

DET KGL. DANSKE VIDENSKABERNES SELSKAB
MATEMATISK-FYSISKE MEDDELELSER, BIND XXVI, NR. 2

THE MOTION OF THE PERIODIC
COMET COMAS SOLÁ (1927 III, 1935 IV,
1944 II) IN THE YEARS 1926-1944

BY

JULIE M. VINTER HANSEN

References.

- (1) H. YUKAWA. Phys. Rev. 76, 300 (1949); 76, 1731, (1949); 77, 219, (1950);
I am grateful to Professor H. YUKAWA for having placed the last
mentioned manuscript at the disposal of the Institute previous to
publication.
 - (2) COURANT and HILBERT, Die Methoden der mathematischen Physik,
2nd ed. I. p. 189.
 - (3) See, for instance, W. PAULI, Rev. Mod. Phys. 13, 203, (1941).
 - (4) F. J. BELINFANTE, Physica 6, 887, (1939); 7, 305, (1940); L. ROSENFELD,
Mém. Acad. Roy. Belg. 6, 30, (1940).
-



KØBENHAVN
I KOMMISSION HOS EJNAR MUNKSGAARD
1951

The present work is a continuation of that published in *Mathematisk-fysiske Meddelelser* X, 13 and XII, 5¹ of the Royal Danish Academy of Sciences and Letters, and is based on the elements given in XII, 5:

Date of Osculation 1926 Nov. 30.0 U.T.

$$\begin{aligned}
 & T = 1927 \text{ March } 22. \text{ 1929 U.T.} \\
 \text{(I)} \quad & \left. \begin{aligned}
 \omega &= 38^\circ 28' 37''.7 \\
 \Omega &= 65^\circ 55' 52''.0 \\
 i &= 13^\circ 45' 47''.1
 \end{aligned} \right\} 1950.0 \\
 & \varphi = 35^\circ 6' 28''.4 \\
 & a = 4.17176
 \end{aligned}$$

The comet was recovered in 1935 through an ephemeris based on this set of elements and with perturbations from Jupiter and Saturn taken into consideration. The computation of the perturbations was made jointly by D. H. SADLER, of the Nautical Almanac Office, Greenwich, and the writer (see XII, 5). The ensuing investigation of the motion of the comet was temporarily interrupted by the war when, during my stay in the U. S. A., I had no access to my former computations. Nevertheless the comet was re-discovered in 1943 through a prediction prepared by DINWOODIE and HENDERSON (*Handbook 1943 of the British Astronomical Association*). For this prediction perturbations by Jupiter and Saturn were taken into consideration and the ephemeris was based on elements (I) with a correction of $-1^d.8$ applied to the time of perihelion passage.

At the apparition in 1935/36 68 observations were obtained. These observations are listed in Table a.

Table a.

Table a (continued).

