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10.

Definitive Orbit of Comet 1890 III. By *S. Ogura* and *H. Kaneko*.

This comet was discovered by *Coggia* in Marseille on July 18, 1890. It was then pretty bright and appeared as a round nebulosity of about 2' in diameter, with central condensation. It moved slowly toward south and was observed by many European and American observers in the western sky, at last on August 13 by Professor *Barnard* on Mt. Hamilton. A parabolic orbit of this comet was determined by *W. Ebert* from 43 observations up to August 6 (A. N. 3151), which represents the observations very well. But there are further observations, most of them made on Mt. Hamilton, not used in this discussion. So we undertook to determine the definitive orbit.

We start from the elements given by *Ebert*, which are:

Elements I.

$$T = 1890 \text{ July } 8.577276 \text{ Berlin m. t.}$$

$$\pi = 99^\circ 58' 22.24''$$

$$\omega = 85 \ 39 \ 36.86$$

$$\Omega = 14 \ 18 \ 25.38$$

$$i = 63 \ 20 \ 3.70$$

$$\log q = 9.8831669.$$

Heliocentric equatorial coordinates.

$$x = [9.9891432] \cdot r \cdot \sin(v + 182^\circ 11' 22''.04)$$

$$y = [9.3632231] \cdot r \cdot \sin(v + 164 \ 51 \ 21.51)$$

$$z = [9.9990212] \cdot r \cdot \sin(v + 91 \ 19 \ 2.76).$$

With these elements the following ephemeris was calculated for Berlin mean time. The sun's coordinates and the constants necessary to reduce the places from mean to apparent ones, were taken from the *Berliner Jahrbuch* for 1890.

Ephemeris for Berlin m. t.

1890	α (true)	δ (true)	$\log \Delta$	Ab. time
July 18.0	8 ^h 44 ^m 29 ^s .69	+45° 1' 43".4	0.19114	12 ^m 54 ^s .0
18.5	48 37.05	44 41 28.4	0.19207	55.6
19.0	52 40.20	44 20 41.9	0.19304	57.4
19.5	8 56 39.15	43 59 25.3	0.19404	12 59.2
20.0	9 0 33.89	43 37 40.4	0.19508	13 1.0
20.5	4 24.42	43 15 28.8	0.19616	3.0
21.0	8 10.77	42 52 52.0	0.19727	5.0
21.5	11 52.96	42 29 51.4	0.19841	7.0
22.0	15 31.01	42 6 28.7	0.19959	9.2
22.5	19 4.97	41 42 45.3	0.20080	11.4
23.0	22 34.87	41 18 42.7	0.20204	13.6
23.5	26 0.77	40 54 22.2	0.20332	16.0
24.0	29 22.73	40 29 45.1	0.20462	18.4
24.5	32 40.79	40 4 53.0	0.20595	20.8
25.0	35 55.01	39 39 47.1	0.20731	23.3
25.5	39 5.47	39 14 28.4	0.20870	25.9
26.0	42 12.23	38 48 58.4	0.21012	28.5
26.5	45 15.35	38 23 18.2	0.21156	31.2
27.0	9 48 14.92	+37 57 28.8	0.21302	13 34.0

1890	α (true)	δ (true)	$\log \Delta$	Ab.time
July 27.5	9 ^h 51 ^m 10 ^s .99	+37° 31' 31".3	0.21451	13 ^m 36.8
28.0	54 3.64	37 5 26.8	0.21603	39.6
28.5	56 52.95	36 39 16.4	0.21756	42.5
29.0	9 59 38.99	36 13 0.9	0.21912	45.5
29.5	10 2 21.84	35 46 41.1	0.22070	48.5
30.0	5 1.57	35 20 18.1	0.22229	51.5
30.5	7 38.25	34 53 52.6	0.22391	54.6
31.0	10 11.96	34 27 25.4	0.22555	13 57.8
31.5	12 42.77	34 0 57.4	0.22720	14 1.0
Aug. 1.0	15 10.75	33 34 29.1	0.22887	4.2
1.5	17 35.98	33 8 1.3	0.23055	7.5
2.0	19 58.52	32 41 34.6	0.23226	10.8
2.5	22 18.45	32 15 9.7	0.23397	14.2
3.0	24 35.84	31 48 47.1	0.23570	17.6
3.5	26 50.74	31 22 27.3	0.23744	21.0
4.0	29 3.24	30 56 10.9	0.23919	24.5
4.5	31 13.38	30 29 58.4	0.24096	28.0
5.0	33 21.24	30 3 50.2	0.24274	31.6
5.5	35 26.87	29 37 46.8	0.24453	35.2
6.0	37 30.34	29 11 48.5	0.24633	38.8
6.5	39 31.70	28 45 55.8	0.24813	42.5
7.0	41 31.01	28 20 9.0	0.24995	46.2
7.5	43 28.33	27 54 28.4	0.25177	49.9
8.0	45 23.72	27 28 54.3	0.25360	53.7
8.5	47 17.22	27 3 27.0	0.25544	14 57.5
9.0	49 8.88	26 38 6.9	0.25728	15 1.3
9.5	50 58.76	26 12 54.1	0.25912	5.1
10.0	52 46.91	25 47 48.9	0.26098	9.0
10.5	54 33.37	25 22 51.5	0.26284	12.9
11.0	56 18.18	24 58 2.0	0.26469	16.8
11.5	58 1.40	24 33 20.7	0.26656	20.7
12.0	10 59 43.07	24 8 47.6	0.26843	24.7
12.5	11 1 23.22	23 44 23.1	0.27029	28.7
13.0	3 1.90	23 20 7.2	0.27216	32.7
13.5	4 39.14	22 56 0.0	0.27403	36.7
14.0	6 15.00	22 32 1.6	0.27591	40.8
14.5	11 7 49.50	+22 8 12.1	0.27778	15 44.8

