No. 153 DEFINITIVE ORBIT OF COMET 1940d-1940IV (WHIPPLE-PARASKEVOPOULOS)

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ABSTRACT

Using all available measures a final orbit was deduced, which comes out elliptical with a period of 432 years.

On September 30, 1940, F. L. Whipple (1940) announced the discovery of Comet 1940d= 1940IV on a Harvard patrol plate of the Aquila region taken on August 18. The comet appeared as a 10.5 magnitude, round coma moving southwestward. Its image was subsequently recognized on several earlier patrol plates beginning on July 29. The comet had also been recorded on a number of patrol plates taken at Sonneberg and at Bloemfontein. Further, it was found independently by J. Paraskevopoulos (1940) on October 8, hence the names of the two discoverers. By that time the comet had moved far into the Southern Hemisphere. J. Bobone at Cordoba and B. Dawson at La Plata (Argentina) obtained the first accurate positions on October 4. The magnitude was called 11.8 at that time. The latter observer was the only one who followed the comet as it slowly faded. His long series of measures extends to January 1, 1941. He did not record any estimates of brightness. By the time of his last measure the magnitude must have been around 15, and since the declination was then −48°, no northern observers contributed any measures thereafter.

Preliminary parabolic orbits were obtained by Whipple and by J. A. Maxwell from positions on patrol plates taken between July 29 and August 10:

	WHIPPLE	MAXWELL
T	Oct 7.894	Oct 7.881 UT
ω	235°16′	235°15′6
Ω	134 10	134 9.8
i	55 12	55 10.6
q	1.0875 AU	1.08756 AU

The last observation, on January 1, 1941, gave the residuals: $+2^m19^s$ and +22′6, from Maxwell's orbit. Since these residuals are too large for a differ-

ential correction, I computed a better parabolic orbit, but it still left residuals of nearly 4′. B. G. Marsden kindly supplied a more accurate elliptic orbit (private communication), which was used as a basis for a differential correction:

T	1940	Oct 8.2478 ET	
ω		235°.7295	1950.0
Ω		134.3663	
i		54.6984	
q		1.082247 AU	
e		0.981073	

Table I shows the residuals from these elements.

TABLE I

Residuals, O - C

UT	Δα	Δδ	Obs.	UT	Δα	Δδ	Obs.
1940 Jul 28.95	-1ˢ.35	+15".6	A	1940 Nov 2.30	-0ˢ.19	- 6".2	D
29.16	-0.18	- 5.6	W	4.23	-0.50	-12.4	D
Aug 1.19	-0.10	+19.7	W	4.27	-0.63	- 9.2	D
1.88	+0.95	+ 5.2	A	5.19	-0.02	- 3.8	D
4.86	-0.01	-10.4	H	5.21	-0.27	- 5.5	D
4.94	+0.07	- 9.5	H	5.23	-0.12	- 5.2	D
5.16	-0.76	- 3.4	W	6.19	0.00	- 4.9	D
5.81	-0.22	- 1.2	G	6.21	-0.14	+ 1.0	D
5.87	-0.65	-10.9	K	7.18	+0.14	+10.9	D
6.13	-0.07	-21.4	G	7.19	-0.27	- 4.3	D
8.17	+1.22	-31.0	W	7.21	+0.25	- 3.8	D
8.21	+0.05	-28.7	T	7.23	-0.39	- 5.1	D
Aug 10.5	+0.52	+28.8	W	12.30	-0.39	- 5.4	D
				13.36	+0.23	- 8.8	D
Aug 21.93	(-2.11)	-17.3	G	Nov 14.96	+0.20	- 7.2	D
23.94	-0.71	(-206.3)	G				
Aug 25.84	-0.26	-04.5	G	Nov 24.21	-0.17	- 1.4	D
				24.25	+0.13	- 3.6	D
Oct 3.73	(+6.99)	-15.4	G	29.23	-0.06	-12.4	D
4.05	(+4.99)	+12.1	B	Dec 1.15	-0.65	-10.1	D
4.98	+0.85	- 1.6	D	2.17	+0.01	- 6.5	D
5.03	-0.10	+ 3.8	B	9.19	-0.10	+ 7.1	D
8.75	+1.53	- 0.1	G	10.21	-0.59	- 7.4	D
9.07	+1.46	+12.0	G	12.27	-0.75	- 4.4	D
12.27	+0.08	- 1.3	D	12.30	-0.57	- 7.5	D
12.29	-0.57	+ 1.0	D	18.08	+0.65	+ 3.9	D
12.31	-0.82	- 2.0	D	Dec 20.06	-0.57	- 4.8	D
13.30	-1.00	+ 3.0	D				
Oct 13.32	(+3.45)	- 1.6	D	Dec 26.16	-0.58	+ 3.1	D
				31.06	-0.33	+ 3.1	D
Oct 24.32	-1.06	- 3.1	D	31.11	-0.05	+10.6	D
25.04	+0.06	+ 7.4	B	1941 Jan 1.06	-0.55	- 7.9	D
26.30	+0.49	+ 1.9	D	Jan 1.08	-0.71	- 7.6	D
26.32	-0.05	+ 0.7	D				
27.03	-0.31	+ 4.4	B	Observers			
27.30	+0.95	+ 0.1	D				
27.32	-0.07	- 3.8	D	D Dawson		La Plata	
29.03	+0.07	+ 6.7	B	B Bobone		Cordoba	
29.23	+0.89	+ 0.1	D	T Thomas		Cambridge	
29.25	+0.15	- 2.4	D	K Koziel		Cracow	
30.20	+0.06	- 4.3	D	G Guthe & Thomas		Bloemfontein	
30.23	+0.35	- 0.6	D	H Hoffmeister		Sonneberg	
				W Whipple		Cambridge	
				A Ahnert		Sonneberg	