No.	Place	U.T. — Ab.t.	α 1950.0 geoc.	δ 1950.0 geoc.	$\Delta \alpha \cos \delta$	$\Delta \delta$	W.No.	Place	U.T. — Ab.t.	α 1950.0 geoc.	δ 1950.0 geoc.	$\Delta \alpha \cos \delta$	$\Delta \delta$	Weight
1	Yerkes	1935 Aug. 9.36457	6 ^h 24 ^m 20 ^s .59	+24°58' 3".3	+2242.3	+406.4	54	Uccle	April 9.86355	11 ^h 54 ^m 13 ^s .69	+21°58' 10".8	+2602.8	-1474.9	1
2	—	11.38173	6 30 1.30	+25 5 9.4	+2250.4	+405.0	55	Kiel	9.86848	11 54 13.62	+21 58 7.1	+2604.3	-1476.9	1
3	Lick	12.46141	6 33 6.19	+25 8 21.7	+2280.4	+384.3	56	Yerkes	12.15588	11 52 56.22	+21 45 7.7	+2565.8	-1438.9	1
4	—	13.48007	6 35 59.65	+25 11 21.6	+2290.3	+374.4	57	Bergedorf	14.88082	11 51 33.77	+21 28 14.3	+2516.4	-1397.6	1
5	Yerkes	24.36943	7 7 13.03	+25 32 43.2	+2395.1	+239.4	58	Lick	16.18745	11 50 58.29	+21 19 39.7	+2492.6	-1377.0	1
6	—	25.36882	7 10 5.89	+25 33 41.1	+2398.1	+224.8	59	—	16.20689	11 50 57.82	+21 19 31.6	+2493.0	-1377.0	1
7	Lick	Sep. 2.45351	7 33 31.71	+25 35 40.3	+2457.6	+111.6	60	Yerkes	17.17479	11 50 33.03	+21 13 36.9	+2473.4	-1323.2	1
8	—	2.48545	7 33 37.22	+25 35 39.6	+2457.2	+111.2	61	—	May 14.14314	11 48 22.36	+17 20 9.1	+1955.1	-1034.2	1
9	Yerkes	5.38684	7 42 2.64	+25 33 49.1	+2475.4	+ 70.8	62	Bergedorf	18.9253-	11 49 40.29	+16 32 28.7	+1866.6	-984.9	1
10	—	6.38364	7 44 56.34	+25 32 51.4	+2482.2	+ 54.8	63	—	19.9391-	11 50 0.47	+16 22 12.3	+1851.1	-976.9	1
11	—	24.39315	8 36 54.08	+24 49 35.7	+2552.6	-214.5	64	—	19.9786-	11 50 1.10	+16 21 48.1	+1847.8	-976.8	1
12	Lick	27.49769	8 45 43.80	+24 38 39.0	+2553.7	-262.5	65	Yerkes	20.12829	11 50 4.16	+16 20 16.1	+1845.2	-976.2	1
13	—	27.50880	8 45 45.76	+24 38 35.8	+2554.7	-263.2	66	Lick	June 10.19535	12 0 53.83	+12 39 43.0	+1514.2	-813.3	1
14	Algier	28.16408	8 47 36.60	+24 36 1.4	+2547.5	-270.0	67	—	10.21618	12 0 54.64	+12 39 29.6	+1513.6	-813.2	1
15	Lick	29.48853	8 51 21.75	+24 30 31.9	+2555.0	-292.2	68	—	July 16.21074	12 31 4.40	+ 6 16 46.7	+1111.4	-624.2	1
16	—	29.49569	8 51 23.01	+24 30 30.0	+2555.7	-292.4								
17	Yerkes	Oct. 7.38841	9 13 26.79	+23 54 7.8	+2560.9	-413.0								
18	Bergedorf	24.13492	9 58 22.39	+22 20 42.8	+2510.2	-659.0								
19	Lick	Nov. 8.52690	10 36 43.95	+20 47 23.0	+2450.4	-865.5								
20	—	8.53315	10 36 44.86	+20 47 21.0	+2450.4	-865.3								
21	—	21.46154	11 6 13.24	+19 33 46.1	+2387.3	-1031.8								
22	—	21.49209	11 6 17.22	+19 33 36.3	+2387.3	-1032.3								
23	Yerkes	23.43815	11 10 28.21	+19 23 32.5	+2373.3	-1054.2								
24	Harvard	25.41399	11 14 38.57	+19 29 55.4	+2352.8	-103.3								
25	Tashkent	Dec. 1.01212	11 26 5.46	+18 47 41.1	+2339.6	-1146.5								
26	Yerkes	2.41029	11 28 51.03	+18 41 40.5	+2334.2	-1167.6								
27	Lick	21.41548	12 2 4.55	+17 47 13.6	+2281.8	-1407.6								
28	—	21.42520	12 2 5.43	+17 47 12.8	+2281.8	-1407.7								
29	Yerkes	21.43661	12 2 6.48	+17 47 14.0	+2282.0	-1405.7								
30	—	27.31821	12 10 34.36	+17 39 40.1	+2278.2	-1480.1								
31	—	1936 Jan. 24.26785	12 36 15.49	+18 44 17.0	+2416.2	-1858.4								
32	Lick	24.43572	12 36 19.84	+18 45 5.2	+2417.7	-1859.2								
33	—	24.45377	12 36 20.25	+18 45 10.1	+2417.1	-1859.5								
34	Yerkes	25.28745	12 36 40.97	+18 49 7.5	+2426.0	-1868.8								
35	—	28.26435	12 37 41.81	+19 3 58.2	+2454.5	-1903.6								
36	—	30.29838	12 38 11.87	+19 14 45.6	+2476.4	-1905.8								
37	Tokyo	30.7222-	12 38 17.0-	+19 16 45.-	+2482.-	-1949.-								
38	—	31.7007-	12 38 27.0-	+19 22 27.-	+2490.-	-1941.-								
39	—	Feb. 1.7208-	12 38 33.8-	+19 28 11.-	+2481.-	-1951.-								
40	—	2.7715-	12 38 41.2-	+19 33 43.-	+2512.-	-1989.-								
41	—	3.8293-	12 38 44.9-	+19 40 18.-	+2526.-	-1972.-								
42	Yerkes	18.25958	12 35 28.99	+21 8 20.8	+2706.1	-2057.8								
43	—	22.19179	12 33 21.62	+21 31 34.8	+2748.9	-2057.3								
44	Uccle	23.11683	12 32 47.61	+21 36 50.1	+2758.6	-2056.0								
45	Yerkes	28.25780	12 29 14.23	+22 3 56.6	+2809.9	-2053.6								
46	—	Mar. 16.20874	12 14 18.87	+22 58 0.5	+2865.8	-1842.7								
47	Bergedorf	16.96213	12 13 35.99	+22 57 5.7	+2860.1	-1867.0								
48	Yerkes	18.21660	12 12 25.51	+22 57 54.0	+2859.7	-1847.2								
49	Uccle	18.96559	12 11 43.45	+22 58 6.3	+2857.5	-1838.9								
50	Bergedorf	20.04561	12 10 40.24	+22 58 14.9	+2846.6	-1818.5								
51	Lick	21.27399	12 9 34.40	+22 57 58.0	+2842.1	-1799.5								
52	—	21.30454	12 9 32.76	+22 57 56.4	+2842.7	-1799.9								
53	Uccle	23.97876	12 7 6.74	+22 55 53.8	+2827.3	-1751.7								