There are 68 observations which are found in *Astr. Nachr.*, *Comptes Rendus*, *Astr. Journ.*, *Bulletin Astr.* and *Annales de Bordeaux*. To determine the mean places of the comparison stars we consulted all the catalogues available here. The places which are found in *Boss' »Preliminary General Catalogue«* were taken without correction, and the others were reduced to the system of *Boss* by applying the systematic corrections and weights as given in his catalogue. *Newcomb's* constant of precession was used to reduce the mean places of the comparison stars to 1890. The following table gives the adopted places of the comparison stars for 1890.0. Beside the catalogues mentioned here, old cata-

logues with small weights as Lal and W_2 were taken into consideration.

Mean places of comparison stars for 1890.0.

*	α	δ	Authority
1	8 ^h 49 ^m 5 ^s .94	+44° 40' 12".8	Bo
2	8 57 10.29	43 52 37.1	Grb, Par ₃ , Rbg, II 109, Bo
3	9 2 54.36	43 23 9.4	Par ₃ , Bo
4	10 58.72	42 31 33.2	Par ₃ , Bo
5	15 43.59	42 40 18.2	Bo
6	18 49.62	41 40 50.8	Par ₃ , Bo
7	19 49.70	41 30 1.1	Par ₂ , Par ₃ , Wa ₂ , Bo
8	20 42.35	41 40 28.7	Par ₂ , Bo
9	22 15.74	41 7 17.9	Bo
10	22 27.27	40 54 34.5	Par ₃ , Bo
11	28 12.00	40 6 33.6	Boss
12	31 22.62	40 3 2.0	Bo
13	31 29.62	40 43 59.5	Boss
14	33 59.94	40 9 50.2	Bo VI
15	34 33.52	39 27 9.4	Boss
16	35 11.37	40 15 31.8	Boss
17	35 18.72	39 44 49.8	Lu
18	37 31.65	38 57 44.3	Lu
19	45 41.57	38 25 48.7	Boss
20	49 8.67	37 42 57.9	Lu, Kü
21	50 11.56	37 17 59.0	Lu
22	52 21.64	37 39 44.9	Lu
23	53 20.51	37 38 3.6	Lu
24	9 56 32.33	+37 22 58.3	Lu

*	α	δ	Authority
25	9 ^h 57 ^m 3 ^s .17	+36° 29' 6".4	Lu
26	10 0 56.46	35 46 49.9	Boss
27	1 48.36	35 52 27.1	Lu
28	1 53.28	36 48 52.3	Lu
29	8 43.70	34 44 51.7	c. w. * 30 (1914.2)
30	9 48.88	34 56 53.7	Lei, Kü
31	13 41.98	34 6 30.4	Par ₂ , Par ₃ , Lei
32	13 45.77	34 3 9.4	Par ₃ , Lei, Kü
33	16 31.50	33 50 11.1	Lei
34	18 24.69	33 5 19.3	Bo VI
35	18 43.93	33 0 10.4	Kü
36	26 57.74	31 19 27.2	Lei
37	35 45.60	30 22 17.4	Lei
38	39 37.97	28 32 35.1	Cbr E., Kü
39	41 15.09	28 54 0.4	Cbr E.
40	47 35.11	26 47 34.6	Par ₂ , Cbr E., Ci ₂
41	10 53 54.41	25 11 44.0	Cbr E., Kü
42	11 2 0.88	23 34 8.0	Par ₁ , Berl B
43	11 6 21.86	+22 39 11.6	Par ₃ , Berl B

Remarks. * 2. $\mu_\alpha = +0^s.0034$, $\mu_\delta = -0^s.026$. —
 * 7. $\mu_\alpha = -0^s.0008$, $\mu_\delta = -0^s.085$. — * 29. Observed at Tokyo with a ring micrometer attached to the equatorial telescope of 16 cm aperture, on March 16, 1914.

In the comparison of the observations with the ephemeris, we used the solar parallax 8".80. The times of observation are corrected for aberration.

Observations of Comet 1890 III.