The observations were grouped in six normal places, as shown in Table II. The early approximate positions were given half weight as compared with the later accurate measures. The equations of condition were computed in the form given by G. Stracke (1929). For that purpose the above ecliptic elements were transformed into equatorial ones:

TABLE II

Normal Places

UT	Residuals, O-C		Weight	Perturbations		To be Corrected		Final Residuals	
	Δαcosδ	Δδ		Δαcosδ	Δδ	Δαcosδ	Δδ	Δαcosδ	Δδ
1940 Aug 2.4	+0".4	- 5".0	6.5	+1".5	+0".2	-1".1	- 5".2	-0".9	-5".5
Aug 23.5	-5.5	-10.9	1.0	-0.2	-0.2	-5.3	-10.7	-0.1	+0.3
Oct 9.1	-7.2	- 1.2	5.5	0.0	0.0	-7.2	- 1.2	+0.1	+1.1
Nov 2.5	-0.9	- 0.4	27.0	+0.1	-0.1	-1.0	- 0.3	-0.3	-0.7
Dec 6.7	-2.7	- 4.2	11.0	+0.7	-0.6	-3.4	- 3.6	+0.3	+1.0
Dec 25.3	-4.1	+ 0.3	5.0	+0.9	-0.8	-5.0	+ 1.1	+0.5	0.0

ω'	261°34′56″.0	1950.0
Ω'	116 33 34.1	
i'	40 49 48.7	

from which the coefficients of the equations of condition were deduced in the equatorial system.

Next the planetary perturbations were computed in 10-day intervals, taking October 8.0 as the date of osculation. The small values interpolated for the dates of the normal places are found in Table II.

The least squares solution was performed on the IBM-1130 computer of the Lunar and Planetary Laboratory with the result:

$$\Delta\omega' = -0''.16 \pm 0''.27$$
$$\Delta\Omega' = +0.33 \pm 0.55$$
$$\Delta i' = +0.35 \pm 0.15$$

$$\Delta e = +0.00000058 \pm 0.00000302$$
$$\Delta q = -0.00000175 \pm 0.00000058 \text{ AU}$$
$$\Delta T = -0.2179 \pm 0.366 \text{ day}$$

The elliptic nature of the orbit is confirmed, and the final representation is as good as one can expect. The corrected equatorial elements were next transformed into ecliptic ones and reduced to the equinox of 1950:

Equatorial

ω'	261°34′55″.84	1940.0
Ω'	116 33 34.43	
i'	40 49 49.05	

Ecliptic			*Ecliptic*	
ω	235°43′44″.4	1940.0	ω 235°.72797	1950.0
Ω	134 18 38.3		Ω 134.44967	
i	54 43 5.8		i 54.71829	

e 0.9810716
q 1.0823270 AU
T 1940 Oct 8.0299 ET

The semi-major axis becomes 57.18007 AU corresponding to a period of 432.4 years.

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