Columns 6 and 7 show the residuals (O—C), resulting from a comparison between the observed right ascensions and declinations (columns 4 and 5), to which aberration was added, and the corresponding right ascensions and declinations interpolated in the ephemeris for t—Ab.t. As these residuals were rather large it was not deemed advisable to proceed to the following apparition in 1943/44 without making a preliminary revision of the orbit. For this purpose the above observations were formed into 13 normal places, which together with 14 normal places from the apparition 1926/27 (X, 13 p. 25) were used for a least squares' solution. The result was the following temporary set of elements:

Osculation 1926 Nov. 30.0 U.T.

$$T = 1927 \text{ March } 22.21359 \text{ U.T.}$$

$$(II) \left. \begin{aligned} \omega' &= 82^\circ 30' 28'' .5 \\ \Omega' &= 24^\circ 33' 24'' .8 \\ i' &= 31^\circ 31' 4'' .9 \end{aligned} \right\} \text{Equator } 1950.0$$

$$e = 0.574 \ 9441$$

$$a = 4.170 \ 144$$

or, referred to the ecliptic:

$$\left. \begin{aligned} \omega &= 38^{\circ}29' 8''.9 \\ \Omega &= 65^{\circ}55'54''.0 \\ i &= 13^{\circ}45'55''.5 \end{aligned} \right\} 1950.0$$

With these elements the rectangular co-ordinates for the years 1926—1944 were computed by the direct co-ordinate method (COWELL'S method) with perturbations from all planets Mercury-Pluto included. This computation was undertaken by H. Q. RASMUSEN of Værsløvgaarden, Værsløv, who also helped in some checking computations.

For the apparition 1943/44 the following 30 observations, listed in Table b, were available to the writer when the comparison with the ephemeris resulting from the above mentioned rectangular co-ordinates was made.

Table b.

