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

KØBENHAVN
I KOMMISSION HOS EJNAR MUNKSGAARD
1951

Printed in Denmark
Bianco Lunos Bogtrykkeri

The present work is a continuation of that published in Mathematisk-fysiske Meddelelser X, 13 and XII, 5[1] 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.

$$
\text{(I)} \qquad
\begin{aligned}
T &= 1927\ \text{March}\ 22.1929\ \text{U.T.} \\
\omega &= 38°28'37''.7 \\
\Omega &= 65°55'52''.0 \quad 1950.0 \\
i &= 13°45'47''.1 \\
\varphi &= 35°\ 6'26''.4 \\
a &= 4.17176
\end{aligned}
$$

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 pre-diction prepared by Dinwoodie and Henderson (Handbook 1943 of the British Astronomical Association). For this pre-diction 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.

[1] Publikationer og mindre Meddelelser fra Københavns Observatorium Nos. 74 and 85.

Table a.

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	$6^h24^m20^s.59$	+24° 58′ 3″.3	+2242″.3	+406″.4	1
2	—	11.38173	6 30 1.30	+25 5 9.4	+2250.4	+405.0	1
3	Lick	12.46141	6 33 6.19	+25 8 21.7	+2280.4	+384.3	1
4	—	13.48007	6 35 59.65	+25 11 21.6	+2290.3	+374.4	1
5	Yerkes	24.36943	7 7 13.03	+25 32 43.2	+2395.1	+239.4	1
6	—	25.36882	7 10 5.89	+25 33 41.1	+2398.1	+224.8	1
7	Lick	Sep. 2.45351	7 33 31.71	+25 35 40.3	+2457.6	+111.6	1
8	—	2.48545	7 33 37.22	+25 35 39.6	+2457.2	+111.2	1
9	Yerkes	5.38684	7 42 2.64	+25 33 49.1	+2475.4	+ 70.8	1
10	—	6.38364	7 44 56.34	+25 32 51.4	+2482.2	+ 54.8	1
11	—	24.39315	8 36 54.08	+24 49 35.7	+2552.6	—214.5	1
12	Lick	27.49769	8 45 43.80	+24 38 39.0	+2553.7	—262.5	1
13	—	27.50880	8 45 45.76	+24 38 35.8	+2554.7	—263.2	1
14	Algier	28.16408	8 47 36.60	+24 36 1.4	+2547.5	—270.0	1/2
15	Lick	29.48853	8 51 21.75	+24 30 31.9	+2555.0	—292.2	1
16	—	29.49569	8 51 23.01	+24 30 30.0	+2555.7	—292.4	1
17	Yerkes	Oct. 7.38841	9 13 26.79	+23 54 7.8	+2560.9	—413.0	1
18	Bergedorf	24.13492	9 58 22.39	+22 20 42.8	+2510.2	—659.0	1
19	Lick	Nov. 8.52690	10 36 43.95	+20 47 23.0	+2450.4	—865.5	1
20	—	8.53315	10 36 44.86	+20 47 21.0	+2450.4	—865.3	1
21	—	21.46154	11 6 13.24	+19 33 46.1	+2387.3	—1031.8	1
22	—	21.49209	11 6 17.22	+19 33 36.3	+2387.3	—1032.3	1
23	Yerkes	23.43815	11 10 28.21	+19 23 32.5	+2373.3	—1054.2	1
24	Harvard	25.41399	11 14 38.57	+19 29 55.4	+2352.8	— 103.3	0
25	Tashkent	Dec. 1.01212	11 26 5.46	+18 47 41.1	+2339.6	—1146.5	1
26	Yerkes	2.41029	11 28 51.03	+18 41 40.5	+2334.2	—1167.6	1
27	Lick	21.41548	12 2 4.55	+17 47 13.6	+2281.8	—1407.6	1
28	—	21.42520	12 2 5.43	+17 47 12.8	+2281.8	—1407.7	1
29	Yerkes	21.43661	12 2 6.48	+17 47 14.0	+2282.0	—1405.7	1
30	—	27.31821	12 10 34.36	+17 39 40.1	+2278.2	—1480.1	1
31	—	1936 Jan. 24.26785	12 36 15.49	+18 44 17.0	+2416.2	—1858.4	1
32	Lick	24.43572	12 36 19.84	+18 45 5.2	+2417.7	—1859.2	1
33	—	24.45377	12 36 20.25	+18 45 10.1	+2417.1	—1859.5	1
34	Yerkes	25.28745	12 36 40.97	+18 49 7.5	+2426.0	—1868.8	1
35	—	28.26435	12 37 41.81	+19 3 58.2	+2454.5	—1903.6	1
36	—	30.29838	12 38 11.87	+19 14 45.6	+2476.4	—1905.8	1
37	Tokyo	30.7222–	12 38 17.0–	+19 16 45.–	+2482.–	—1949.–	0
38	—	31.7007–	12 38 27.0–	+19 22 27.–	+2490.–	—1941.–	0
39	—	Feb. 1.7208–	12 38 33.8–	+19 28 11.–	+2481.–	—1951.–	0
40	—	2.7715–	12 38 41.2–	+19 33 43.–	+2512.–	—1989.–	0
41	—	3.8293–	12 38 44.9–	+19 40 18.–	+2526.–	—1972.–	0
42	Yerkes	18.25958	12 35 28.99	+21 8 20.8	+2706.1	—2057.8	1
43	—	22.19179	12 33 21.62	+21 31 34.8	+2748.9	—2057.3	1
44	Uccle	23.11683	12 32 47.61	+21 36 50.1	+2758.6	—2056.0	1
45	Yerkes	28.25780	12 29 14.23	+22 3 56.6	+2809.9	—2053.6	1
46	—	Mar. 16.20874	12 14 18.87	+22 58 0.5	+2865.8	—1842.7	1
47	Bergedorf	16.96213	12 13 35.99	+22 57 5.7	+2860.1	—1867.0	1
48	Yerkes	18.21660	12 12 25.51	+22 57 54.0	+2859.7	—1847.2	1
49	Uccle	18.96559	12 11 43.45	+22 58 6.3	+2857.5	—1838.9	1
50	Bergedorf	20.04561	12 10 40.24	+22 58 14.9	+2846.6	—1818.5	1
51	Lick	21.27399	12 9 34.40	+22 57 58.0	+2842.1	—1799.5	1
52	—	21.30454	12 9 32.76	+22 57 56.4	+2842.7	—1799.9	1
53	Uccle	23.97876	12 7 6.74	+22 55 53.8	+2827.3	—1751.7	1

