No. 155 THE ORBIT OF COMET 1941c–1941 IV (DE KOCK-PARASKEVOPOULOS)

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ABSTRACT

The 156 observations of Comet 1941c, covering an interval of 268 days, have been grouped in 7 normal places. The differential correction led to an elliptic orbit with an eccentricity of 0.9999574. Both the original and the future values of the reciprocal semi-major axis remain positive.

On the morning of January 15, 1941, when the variable-star observer R. P. de Kock, at Paarl (S.A.), set his telescope on R Lupi, he discovered a comet which he estimated with the naked eye as of 5.8 magnitude. He reported his discovery to the Royal Observatory, Capetown. The brightness increased rapidly during the following days. The comet was independently picked up by J. S. Paraskevopoulos at the Boyden Station, Bloemfontein, on January 23 when he called the brightness 3.5 magnitude and estimated the tail as 5° in length. That same morning the comet was independently found by R. Grandón at Santiago (Chile) and on January 24 by M. Dartayet, J. Bobone and Cecilio at Córdoba (Argentina) and by E. Roubaud and A. Pochintesta at Montevideo (Uruguay). By that time the comet had reached second magnitude. As a naked eye spectacle the comet was at its best on the evening of February 2. R. H. Stoy (1941) gave a detailed description of the tail activity, which he compared with that of Donati's comet 1858VI. On January 30 the comet came within 0.26 astronomical units of the earth. Its motion was then as fast as 27″ per minute of time. Insufficient precision of timing may partly account for the scattering of some of the measures at the time.

After the full moon on February 12 the comet was less bright but was abundantly observed. On February 19 no less than ten observations were reported. On March 16 the magnitude was estimated at 8.0 by both E. Loreta and E. Buchar. Measures continued until March 29 when I last recorded the comet at low altitude in the evening sky. After conjunction of the comet with the sun I picked it up in the morning sky when it was reduced to a round, diffuse coma of 12″ in diameter and magnitude 15. Only a small number of measures were obtained after that; the last one is by H. M. Jeffers at the Lick Observatory on September 17. He described the comet as a sharp coma of 10″ diameter and magnitude 17, surrounded by a faint haze.

Many computers deduced orbits from short arcs after the discovery. They showed that perihelion passage occurred on January 27, 1941, and that the comet moved in a retrograde orbit inclined only 12° to the ecliptic. I thought the best available orbit was the one obtained by Chang and Li (1944) from five normal positions by variation of geocentric distances. However, these elements left unacceptable residuals and something must be wrong with them. As a start for the differential correction I used instead the parabolic elements by Bobone (1941) based on Cór-

doba positions on January 25, February 13, and March 2:

$$\left.\begin{aligned} T &= 1941\ \text{January}\ 27.66038\ \text{UT} \\ \omega &= 268^\circ\ 40'\ 26''.0 \\ \Omega &=\ 42\ \ 15\ \ 7.3 \\ i &= 168\ \ 11\ 47.3 \\ q &= 0.790012\ \text{AU} \end{aligned}\right\} 1941.0$$

Table I gives the residuals from this orbit. Some of the positions were given only approximately and deserved low weight. Others based on multiple exposures were of the highest weight. This was taken into account in grouping the 156 measures in the seven normal places listed in Table II. A number of measures showing unacceptably large residuals were omitted.