No.	1890 Berlin m. t.	Observatory	*	Red. ad l. app. in α in δ	Comet—Star in α in δ	Parallax in α in δ	Obs.—Cal. in α in δ
1	July 18.45119	Marseille	1	-0.831 +4.63	-0 ^m 53 ^s .40 + 2' 29".1	+0.237 +5".04	(-1.14) (-36".8)
2	19.41064	"	2	-0.791 +4.79	-1 12.78 +10 19.4	+0.305 +4.47	+0.27 + 9.8
3	20.40515	"	3	-0.763 +4.84	+0 46.61 - 3 28.0	+0.311 +4.34	-0.49 + 7.2
4	21.40679	"	4	-0.725 +4.96	+0 13.26 + 2 21.9	+0.307 +4.32	-0.29 - 6.1
5	21.42778	Bordeaux	5	-0.719 +5.14	-4 22.08 - 7 13.1	+0.293 +4.40	-0.04 + 2.4
6	21.43115	Toulouse	4	-0.725 +4.95	+0 24.68 + 1 19.4	+0.287 +4.51	+0.35 - 0.7
7	21.43534	Paris	4	-0.725 +4.95	+0 25.95 + 1 14.1	+0.252 +4.70	-0.26 + 5.8
8	21.45559	Kiel	4	-0.725 +4.95	+0 35.50 + 0 11.2	+0.166 +5.14	+0.27 - 0.4
9	21.66274	Cambridge M.	4	-0.724 +4.92	+2 4.89 - 9 26.0	+0.244 +4.85	(-1.25) - 0.2
10	22.40034	Nice	8	-0.684 +5.13	-2 19.24 + 6 54.9	+0.303 +4.27	+0.08 + 2.4
11	22.40623	Marseille	8	-0.684 +5.13	-2 16.93 + 6 37.3	+0.305 +4.27	-0.11 + 1.7
12	22.41452	Padua	7	-0.683 —	-1 18.79 —	+0.259 —	(+1.81) —
13	22.41452	"	8	-0.684 +5.12	-2 12.46 + 6 32.1	+0.259 +4.67	(+0.78) (+20.6)
14	22.43942	Toulouse	6	-0.688 +5.06	-0 9.63 + 4 41.5	+0.273 +4.58	+0.32 + 3.1
15	22.45658	Paris	8	-0.685 +5.13	-1 55.68 + 4 15.3	+0.221 +4.89	-0.34 + 4.3
16	22.45684	Kiel	8	-0.685 +5.13	-1 54.53 + 4 20.7	+0.164 +5.12	+0.64 +10.7
17	22.61722	Cambridge M.	8	-0.683 +5.09	-0 47.98 - 3 27.8	+0.311 +4.21	-0.54 + 1.4
18	22.61879	Albany	8	-0.683 +5.09	-0 47.68 - 3 32.1	+0.316 +4.13	(-0.90) + 1.5
19	22.73771	Mt. Hamilton	7	-0.683 +5.04	+0 55.49 + 1 11.9	+0.357 +3.71	-0.40 0.0
20	23.37064	Rom	13	-0.641 +5.31	-6 21.88 +16 31.7	+0.326 +3.95	-0.46 - 1.2
21	23.38637	Nice	10	-0.663 +5.02	+2 47.44 + 5 12.2	+0.316 +4.03	+0.04 + 0.2
22	23.39853	Marseille	10	-0.663 +5.01	+2 51.93 + 4 28.6	+0.310 +4.12	-0.45 - 7.8
23	23.41096	Kremsmünster	9	-0.663 +5.01	+3 9.37 - 8 50.0	+0.241 +4.71	+0.30 - 5.9
24	23.45320	Paris	10	-0.664 +5.00	+3 14.42 + 1 54.7	+0.224 +4.82	-0.42 - 0.6
25	23.61189	Cambridge M.	13	-0.640 +5.28	-4 43.48 + 4 46.6	+0.314 +4.09	-0.49 + 2.5