No.	Place	U. T.-Ab.t	α 1950.0 geoc.	δ 1950.0 geoc.	$\Delta\alpha \cos\delta$	$\Delta\delta$
1	Turku	1943 Oct. 2.03810	2h42 ^m 11 ^s .31	+1° 19' 41".2	-137.8	-67.4
2	—	6.02666	2 40 25.37	+1 13 39.3	-139.1	-68.0
3	Mc.Donald	21.18430	2 30 1.66	+0 56 12.6	-151.5	-76.5
4	—	23.20567	2 28 18.28	+0 55 16.2	-152.5	-74.8
5	—	24.19296	2 27 25.38	+0 55 14.4	-151.7	-58.2
6	—	25.18506	2 26 31.27	+0 55 10.6	-151.2	-50.7
7	—	26.36959	2 25 25.47	+0 55 7.3	-151.5	-50.1
8	—	28.22500	2 23 40.15	+0 54 58.8	-153.1	-75.7
9	Vienna	28.94666	2 22 58.69	+0 55 14.5	-150.9	-74.4
10	—	Nov. 2.84963	2 18 9.37	+0 59 21.8	-149.9	-56.4
11	Yerkes	14.01353	2 7 5.68	+1 24 9.5	-150.3	-66.2
12	—	25.02669	1 57 31.60	+2 14 21.9	-144.9	-76.0
13	—	28.01298	1 55 22.56	+2 32 33.3	-143.0	-74.2
14	—	Dec. 15.01276	1 48 15.67	+4 50 51.5	-123.2	-70.0
15	—	22.99957	1 48 17.88	+6 13 48.8	-113.9	-74.4
16	Lick	24.26289	1 48 30.43	+6 27 51.9	-114.9	-72.7
17	Yerkes	1944 Jan. 13.02220	1 58 56.97	+10 32 59.4	-99.9	-70.7
18	Lick	18.16747	2 3 44.09	+11 42 59.7	-99.2	-68.5
19	—	18.17691	2 3 44.83	+11 43 6.8	-96.9	-69.2
20	Yerkes	21.07739	2 6 47.69	+12 23 21.8	-95.2	-68.5
21	—	24.05676	2 10 10.92	+13 5 13.3	-94.7	-67.2
22	Lick	Feb. 12.17378	2 37 41.57	+17 40 43.6	-91.2	-62.3
23	Yerkes	17.04042	2 46 10.75	+18 51 5.6	-88.3	-62.6
24	—	19.06638	2 49 52.72	+19 20 13.7	-87.7	-62.6
25	Mc.Donald	Mar. 21.10643	3 57 56.20	+26 12 38.3	-85.3	-50.7
26	—	27.08786	4 13 17.47	+27 19 28.8	-86.2	-48.5
27	Yerkes	June 14.11951	8 7 57.07	+29 43 18.4	-74.1	-1.6
28	—	14.12709	8 7 58.05	+29 43 18.7	-78.6	+2.0
29	—	15.12226	8 10 51.70	+29 35 43.7	-79.6	-3.0
30	—	15.12880	8 10 53.04	+29 35 46.1	-77.0	+2.4

All observations given the weight 1.