TABLE I

Residuals O - C

UT	Δα	Δδ	Obs
1941			
Jan 18.06978	+2ˢ.21	- 5″.8	Wo
18.09057	+1.76	- 4.5	Wo
19.05585	+0.39	+ 3.6	Wo
20.06857	+0.21	+ 3.5	Wo
20.11945	+1.08	- 4.2	S
21.11120	+1.70	+ 0.2	S
22.10615	+1.23	-15.6	S
23.11920	+0.47	- 4.0	S
24.11590	+0.44	+ 6.9	S
24.30050	+1.45	+[illegible]	G
24.34031	+0.93	+[illegible]	B
24.35581	+1.76	-	B
25.06906	-0.17	-	Wo
25.12599	+0.01	-	S
25.32977	-0.07	-	G
26.09695	+1.86	-	Wo
26.12394	-1.16	-	S
26.31447	+2.87	+ 0.5	C
Feb 2.80564	-0.67	+12.5	S
4.80575	-	- 2.8	S
5.60773	+0.40	- 7.9	V
5.98119	+0.21	+ 2.8	Ra
5.99301	+0.68	+ 2.3	Wi
5.99976	-0.02	+ 1.7	A
6.69575	-0.72	+ 7.0	Va
7.43198	-0.69	-	Rh
7.79528	+0.11	+ 2.0	S
9.01317	+0.35	+ 3.2	Wi
9.01322	-0.02	- 3.6	V
9.03076	+0.84	+ 6.6	L
9.79044	+0.04	+ 6.7	S
9.99826	-0.11	+ 2.5	A
10.75907	+0.16	+ 1.6	Ku
10.76537	-0.05	-	J
10.76989	+0.20	- 3.5	J
10.78022	-0.15	+ 2.4	Ri
10.97578	+0.16	-	H
10.99819	-0.19	- 4.8	A
11.00977	-0.20	+ 3.2	V
11.01287	+0.14	+ 2.1	Ra
11.73364	-0.52	+ 7.5	K
11.75766	-0.42	-12.8	Va
12.00037	+0.13	+ 0.4	A
12.03635	+0.24	+ 0.8	L
12.72275	-0.02	- 2.7	G1
12.79403	-	- 4.9	Kn
13.02553	-0.03	- 0.6	A
13.84959	0.00	- 8.7	D
14.72983	+0.65	- 7.3	K
14.77795	+0.54	- 3.7	S
14.82723	+0.25	+ 3.6	Ri
15.01373	-0.06	- 0.9	V
15.75036	-0.37	+ 7.3	Ko
15.77251	+0.30	+ 2.5	K
15.77825	+0.30	+ 7.3	Ar
15.77970	-0.07	+ 9.6	J
15.81209	0.00	- 2.8	Vo
15.99976	-0.02	+ 3.8	A
16.58562	-0.14	+ 8.9	Z
16.60572	-0.26	+ 2.6	Z
16.75978	-0.13	+ 0.4	J
16.76463	-0.23	+ 1.4	J
17.71842	-	+ 1.3	G1
17.72354	+0.20	+ 0.5	K
Feb 18.01392	+0ˢ.12	+ 1″.6	V
18.63487	-0.04	- 1.8	Z
19.03746	+0.19	+11.8	L
19.73653	+0.12	0.0	K
19.77230	-0.05	- 0.3	P
19.78962	-0.40	+ 1.0	Ri
19.80285	+0.30	+ 4.8	P
19.80979	+0.04	- 0.2	V
19.81384	+0.21	+ 7.5	Ri
19.99830	+0.24	+10.9	Ri
20.00264	+0.13	+ 1.2	H
20.03805	+0.31	+ 7.4	V
20.62157	+0.12	- 0.7	L