Table a (continued).

No.	Place	U.T. — Ab.t	α 1950.0 geoc.	δ 1950.0 geoc.	$\Delta\alpha\cos\delta$	$\Delta\delta$	Weight
54	Uccle	April 9.86355	$11^h54^m13^s.69$	$+21°58'10''.8$	$+2602''.8$	$-1474''.9$	1
55	Kiel	9.86848	11 54 13.62	+21 58 7.1	+2604.3	—1476.9	1
56	Yerkes	12.15588	11 52 56.22	+21 45 7.7	+2565.8	—1438.9	1
57	Bergedorf	14.88082	11 51 33.77	+21 28 14.3	+2516.4	—1397.6	1
58	Lick	16.18745	11 50 58.29	+21 19 39.7	+2492.6	—1377.0	1
59	—	16.20689	11 50 57.82	+21 19 31.6	+2493.0	—1377.0	1
60	Yerkes	17.17479	11 50 33.03	+21 13 36.9	+2473.4	—1323.2	1
61	—	May 14.14314	11 48 22.36	+17 20 9.1	+1955.1	—1034.2	1
62	Bergedorf	18.9253–	11 49 40.29	+16 32 28.7	+1866.6	—984.9	1
63	—	19.9391–	11 50 0.47	+16 22 12.3	+1851.1	—976.9	1
64	—	19.9786–	11 50 1.10	+16 21 48.1	+1847.8	—976.8	1
65	Yerkes	20.12829	11 50 4.16	+16 20 16.1	+1845.2	—976.2	1
66	Lick	June 10.19535	12 0 53.83	+12 39 43.0	+1514.2	—813.3	1
67	—	10.21618	12 0 54.64	+12 39 29.6	+1513.6	—813.2	1
68	—	July 16.21074	12 31 4.40	+ 6 16 46.7	+1111.4	—624.2	1

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.