No.	1890 Berlin m. t.	Observatory	*	Red. ad l. app.		Comet—Star		Parallax		Obs.—Cal.	
				in α	in δ	in α	in δ	in α	in δ	in α	in δ
26	July 23.74687	Mt. Hamilton	13	-0.639	+5.26	-3 ^m 49.24	-1' 51.1	+0.342	+3.82	(-0.90)	+2.6
27	24.37649	Palermo	16	-0.622	+5.27	-3 18.36	-4 43.4	+0.332	+3.90	+0.49	-5.3
28	24.38947	Nice	11	-0.635	+5.02	+3 45.40	+3 44.1	+0.309	+4.03	-0.27	+2.7
29	24.39626	Padua	14	-0.622	+5.24	-2 0.39	+0 20.7	+0.279	+4.36	(-0.80)	(+16.8)
30	24.39626	"	16	-0.622	+5.24	-3 11.63	-5 18.6	+0.279	+4.36	-0.61	(+19.1)
31	24.43858	Paris	12	-0.627	+5.13	+0 54.07	+4 45.3	+0.243	+4.62	-0.36	0.0
32	24.73922	Mt. Hamilton	17	-0.613	+5.20	-1 4.61	+7 56.2	+0.346	+3.65	-0.35	+0.6
33	25.39168	Wien	15	-0.606	+5.06	+3 51.66	-7 21.1	+0.253	+4.49	+0.31	-0.6
34	25.40907	Marseille	15	-0.606	+5.06	+3 57.78	-8 8.6	+0.292	+4.19	-0.12	+4.5
35	25.45349	Kiel	15	-0.607	+5.04	+4 14.46	-10 38.0	+0.168	+5.00	-0.37	+1.2
36	25.74602	Mt. Hamilton	18	-0.591	+5.09	+3 6.25	+4 2.5	+0.335	+3.72	-0.18	-1.3
37	26.39105	Marseille	19	-0.563	+5.22	-1 6.09	+2 56.5	+0.306	+3.91	-0.53	-0.3
38	26.43471	Bordeaux	19	-0.563	+5.22	-0 49.42	+0 40.8	+0.270	+4.32	+0.22	-0.8
39	27.37856	Wien	20	-0.543	+5.15	+1 20.20	-5 17.3	+0.260	+4.27	+0.05	-0.3
40	27.41042	Dresden	20	-0.543	+5.15	+1 31.23	-6 53.6	+0.220	+4.60	-0.12	+3.2
41	27.41434	Berlin	22	-0.533	+5.26	-1 40.70	-3 58.9	+0.210	+4.66	-0.45	-2.8
42	27.41843	"	23	-0.532	+5.28	-2 37.69	-2 23.5	+0.205	+4.70	-0.01	+4.2
43	27.42502	Bordeaux	22	-0.532	+5.28	-1 36.48	-4 44.4	+0.277	+4.16	+0.10	(-15.4)
44	27.42502	"	22	-0.532	+5.28	-1 36.72	-4 39.4	+0.277	+4.16	-0.14	-10.3
45	27.62394	Albany	24	-0.521	+5.33	-4 38.93	+1 53.6	+0.291	+4.02	(-0.93)	-2.8
46	27.74570	Mt. Hamilton	21	-0.534	+5.11	+2 24.46	+0 37.4	+0.325	+3.66	-0.44	+1.9
47	28.38511	Wien	28	-0.499	+5.35	-5 38.72	-3 45.8	+0.250	+4.32	-0.03	-1.5
48	28.73045	Mt. Hamilton	25	—	+5.13	—	-2 4.9	—	+3.39	—	-0.8
49	28.73945	"	25	-0.506	—	+1 9.41	—	+0.326	—	-0.47	—
50	29.37011	Wien	27	-0.486	+5.15	-0 8.25	+0 52.4	+0.260	+4.12	+0.04	-3.0
51	29.43059	Bordeaux	26	-0.475	+5.04	+1 3.21	+2 47.8	+0.264	+4.16	+0.04	(-33.7)
52	29.72202	Mt. Hamilton	26	—	+5.08	—	-12 2.8	—	+3.24	—	-3.2
53	29.73877	"	26	-0.485	—	+2 40.39	—	+0.321	—	(-1.81)	—
54	30.72967	"	29	—	+5.09	—	-3 23.2	—	+3.32	—	-6.8
55	30.73459	"	29	-0.454	—	+0 6.69	—	+0.319	—	-0.47	—
56	31.37030	Wien	32	-0.435	+5.10	-1 41.86	+4 26.8	+0.252	+4.07	-0.19	-4.0
57	31.37833	"	31	-0.435	+5.11	-1 35.77	+0 42.5	+0.245	+4.16	-0.32	-1.7
58	31.73539	Mt. Hamilton	33	—	+5.12	—	-1 46.4	—	+3.38	—	+3.5
59	Aug. 1.59260	Cambridge M.	34	-0.413	+4.99	-0 22.93	-2 13.4	+0.289	+3.57	(-0.94)	+7.2
60	1.72390	Mt. Hamilton	35	-0.410	+4.99	-0 3.98	-4 9.6	+0.315	+3.20	-0.28	-1.6
61	3.72839	"	36	-0.381	+4.86	+0 53.73	-9 2.6	+0.302	+3.22	-0.17	+5.9
62	4.60629	Albany	37	-0.343	+4.85	-4 5.96	+1 58.9	+0.269	+3.59	(-1.18)	0.0
63	6.40991	Bordeaux	39	-0.319	+4.64	-2 5.13	-3 29.0	+0.248	+3.72	-0.10	+4.7
64	6.72828	Mt. Hamilton	38	-0.320	+4.54	+0 48.30	+1 27.7	+0.288	+3.16	-0.18	+1.7
65	8.73076	"	40	-0.289	+4.34	+0 33.31	+4 2.2	+0.277	+3.15	-0.57	-0.2
66	10.72535	"	41	—	+4.07	—	-0 12.8	—	+3.06	—	-0.9
67	12.72221	"	42	—	+3.92	—	-0 37.3	—	+2.97	—	+2.6
68	13.72534	"	43	—	+3.80	—	+5 45.1	—	+3.00	—	-7.1

Now we derived the following 6 normal places by combining the observations between two horizontal lines. The residuals in brackets were rejected because of great deviations, and equal weight was given to all other observations.

Normal Places.