20.63298	+0.02	+ 1.1	Z
20.76391	+0.29	+ 0.7	V
20.76755	+0.50	- 1.2	V
20.77155	+0.70	+ 7.2	V
20.77557	+0.02	+ 2.0	Ri
20.98790	+0.39	+ 9.9	H
Feb 21.03448	+0.10	- 0.3	L
21.74997	+0.05	+ 0.8	V
21.75248	-0.62	+ 1.5	F
22.00068	-0.18	+ 3.9	G
22.01084	0.00	- 4.8	Ra
22.71824	-0.18	+ 3.9	G
22.73108	+0.04	+ 9.0	K
22.76716	-0.07	+ 6.1	S
22.83215	+2.60	+ 0.7	Ri
24.09226	+0.20	- 6.3	V
25.01169	+0.09	- 0.1	H
25.63476	+0.08	-10.4	Z
25.72892	+0.14	+ 5.3	K
25.76854	+0.05	+ 4.9	S
26.01939	+0.13	+ 1.6	L
26.03998	+0.10	+ 1.4	V
26.77057	+0.20	- 0.6	V
26.77449	+0.24	+ 3.8	Ri
27.65149	+0.11	+ 6.4	Z
27.76043	+0.20	+ 9.4	S
27.78480	+0.27	- 1.0	F
27.82410	-	+ 2.9	Kn
28.77357	-0.28	-	Cp
28.78707	+0.28	- 1.4	F
Mar 1.03183	+0.29	+ 0.2	V
1.76122	+0.71	+ 6.9	K
1.77017	+0.22	+ 0.3	Vo
2.74768	+0.26	-	Pr
2.75408	+0.12	+10.4	K
3.01270	+0.15	+ 5.2	L
3.01537	+0.23	+ 2.5	L
4.01776	+0.90	- 0.8	Ra
4.72056	+0.14	+ 0.5	G1
4.75662	+0.04	+ 1.3	Vo
4.76425	+0.42	- 0.6	Vo
4.77702	+0.51	+ 4.0	Vo
5.78733	+0.49	- 5.4	Vo
6.00457	+0.08	+ 2.5	Ra
6.77055	+0.43	- 0.8	Vo
6.78262	+0.63	-	Gi
6.78831	0.00	-	J
6.91560	+0.03	+ 2.5	Gi
7.75433	+0.31	-	K
Mar 8.71808	-0ˢ.04	- 6″.0	G1
9.76084	+0.28	+ 1.2	Vo
9.76430	+0.45	+ 6.0	Vo
12.97026	+0.25	+ 1.0	Vo
12.75870	+0.11	- 0.2	Vo
13.76636	+0.27	- 8.1	Vo
14.76970	+0.01	+ 1.3	Vo
14.78585	+0.05	- 1.0	J
14.80202	+0.03	+ 6.5	J
15.77016	+0.13	- 1.5	V
15.78839	-0.14	+ 1.3	Ar
15.79272	-0.11	+ 1.0	Ar
15.79604	+0.28	+ 0.1	Ar
17.75985	+0.08	-	K
17.77924	+0.03	-	Vo
18.05250	+0.09	+ 1.0	Vo
19.01774	+0.03	+ 1.0	L
19.05517	0.00	- 0.9	V
19.79057	+0.39	+ 7.2	Vo
20.02061	+0.05	-	L
20.79883	-0.27	+ 5.8	J
22.05206	-0.12	+ 1.7	V
22.05484	-0.10	+ 0.5	V
29.05102	+0.44	- 2.4	V
Jul 4.32120	+0.39	+ 7.7	V
4.33339	+0.16	+ 6.8	V
6.35064	-0.27	+ 4.0	V
Jul 23.45159	-0.63	+ 8.2	Je
23.46477	-0.71	+ 8.6	Je
Sep 17.36267	-3.78	+ 3.8	Je

