_z &= 2.06761 & r(di) &= \pm 0.36 \end{aligned}$$

$$\begin{aligned} \log p_t &= 1.95204 & r(dT) &= \pm 0.0004079 \\ \log p_u &= 2.36890 & r(dq) &= \pm 0.0000025 \\ \log p_w &= 1.08080 & r(de) &= \pm 0.0000111 \end{aligned}$$

The higher order of differentials, neglected in the calculation of the coefficients of the equations of condition, will have no effect on the result obtained. An inquiry was made before concluding this part of the work, and the corrections found were inappreciable.

#### 8. Variation of the Eccentricity etc.

To form some idea of the effect on the residuals by an alteration of the eccentricity, the values of the corrections to the elements (A), with the exception of  $de$ , were intro-

duced into the equations of condition and the following equations are the result.

## Right Ascension.

+0.2587	$10^5 de$	=	+ 6.9804
+0.8630	$10^5 de$	=	+24.8040
+1.1899	$10^5 de$	=	+33.5691
+1.5886	$10^5 de$	=	+40.6947
+1.5408	$10^5 de$	=	+38.0329
+0.5763	$10^5 de$	=	+22.4285
+0.4381	$10^5 de$	=	+12.9932
+0.0664	$10^5 de$	=	+ 8.7530
-0.0487	$10^5 de$	=	+ 0.8838
-0.1899	$10^5 de$	=	+ 1.3151
-0.2605	$10^5 de$	=	+ 1.2292
+1.5647	$10^5 de$	=	+55.0504
+1.4342	$10^5 de$	=	+40.7309
-0.6334	$10^5 de$	=	- 8.8733
-0.8856	$10^5 de$	=	-16.8105
-0.3211	$10^5 de$	=	-12.3968

## Declination.

+3.8054	$10^5 de$	=	+110.0992
+4.8941	$10^5 de$	=	+133.8399
+4.4124	$10^5 de$	=	+124.5477
+3.4510	$10^5 de$	=	+ 87.5113
+2.3299	$10^5 de$	=	+ 71.7027
+0.9486	$10^5 de$	=	+ 28.9931
+0.7529	$10^5 de$	=	+ 23.0155
+0.1154	$10^5 de$	=	+ 3.1929
-0.0896	$10^5 de$	=	- 2.3868
-0.3781	$10^5 de$	=	-12.6006
-0.5133	$10^5 de$	=	- 8.6338
+0.5723	$10^5 de$	=	+21.2271
+1.1259	$10^5 de$	=	+35.6763
+0.6029	$10^5 de$	=	+14.8400
-0.9492	$10^5 de$	=	-30.6684
-1.2268	$10^5 de$	=	-43.0691
-1.3276	$10^5 de$	=	-33.0926

A least square solution of the foregoing equations gives  $\log 10^5 de = 1.44676$ , comme il faut.

The summation of the squares of the coefficients of  $10^5 de$  equals 96.816. If now the eccentricity be varied, then the effect on  $[p vv]$  may be seen from the following equation:

$$[p vv] = 884.05 + 96.816 (10^5 de)^2$$

and similarly we have

$$\begin{aligned} [p vv] &= 884.05 + 1444.49 (\Delta\omega)^2 \\ &= 884.05 + 992.28 (\Delta\Omega)^2 \\ &= 884.05 + 418.48 (\Delta i)^2 \\ &= 884.05 + 4184.57 (10^3 \Delta T)^2 \\ &= 884.05 + 1905.95 (10^5 dq)^2. \end{aligned}$$

The coefficients in the foregoing equations being the same as those of the normal equations, that are to be found along the diagonal of the left hand series.

## 9. Conclusion.

The orbit elements deduced represent the observed positions very closely, the residuals being well within the limits of error to which comet observations are liable. No further adjustment would lead to any appreciable corrections to the elements that are found.

For 1900.0 we have therefore the following

## Definitive Orbit Elements

## Comet 1898 VII.

Epoch of Osculation 1898 June 21.

$T = 1898 \text{ Sept. } 14.0442056 \text{ G. M. T.}$

$\omega = 233^\circ 15' 18''.66$

$\Omega = 74^\circ 0' 58.17$

$i = 69^\circ 56' 0.37$

$\log q = 0.2308587$

$\log e = 0.0004487$

$e = 1.0010336$

The discussion, now completed, is presented as a contribution to the science of astronomy. The work has

Sydney 1900 Aug. 3.

been undertaken and completed under circumstances of some difficulty. Here in Australia we are destitute of many of the scientific aids that are available to those engaged in similar investigations in older lands. The extent to which personal assistance is available is also limited, and the number of those interested in such work in Australia, to supply an environment to sustain one's enthusiasm, is more limited still. But I do not hesitate to say, that the work has afforded really pleasant relaxation for several months from the everyday occupation of a Colonial Government department.

I am indebted to Mr. John Tebbutt, Mr. H. C. Russell, Sir David Gill, Professor James Keeler, Mr. E. F. Coddington, and Professor Antonio Abetti, who have kindly sent manuscript copies of their observations, I thank them sincerely for their courtesy.

My thanks are also due to the Rev. Dr. Roseby, of Sydney, who has kindly undertaken the task of revising the manuscript.

C. J. Merfield.

**Berichtigung zum Berliner Jahrbuch für 1903** und dem Sonder-Abdruck über die kleinen Planeten aus demselben. Die Oppositions-Ephemeride des Planeten (118) Peitho auf Seite 415 gilt nicht für 1900-1901, sondern für 1901-1902. Die Angaben auf Seite 384 und 404 sind entsprechend zu corrigiren. J. Bauschinger.