1890	α calc.	δ calc.	$A\alpha \cos \delta$	wt.	$A\delta$	wt.
I July 21.0	137° 2' 41".52	+42° 52' 51".95	-0.30	7	-0.22	8
II 23.0	140 38 43.07	41 18 42.65	-1.59	13	+0.99	15
III 26.0	145 33 3.43	38 48 58.45	-1.81	18	-0.36	17
IV 30.5	151 54 33.76	34 53 52.55	-2.59	8	-1.19	10
V Aug. 6.5	159 52 55.52	28 45 55.76	-3.37	4	—	—
VI 8.5	161 49 18.29	+27 3 26.96	—	—	+0.84	8

Perturbations due to Mercury, Venus, Earth, Jupiter and Saturn were calculated for every 10 days and were found to be very small. In the following table ξ , η , ζ denote the perturbations in equatorial rectangular coordinates in the unit of the 7th decimal, osculating epoch being July 30.0, 1890.

Perturbations.						
	1890	ξ	η	ζ	$\Delta\alpha \cos \delta$	$\Delta\delta$
July	21.0	0	+1	0	-0.001	-0.001
	23.0	0	+1	0	-0.001	-0.001
	26.0	0	0	0	0	0
	30.5	0	0	0	0	0
Aug.	6.5	0	+1	0	-0.001	0
	8.5	0	+2	0	-0.002	-0.001

wt.		α						
(1)	7	-0.29	=	8.14604 _n	∂T	+8.65102	∂e	+9.32046 _n $\partial \log q$ +9.58602 $\partial \pi'$ +9.36688 _n $\partial \delta'$ +9.40844 $\partial i'$
(2)	13	-1.58	=	8.11575 _n	8.68974	9.35249 _n	9.55616	9.25240 _n 9.43275
(3)	18	-1.81	=	8.06664 _n	8.73008	9.37886 _n	9.50755	8.99028 _n 9.45377
(4)	8	-2.59	=	7.98726 _n	8.76390	9.38518 _n	9.42832	8.25813 9.45968
(5)	4	-3.36	=	7.85631 _n	8.77862	9.34774 _n	9.29547	9.24053 9.42688

		δ						
(6)	8	-0.21	=	7.96754	∂T	+8.32654 _n ∂e	+9.96687 $\partial \log q$ +9.52079 _n $\partial \pi'$	+9.65070 $\partial \delta'$ +9.44458 $\partial i'$
(7)	15	+1.00	=	7.99474	8.40537 _n	9.99137	9.55961 _n	9.68542 9.40204
(8)	17	-0.36	=	8.02068	8.49114 _n	0.02493	9.60442 _n	9.72266 9.33174
(9)	10	-1.19	=	8.03620	8.56628 _n	0.06661	9.65124 _n	9.75614 9.21418
(10)	8	+0.85	=	8.01896	8.58257 _n	0.12047	9.70454 _n	9.78030 9.94548

Each equation of condition was multiplied by the square root of its weight, and then the equations were rendered homogeneous by introduction of new unknown quantities, such that:

$$\begin{aligned} x &= [8.69428] \partial T & t &= [0.21964] \partial \pi' \\ y &= [9.35772] \partial e & u &= [0.33788] \partial \delta' \\ z &= [0.64015] \partial \log q & w &= [0.08141] \partial i' \\ & & \text{unit of error} &= [0.88532]. \end{aligned}$$

With these substitutions we obtained the following normal equations, with coefficients in natural numbers

$$\begin{aligned} &+ 5.34271x - 4.28224y + 3.58374z - 0.65848w - 5.29106t + 3.51784u = +2.59121 \\ &- 4.28224x + 3.72412y - 2.54106z + 1.38862w + 4.12658t - 2.34725u = -2.76258 \\ &+ 3.58374x - 2.54106y + 3.69938z + 1.76366w - 4.04689t + 3.58264u = +0.67504 \\ &- 0.65848x + 1.38862y + 1.76366z + 4.47238w - 0.11809t + 1.82694u = -2.61839 \\ &- 5.29106x + 4.12658y - 4.04689z - 0.11809w + 5.44836t - 3.95754u = -2.15196 \\ &+ 3.51784x - 2.34725y + 3.58264z + 1.82694w - 3.95754t + 3.61123u = +0.31204 \end{aligned}$$

From these normal equations the elimination equations were found as follows:

$$\begin{aligned} &+ 5.34271x - 4.28224y + 3.58374z - 0.65848w - 5.29106t + 3.51784u = +2.59121 \\ &\quad + 0.29187y + 0.33138z + 0.86083w - 0.11422t + 0.47235u = -0.68572 \\ &\quad \quad + 0.91921z + 1.22801w - 0.36813t + 0.68664u = -0.28456 \\ &\quad \quad \quad + 0.21176w + 0.05845t - 0.04991u = +0.10354 \\ &\quad \quad \quad \quad + 0.00022t - 0.00007u = +0.00327 \\ &\quad \quad \quad \quad \quad + 0.00580u = -0.04640 \end{aligned}$$

As we see from these equations, the coefficients of the last two unknown quantities t and u are very small, which makes the evaluation of these unknowns quite uncertain. Now, the first four unknowns were expressed in terms of t and u (*Oppolzer*, *Bahnbestimmung*, Bd. II, p. 362-370) with the following results:

$$\begin{aligned} w &= +0.48894 - 0.27601t + 0.23569u \\ z &= -0.96276 + 0.76922t - 1.06185u \\ y &= -2.69844 + 0.33206t - 1.10792u \\ x &= -0.97174 + 0.70650t - 0.80506u \end{aligned}$$