Observers

A	Anderson - McCormick
Ar	Arend - Uccle
B	Bobone - Córdoba
C	Castro - Santiago
Cp	Campa - Milan
G	Grandón - Santiago
Gi	Gialanella - Rome
G1	Gleissberg - Istanbul
H	Hollander - Yale
J	Jekhowsky - Toulouse
Je	Jeffers - Lick
K	Krumpholz - Vienna
Kn	Knöchel - Danzig
Ko	Koziel - Cracow
Ku	Kulin - Budapest
L	Lyons - Washington
La	Lanze - Tashkent
M	Missana - Turin
Pr	Protitch - Belgrade
Ra	Raynsford - Washington
Rh	Rheinberger - Riverview
Ri	Rigaux - Uccle
S	Stoy - Capetown
V	Van Biesbroeck - Yerkes
Va	Väisälä - Turku
Vo	Volk - Wurzberg
Wi	Willis - Washington
Wo	Wood - Johannesburg

TABLE II

Normal Places

UT	Residuals, O-C Δαcosδ	Δδ	Weight	Perturbations Δαcosδ	Δδ	Be Corrected Δαcosδ	Δδ	Final Residuals Δαcosδ	Δδ
1941 Jan 23.0	+ 5″.3	-3″.5	18	0″.0	0″.0	+ 5″.3	-3″.5	0″.0	+0″.1
Feb 15.0	+ 0.3	+1.0	61	0.0	0.0	+ 0.3	+1.0	+0.4	+0.4
Mar 2.0	+ 0.2	+2.2	46	0.0	0.0	+ 0.2	+2.2	-0.2	-0.4
Mar 28.0	+ 1.3	+0.5	21	0.0	+0.1	+ 1.3	+0.4	+1.0	-0.7
Jul 5.0	+ 1.3	+5.9	3	+1.1	+0.3	- 0.2	+5.6	-0.2	+0.6
Jul 23.46	- 9.6	+8.4	2	+4.2	+0.5	-13.3	+7.9	+0.5	-2.0
Sep 17.35	-54.9	+3.8	1	+13.6	+3.9	-68.5	-0.1	-1.1	+2.4

Planetary perturbations were computed in 20-day intervals for the planets Venus to Neptune and interpolated for the dates of the normal places. The date February 5 was used as osculation time. The results are given in Table II.

The equations of condition were computed in the form given by Stracke (1929) for which it was necessary to transform the ecliptic elements into equatorial ones:

$$\left.\begin{aligned} \omega' &= 151^\circ 14' 14''.9 \\ \Omega' &=\ 19\ \ 17\ 10.4 \\ i' &= 163\ \ 23\ 26.7 \end{aligned}\right\} 1941.0$$

The least squares solution was performed on the IBM 1130 computer of the Lunar and Planetary Laboratory. The final corrections and their probable errors came out as follows:

$$\begin{aligned} \Delta\omega' &= +4''.65 \pm 0''.46 \\ \Delta\Omega' &= +1.01 \pm 0.78 \\ \Delta i' &= -1.01 \pm 0.24 \\ \Delta e &= -0.0000426 \pm 0.0000098 \\ \Delta q &= +0.0000009 \pm 0.0000003\ \text{AU} \\ \Delta T &= -0.0014885 \pm 0.0000674\ \text{day} \end{aligned}$$

Then the final elements (osculation date 1941 Feb. 5.0) are:

Equator

1941

$$\begin{aligned} \omega' &= 151^\circ 14' 19''.6 \\ \Omega' &=\ 19\ \ 17\ 11.4 \\ i' &= 163\ \ 23\ 25.7 \end{aligned}$$

Ecliptic 1941	*Ecliptic* 1950
$\omega = 268^\circ 40' 25''.6$	$\omega = 268^\circ 40' 10''.2$
$\Omega =\ 42\ \ 15\ 10.3$	$\Omega =\ 42\ \ 22\ 57.7$
$i = 168\ \ 11\ 48.8$	$i = 168\ \ 11\ 51.6$

$$\begin{aligned} e &= 0.9999574 \\ q &= 0.7900129\ \text{AU} \\ T &= 1941\ \text{Jan}\ 27.658892\ \text{UT} = \text{Jan}\ 27.659176\ \text{ET} \end{aligned}$$

To complete the information about this comet it is necessary to establish what the original and future

values of the eccentricity are when the comet is far removed from the center of the solar system. Dr. B. G. Marsden kindly offered to perform the necessary computations on the CDC 6400 computer of the Smithsonian Astrophysical Observatory in Cambridge. From the above elements $1/a = +0.0000539$ results for the value of the reciprocal semi-major axis at the time of oscultation 1941 Feb. 5.0. The result of the computation is as follows:

	1/a
Osculation 1941 Feb 5.0	+0.0000539
Perturbations 1941–1921	+0.0009583
Reduction to barycenter	−0.0000655
Original value (1921 Jan 31.0) at r = 40.5 AU	+0.0009467
Perturbations 1941–1961	−0.0001979
Reduction to barycenter	+0.0001914
Future value (1961 Jan 21.0) at r = 40.7 AU	+0.0000474

This shows that the comet is a permanent member of the solar system.

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