(II)
$$\left.\begin{aligned} T &= 1927\ \text{March}\ 22.21359\ \text{U.T.} \\ \omega' &= 82°30'28''.5 \\ \Omega' &= 24°33'24''.8 \\ i' &= 31°31'\ 4''.9 \\ e &= 0.574\ 9441 \\ a &= 4.170\ 144 \end{aligned}\right\}\ \text{Equator 1950.0}$$

or, referred to the ecliptic:

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

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 Værslevgaarden, Værslev, 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	1943Oct. 2.03810	$2^h42^m11^s.31$	+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
		1944				
17	Yerkes	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.

Table c.

No.	U. T. — Ab.t.	α 1950.0	δ 1950.0	Perturbations in x	Perturbations in y	Perturbations in z	Weight $\sqrt{p}$	O - C $\Delta\alpha \cos\delta$	O - C $\Delta\delta$
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	—0.000 001	5.7	+1.4	—0.1
IV	24.20689	+35 44 58.2	+12 24 0.0	—0.000 001	—0.000 002	—0.000 001	4.5	—0.9	—1.4
V	1927 Jan. 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 39 11.6	+19 2 39.0	—0.000 006	—0.000 004	—0.000 002	4.4	+0.2	—0.7
VII	Feb. 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	Mar. 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	Apr. 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	May 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	1935 Aug. 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	Sep. 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	Nov. 3.39824	+156 4 35.4	+21 18 23.5	+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	1936 Jan. 26.16781	+189 15 25.0	+18 53 16.5	+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 58 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	+0.033 549	+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	1943 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	—6.9	+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	—10.9	+1.7
XXXI	Dec. 20.75841	+ 27 1 3.9	+ 5 49 35.5	+0.125 806	—0.030 144	—0.046 547	1.7	—7.2	—0.4
XXXII	1944 Jan. 18.90015	+ 31 7 15.3	+11 53 6.5	+0.135 435	—0.014 076	—0.040 380	2.2	—6.9	—1.0
XXXIII	Feb. 16.09353	+ 41 7 10.2	+18 37 26.1	+0.141 490	+0.004 376	—0.032 026	1.7	—6.1	+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

The 30 observations were formed into 8 normal places that together with the 27 normal places from the two previous apparitions yielded 70 equations of condition for a least squares' solution, from which resulted the following set of elements:

Osculation 1926 Nov. 30.0 U.T.

$$T = 1927 \text{ March } 22.19299 \pm 0.000721 \text{ U.T.}$$

(III)

$$\left.\begin{aligned} \omega' &= 82°30'\ 9''.93 \pm 1''.032 \\ \Omega' &= 24°33'13''.38 \pm 0''.426 \\ i' &= 31°30'59''.83 \pm 0''.302 \end{aligned}\right\} \text{Equator } 1950.0$$

$$\begin{aligned} e &= 0.57496013 \pm 0.000\,000370 \\ a &= 4.1701778 \pm 0.000\,00019 \end{aligned}$$

$$\left.\begin{aligned} \omega &= 38°28'43''.74 \\ \Omega &= 65°55'50''.94 \\ i &= 13°45'47''.67 \end{aligned}\right\} \text{Ecliptic } 1950.0$$

$$\begin{aligned} x &= -0.9697348\ (\cos E - e) - 3.2346013 \sin E \\ y &= +3.4320184\ (\cos E - e) - 1.0605087 \sin E \\ z &= +2.1613068\ (\cos E - e) + 0.2327200 \sin E \end{aligned}$$

The data for the 35 normal places are shown in Table c, where in columns 9 and 10 are listed the final residuals (O—C), derived from a direct comparison between the right ascensions and declinations of the normal places (columns 3 and 4) and the corresponding quantities computed from the above elements III for the time t—Ab.t. It should be mentioned that in all computations of right ascensions and declinations the rectangular solar co-ordinates have been corrected for $\Delta L\odot = +1''.00$, that is, the values provided by E. C. Bower (Lick Observatory Bulletin 445, p. 36) have been divided by 1.47.

University Observatory, Copenhagen,
1950 June.

Indleveret til selskabet den 15. juni 1950.
Færdig fra trykkeriet den 31. januar 1951.