Substituting these values in the equations of condition, the unknowns t and u were first determined, and then the others from the above relations. In this way, the corrections to the Elements I. were found as follows:

In computing the differential coefficients for the equations of condition, the elements previously used were referred to the equator. They thus become:

$$\begin{aligned} T &= 1890 \text{ July } 8.577276 \text{ Berlin m. t.} \\ \pi' &= 104^\circ 6' 17''.23 \\ \omega' &= 91 \ 19 \ 2.77 \\ \delta' &= 12 \ 47 \ 14.46 \\ i' &= 86 \ 9 \ 16.81 \end{aligned} \left. \vphantom{\begin{aligned} T \\ \pi' \\ \omega' \\ \delta' \\ i' \end{aligned}} \right\} 1890.0$$

$$\log q = 9.8831669.$$

The calculated values of α and δ being corrected for perturbations, we obtained the following logarithmic equations of condition.

$$\begin{aligned} \partial T &= +0.014916 & \partial i' &= -0'.44''.44 \\ \partial e &= +0.0021432 & \partial \pi' &= +1 \ 32.53 \\ \partial \log q &= +0.0001979 & \partial \delta' &= -0 \ 29.24 \end{aligned}$$

From these values the following hyperbolic elements referred to the ecliptic of 1890.0 were obtained.

Elements II.

$$\begin{aligned} T &= 1890 \text{ July } 8.592192 \text{ Berlin m. t.} \\ \pi &= 99^\circ 59' 46''.84 \\ \omega &= 85 \ 41 \ 49.06 \\ \delta &= 14 \ 17 \ 57.78 \\ i &= 63 \ 19 \ 16.59 \end{aligned} \left. \vphantom{\begin{aligned} T \\ \pi \\ \omega \\ \delta \\ i \end{aligned}} \right\} 1890.0$$

$$\log q = 9.8833648$$

$$e = 1.0021432.$$

Normal places were calculated with the new elements, and the residuals (obs.-cal.) were compared with those obtained by substituting the increments of the elements in the equations of condition. The results are shown in the following table.

1890	Elements		Equation	
	$\Delta\alpha \cos \delta$	$\Delta\delta$	$\Delta\alpha \cos \delta$	$\Delta\delta$
July 21.0	+0".66	-1".06	+0".42	-1".06
23.0	+0.04	+0.79	-0.36	+0.78
26.0	+0.63	+0.05	+0.08	+0.04
30.5	+0.65	-0.49	+0.05	-0.52
Aug. 6.5	+0.48	—	-0.03	—
8.5	—	+0.16	—	+0.17

$\Delta\delta$ coincide very well, while there are remarkable discordances in $\Delta\alpha$, which are due to the uncertain character of the equations. To make the coincidence better, the corrections to the elements II. were again calculated. In each equation of condition the right hand side was unaltered, while the left hand side was replaced by the residuals found from the elements II.; as given in the above table. The equations being again solved in the same way, we obtained the following corrections. r_0 is the probable error of the equation of weight unity.

$$\begin{aligned}\partial T &= -0^d002893 \pm 0^d009258 \\ \partial e &= -0.0002486 \pm 0.0010684 \\ \partial \log q &= -0.0000348 \pm 0.0001151 \\ \partial i' &= + 9".26 \pm 30".48 \\ \partial \pi' &= -24.69 \pm 79.15 \\ \partial \Omega' &= + 0.73 \pm 9.99 \\ \Sigma(pvv) &= 23".757 \quad r_0 = \pm 1".64.\end{aligned}$$

The elements referred to the ecliptic of 1890.0 are now as follows:

$$\begin{aligned}+ 5.34271x + 3.58374z - 0.65848w - 5.29106t + 3.51784u &= + 2.59121 \\ + 1.29544z + 2.20536w - 0.49781t + 1.22292u &= - 1.06308 \\ + 0.63680w + 0.07724t + 0.17862u &= - 0.48927 \\ + 0.00781t - 0.02543u &= + 0.06500 \\ + 0.00755u &= - 0.04168\end{aligned}$$

The coefficients of the last two unknowns t and u being very small, the evaluation of the unknowns is also very uncertain. We proceeded in the same way as in the case of the hyperbolic elements to determine the unknowns. Thus we found the following corrections to the elements I.

$$\begin{aligned}\partial T &= -0^d0002621 \\ \partial \log q &= -0.0000230 \\ \partial i' &= + 12".56 \\ \partial \pi' &= -45.23 \\ \partial \Omega' &= -19.58.\end{aligned}$$

The parabolic elements referred to the ecliptic of 1890.0 are:

Elements IV.

$$\begin{aligned}T &= 1890 \text{ July } 8.574655 \text{ Berlin m. t.} \\ \pi &= 99^\circ 57' 22".52 \\ \omega &= 85 39 20.28 \\ \Omega &= 14 18 2.24 \\ i &= 63 20 14.27 \\ \log q &= 9.8831439.\end{aligned} \quad \left. \begin{array}{l} \\ \\ \\ \\ \end{array} \right\} 1890.0$$