No.	U. T. — Ab.t.	1950.0			Perturbations in			Weight 1/p	O - C	
		α 1950.0	δ 1950.0	x	y	z	$\Delta\alpha \cos\delta$		$\Delta\delta$	
I	1926 Nov. 11.24089	+42°56'39".7	6°59'29".1	0.000 000	0.000 000	0.000 000	4.6	-0.7	+0.7	
II	26.73031	+39 8 46.8	+ 8 20 3.9	0.000 000	0.000 000	0.000 000	6.4	+0.1	+0.9	
III	Dec. 7.40212	+37 6 4.5	+ 9 40 11.8	-0.000 001	0.000 000	0.000 000	5.7	+1.4	-0.1	
IV	24.20689	+36 44 58.2	+12 24 0.0	-0.000 001	-0.000 002	-0.000 001	4.5	-0.9	-1.4	
V	3.93345	+36 17 59.5	+14 27 47.5	-0.000 002	-0.000 003	-0.000 001	4.5	+1.8	-1.2	
VI	25.32095	+40 53 11.6	+19 2 39.0	-0.000 006	-0.000 004	-0.000 002	4.4	+0.2	-0.7	
VII	3.43648	+43 42 18.8	+21 4 45.1	-0.000 010	-0.000 006	-0.000 002	3.7	+0.6	-0.2	
VIII	17.35245	+49 35 3.0	+24 8 42.7	-0.000 014	-0.000 010	-0.000 004	2.6	-1.9	-2.4	
IX	1.47835	+55 47 1.0	+26 39 30.2	-0.000 019	-0.000 014	-0.000 006	2.2	-0.4	-2.4	
X	20.45936	+67 13 48.5	+30 0 38.7	-0.000 027	-0.000 017	-0.000 007	1.4	+4.0	-3.0	
XI	30.46293	+73 58 24.5	+31 22 1.8	-0.000 031	-0.000 021	-0.000 010	2.6	-1.7	+1.3	
XII	26.81407	+94 1 7.4	+33 9 26.9	-0.000 045	-0.000 034	-0.000 017	2.0	-1.6	+0.8	
XIII	5.39050	+100 31 18.3	+33 4 57.1	-0.000 049	-0.000 036	-0.000 019	1.4	-3.0	-1.2	
XIV	24.10799	+114 32 50.8	+31 53 25.4	-0.000 059	-0.000 042	-0.000 022	2.0	+0.5	+0.8	
XV	11.67190	+97 42 35.4	+25 5 55.6	+0.147 810	+0.013 602	+0.028 378	2.0	-4.6	+0.9	
XVI	31.74122	+112 8 5.1	+25 36 8.6	+0.150 309	+0.028 695	-0.020 981	1.8	+2.2	+0.3	
XVII	29.20828	+132 38 21.4	+24 31 43.1	+0.148 646	+0.050 760	-0.008 840	2.5	+3.5	+1.4	
XVIII	3.39824	+156 4 35.4	+24 31 43.1	+0.137 867	+0.075 691	+0.007 044	1.7	+0.2	+1.2	
XIX	25.96273	+168 56 58.6	+19 10 52.3	+0.126 872	+0.088 598	+0.016 551	2.2	+5.7	-0.2	
XX	Dec. 22.89877	+181 4 31.0	+17 45 17.4	+0.111 332	+0.100 067	+0.026 335	2.0	+5.3	+0.6	
XXI	Jan. 26.16781	+189 15 25.0	+21 18 23.5	+0.090 422	+0.108 748	+0.035 824	2.4	+5.6	+4.3	
XXII	Feb. 22.95642	+188 13 39.6	+21 35 44.9	+0.074 158	+0.111 852	+0.041 198	2.0	-0.2	+1.3	
XXIII	Mar. 19.61946	+182 46 57.4	+22 38 12.4	+0.060 368	+0.112 440	+0.044 620	2.8	-0.7	+4.3	
XXIV	Apr. 13.76253	+178 1 52.0	+21 35 22.1	+0.048 204	+0.111 515	+0.046 831	2.6	+0.9	+3.5	
XXV	May 18.62287	+177 23 49.2	+16 35 31.2	+0.035 549	+0.108 620	+0.048 495	2.2	+2.9	-4.4	
XXVI	June 10.20574	+180 13 38.3	+12 39 39.4	+0.025 323	+0.106 106	+0.048 928	1.4	+1.8	+1.8	
XXVII	July 16.21071	+187 46 2.6	+ 6 16 52.1	+0.014 013	+0.101 511	+0.048 884	1.0	+4.8	+0.5	
XXVIII	Oct. 4.03238	+40 20 40.0	+ 1 16 46.9	+0.095 096	-0.057 170	-0.053 186	1.4	-7.9	-3.7	
XXIX	26.39486	+ 36 21 19.9	+ 0 54 59.8	+0.103 925	-0.051 488	-0.052 401	2.8	-10.9	+7.0	
XXX	Nov. 22.35107	+ 29 54 51.7	+ 1 59 52.9	+0.114 782	-0.042 522	-0.050 371	1.7	-7.2	-0.4	
XXXI	Dec. 20.75841	+ 27 1 3.9	+ 5 49 35.5	+0.125 806	-0.030 144	-0.046 547	1.7	-6.9	-1.0	
XXXII	Jan. 18.90015	+ 31 7 15.3	+11 53 6.5	+0.135 435	-0.014 076	-0.040 380	2.2	-6.1	+0.5	
XXXIII	Feb. 16.09353	+ 41 7 10.2	+18 37 26.1	+0.141 490	+0.004 376	-0.032 026	1.7	-0.04	+0.5	
XXXIV	Mar. 24.09714	+ 61 22 45.0	+26 46 45.1	+0.141 867	+0.030 748	-0.018 019	1.4	-2.3	-0.8	
XXXV	June 14.62442	+122 20 57.2	+29 39 38.2	+0.110 574	+0.076 116	+0.013 714	2.0	+5.7	-1.8	