Elements III.

$$\begin{aligned}T &= 1890 \text{ July } 8.589299 \text{ Berlin m. t.} \\ \pi &= 99^\circ 59' 21".37 \\ \omega &= 85 41 23.78 \\ \Omega &= 14 17 57.59 \\ i &= 63 19 25.90 \\ \log q &= 9.8833300 \\ e &= 1.0018946.\end{aligned} \quad \left. \begin{array}{l} \\ \\ \\ \\ \end{array} \right\} 1890.0$$

Heliocentric equatorial coordinates.

$$\begin{aligned}x &= [9.9891570] \cdot r \cdot \sin(\nu + 182^\circ 13' 4".35) \\ y &= [9.3630697] \cdot r \cdot \sin(\nu + 164 49 59.77) \\ z &= [9.9990162] \cdot r \cdot \sin(\nu + 91 20 39.12).\end{aligned}$$

Residuals now become:

1890	Elements		Equation	
	$\Delta\alpha \cos \delta$	$\Delta\delta$	$\Delta\alpha \cos \delta$	$\Delta\delta$
July 21.0	+0".32	-1".06	+0".42	-1".05
23.0	-0.52	+0.76	-0.35	+0.78
26.0	-0.13	+0.05	+0.09	+0.03
30.5	-0.18	-0.58	+0.03	-0.51
Aug. 6.5	-0.18	—	-0.05	—
8.5	—	+0.10	—	+0.16

Still there are some systematic differences in $\Delta\alpha$, but they not being so large, the elements III. may be regarded as definitive.

Because of the large probable errors of the hyperbolic elements, a solution for parabola was made. In the original equations of condition ∂e was put equal to zero, and by introducing the same homogeneous factors, we obtained the normal equations differing from the original ones only by the suppression of the terms in y . The elimination equations are:

The residuals are as follows:

1890	Elements		Equation	
	$\Delta\alpha \cos \delta$	$\Delta\delta$	$\Delta\alpha \cos \delta$	$\Delta\delta$
July 21.0	+1".15	-0".52	+0".81	-0".55
23.0	+0.06	+0.91	-0.33	+0.89
26.0	+0.23	-0.16	-0.18	-0.22
30.5	+0.41	-0.92	-0.13	-0.94
Aug. 6.5	+1.21	—	+0.68	—
8.5	—	+0.56	—	+0.54

As in the case of the hyperbola, the residuals in δ coincide very well, but in α there are remarkable discordances. So we again solved the equations with the residuals in the above table. Finally we found the following corrections to the elements IV.

$$\begin{aligned}\partial T &= -0^d000169 \pm 0^d003415 \\ \partial \log q &= -0.0000011 \pm 0.0000379 \\ \partial i' &= +0".23 \pm 12".10 \\ \partial \pi' &= +0.05 \pm 43.85 \\ \partial \Omega' &= +1.14 \pm 9.39 \\ \Sigma(pvv) &= 34".143 \quad r_0 = \pm 1".76.\end{aligned}$$

Now the final parabolic elements become: .

Elements V.

$$\begin{aligned} T &= 1890 \text{ July } 8.574486 \text{ Berlin m. t.} \\ \pi &= 99^\circ 57' 22''.20 \\ \omega &= 85 \ 39 \ 18.71 \\ \Omega &= 14 \ 18 \ 3.49 \\ i &= 63 \ 20 \ 14.61 \\ \log q &= 9.8831428. \end{aligned} \quad 1890.0$$

Heliocentric equatorial coordinates.

$$\begin{aligned} x &= [9.9891519] \cdot r \cdot \sin(v + 182^\circ 10' 51''.11) \\ y &= [9.3630343] \cdot r \cdot \sin(v + 164 \ 51 \ 23.35) \\ z &= [9.9990230] \cdot r \cdot \sin(v + 91 \ 18 \ 36.03). \end{aligned}$$

The residuals are shown in the following table.

Tokyo Observatory, 1914 May.

1890	Elements		Equation	
	$\Delta \alpha \cos \delta$	$\Delta \delta$	$\Delta \alpha \cos \delta$	$\Delta \delta$
July 21.0	+0.87	-0.49	+0.80	-0.55
23.0	-0.22	+0.97	-0.32	+0.88
26.0	+0.05	-0.09	-0.20	-0.19
30.5	+0.29	-0.81	-0.08	-0.95
Aug. 6.5	+1.26	—	+0.64	—
8.5	—	+0.58	—	+0.53

From the hyperbolic elements III. and the parabolic elements V. we see that the probable errors in the elements are several times greater for the hyperbola, but the sum of the residuals a little greater for the parabola. But for both sets of elements, the residuals not being so great, they may be said to represent the observations pretty well.

S. Ogura and H. Kaneko.

Beobachtungen von Algolsternen. Von R. Lehnert.

Aus der Zeit meiner Bamberger Tätigkeit, die ich bei Ausbruch des Krieges bis auf weiteres aufgab, liegen vom Jahre 1913 noch eine Anzahl Bestimmungen des kleinsten Lichtes von verschiedenen Algolsternen und dem β Lyrae-Stern Z Vulpeculae vor, die ich hiermit der Öffentlichkeit übergeben möchte. Die Beobachtungen sind wieder alle mit dem 6-zölligen Bamberger Kometensucher angestellt worden bis auf die mit * bezeichneten Minima von Y Cygni und U Sagittae, welche ich mit meinem 72 mm-Fernrohr in Freiberg beobachtete; diese sind daher etwas unsicherer als die übrigen. — Die Zusammenstellung selbst bildet die Fortsetzung zu den in A. N. 4596 und 4641 enthaltenen Veröffentlichungen über Algolsterne. Wiederum sind alle Zeiten heliozentrisch und in m. Z. Greenwich zu verstehen; E gibt auch hier die Nummer der Epoche nach den Elementen in den Ephemeriden für 1913, n die Anzahl der Schätzungen und B—R die Verbesserung der Ephemeride.

Stern	n	E	m. Z. Gr. des Min. 1913	Jul. Datum 241... bzw. 242...	Gr.	B—R
U Cephei	17	4768	Jan. 8 9 ^h 27 ^m	9776.3938	9 ^m 7	+32 ^m
	16	4823	Mai 25 11 52	9913.4944	9.7	+20
TV Cass.	9	267	Febr. 23 7 11	9822.2993	8.1	+7
	10	351	Juli 25 12 54	9974.5375	8.0	-22
	16	378	Sept. 12 11 48	0023.4917	8.2	-2
	12	384	Sept. 23 8 50	0034.3681	8.2	-1
RZ Cass.	5	2064	Febr. 23 10 3	9822.4188	7.8	-30
	12	2228	Sept. 7 10 31	0018.4382	7.8	-35
	12	2243	Sept. 25 8 50	0036.3681	7.8	-34
Algol	12	3202	Febr. 22 8 8	9821.3389	3.6	-13

Stern	n	E	m. Z. Gr. des Min. 1913	Jul. Datum 241... bzw. 242...	Gr.	B—R
Algol	13	3277	Sept. 25 9 ^h 15 ^m	0036.3854	3 ^m 5	-17 ^m
R. Can. maj.	4	8332	Febr. 23 9 11	9822.3757	6.6	-12
Y Camel.	11	1061	Febr. 14 12 33	9813.5229	12	+24
Y Leonis	17	1032	Jan. 26 11 26	9794.4764	12	-8
TW Drac.	19	366	Juli 29 13 17	9978.5535	8.7	+22
•	20	382	Sept. 12 11 3	0023.4604	8.7	+27
	9	387	Sept. 26 11 57	0037.4979	8.7	+34
U Sagitt.	7	851	Aug. 27 7 41	0007.3201	8.7	+18
	17	859	Sept. 23 8 45	0034.3646	8.8	+18
Z Vulpec.	14	706	Sept. 7 10 57	0018.4563	9.4	-35
	15	708	Sept. 12 8 48	0023.3667	9.3	-34
Y Cygni	9	6510	Aug. 23 10 43	0003.4465	8.0	-3 ^h 5
	16	6512	Aug. 26 10 17	0006.4285	8.1	-3 26
	13	6520	Sept. 7 9 50	0018.4097	8.1	-3 31
	12	6532	Sept. 25 9 22	0036.3903	8.1	-3 28
	9	6534	Sept. 28 9 25	0039.3924	8.1	-3 20
	6	6542	Okt. 10 8 46	0051.3653	8.1	-3 37

Die starke Abweichung der Minima von Y Cygni, die im Jahre 1913 solche gerader Zählung waren, führten auf die verbesserten Näherungselemente: Ger. Min. = 1913 Sept. 25^d 9^h 23^m 9^s m. Z. Greenwich + 2^d 23^h 54^m 43^s 1^h E = 2420036.3916 + 2^d 996332 E (s. a. V. J. S. 48.289 u. 390). Die Minima von TW Draconis vom 29. Juli und 26. Sept. sind je aus zwei benachbarten Erscheinungen kombiniert; dasjenige von U Sagittae vom 27. August beruht nur auf einem Aufstieg unter Benutzung einer früheren Lichtkurve.

Freiberg i. Sa., 1914 Nov. 8.

Rudolf Lehnert.

Die Bahn des Kometen 1913f (Delavan). Von G. Van Biesbroeck.

Dieser Komet ist nun während eines Zeitintervalls von mehr als einem Jahr und über einen heliozentrischen Bogen von mehr als 180° verfolgt worden. Die Abweichung meiner Ephemeride (A. N. 4739 u. f.) überstieg Ende 1914 nicht 2', woraus ersichtlich, daß die aus den Beobachtungen 1913 Dez. bis 1914 April abgeleitete parabolische Bahn schon eine gute Näherung darstellt. Bei der Bahnbestimmung bin

ich jetzt eine Stufe weiter gegangen und habe untersucht, inwiefern die bisherige Laufbahn eine Abweichung von der Parabel aufweist.

In den letzten Monaten sind mir hier leider keine anderswo erhaltene Beobachtungen bekannt geworden; ich bin also auf eigene, wegen trüben Wetters in der letzten Zeit recht lückenhafte Positionsbestimmungen angewiesen. Das