No. 146 THE ORBIT OF COMET BURNHAM-SLAUGHTER 1958e-1959I

by G. VAN BIESBROECK

ABSTRACT

Using 94 observations covering an interval of 592 days, a preliminary set of parabolic elements was improved differentially, taking into account the perturbations by all the planets from Venus to Neptune. The final solution yields a very nearly parabolic ellipse. Backward and forward computations of the perturbations over 20 year intervals show that the comet is a permanent member of the solar system.

This comet was discovered September 7, 1958, (1958) with the 13-inch telescope of the Lowell Observatory by Robert Burnham, Jr., and Charles D. Slaughter in the course of the proper motion survey. This was the third comet found by Burnham, who had previously found Comet 1958*a* and who was co-discoverer of Comet 1957*f*. The new comet, a diffuse object of magnitude 14, showed a centrally condensed nucleus in an asymmetrical coma extending 30″ into a fan-shaped tail toward the southeast. On September 14 Miss E. Roemer noticed a well-condensed, but distinctly not stellar, nucleus of magnitude 17. The comet slowly brightened and the tail extension turned clockwise, pointing toward position angle 50° on December 2. In the first days of 1959 the comet presented itself as a diffuse coma of total magnitude 13.5 still elongated in the first quadrant. The nearly stellar nucleus had then reached magnitude 15.8. Maximum brightness occurred in March 1959, when I described the comet as a round coma, centrally condensed and of total magnitude 13 (March 13), while Beyer called the magnitude 11.1 on March 11. As the comet moved into the evening sky, it was followed at low altitude until June 2, the total magnitude being 14 at that time. After conjunction with the sun, the object was picked up in the morning sky on December 4, 1959, by Roemer who then called the magnitude 19.5. This assiduous observer recorded the receding comet for several months more until April 21, 1960, when the magnitude had dropped to 19.7 This extended the duration of visibility to 592 days. Preliminary elements were deduced by M. P. Candy (1958a) and Roemer (1958). From a longer arc covering the period September 7 to November 4, Candy (1958b) computed the following elements:

Perihelion 1959 Mar. 11.52737 ET

$$\left.\begin{aligned} \omega &= 100^\circ\!.7341 \\ \Omega &= 323^\circ\!.0806 \\ i &= 61^\circ\!.2588 \end{aligned}\right\} 1950.0$$
$$q = 1.628380$$

which did not show an appreciable deviation from the parabola. This orbit proved to be a very good approximation for the whole duration of visibility and corrections to it were found for the final solution.

Table I gives the residuals from this orbit. A number of positions that were obviously in error were ignored. Not utilized were the measures by Waterfield at Ascot, nor those of Raudsaar at Tartu, which proved to be of very low weight. Roemer's positions were given weight 2. All the others were given weight 1 in deriving the normal places (Table II).

The perturbations by all the planets except Mercury and Pluto were computed in 20 day intervals taking 1959 July 1 as date of osculation. The values transformed in equatorial coordinates and interpolated for the dates of the normal places are given in Table II.

The coefficients of the equations of condition were completed according to Stracke's (1929) form.

TABLE I

Residuals O - C

	UT	Δα	Δδ	Ob*
1958				
Sept	11.227	$-0^{s}.11$	$-1''.8$	G
	12.140	-0.18	-1.3	V
	13.063	-0.21	+1.5	V
	13.780	-0.22	+1.6	A
	14.246	-0.22	+0.8	R
	14.276	-0.23	-1.0	R
	14.786	-0.25	+1.9	A
	15.101	-0.22	0.0	V
	15.292	-0.24	-0.2	R
	15.311	-0.22	-0.1	R
	15.974	-0.05	+1.1	A
	16.242	-0.24	+1.9	G
	19.072	-0.30	-0.8	V
	20.212	-0.38	-1.7	G
	20.234	-0.28	+1.0	R
	20.252	-0.32	+1.1	R
	21.284	-0.30	+0.6	R
	21.293	-0.30	0.0	R
Oct	4.175	0.00	+1.1	R
	4.181	+0.02	-0.7	R
	9.904	+0.09	-0.2	A
	10.895	-0.03	+3.6	A
	11.734	+0.27	-0.5	A
Oct	29.022	-0.42	+1.1	V
	29.715	-0.02	+0.7	A
	29.791	-0.16	-0.7	A
	30.006	-0.14	+0.5	V
	30.012	+0.07	+0.6	V
	30.745	+0.15	+0.9	A
	31.993	+0.01	+0.3	V
Nov	4.119	+0.10	+0.8	R
	4.158	+0.03	0.0	R
	10.056	+0.02	-0.6	R
	10.112	+0.03	-0.5	R
	11.059	+0.19	+0.8	V

	UT	Δα	Δδ	Ob
1958				
Nov	19.038	$+0^{s}.16$	$-1''.3$	V
	20.991	+0.02	+1.7	V
	26.999	+0.85	-1.1	V
	27.004	+0.78	-0.1	V
	27.697	+0.39	-0.7	A
	28.678	+0.44	-1.9	A
	28.981	+0.73	+1.3	V
	29.692	+0.15	-0.1	A
Dec	2.017	+0.33	-0.5	V
	2.115	+0.29	+0.3	R
	2.121	+0.30	+0.7	R
	2.741	+0.87	+2.5	A
	3.692	+0.32	+0.2	A
	3.788	+0.55	+1.3	A
	4.686	+0.14	-1.1	A
	5.985	-0.04	+1.3	V
	8.695	+0.33	+1.1	A
	9.046	+0.69	+0.8	V
	9.993	+0.22	-2.6	V
	11.987	+0.50	-4.7	V
1959				
Jan	4.998	+0.91	+1.1	V
	6.007	+0.39	+0.6	V
	10.004	+0.87	+2.3	V
	12.063	+0.34	+2.0	R
	12.091	+0.84	+6.2	R
Jan	31.038	+1.49	+1.8	V
Feb	1.077	+1.34	+1.4	R
	1.104	+1.38	+0.6	R
	2.929	+1.69	+0.9	V
	6.078	+1.67	+3.2	R
	6.084	+1.67	+3.6	R
	7.004	+1.50	+4.1	V
Feb	28.075	+2.69	+1.4	VM

	UT	Δα	Δδ	Ob
1959				
Mar	4.096	$+3^{s}.06$	$+0''.2$	R
	11.047	+3.78	+0.8	V
	12.053	+3.39	-0.2	V
	13.068	+3.19	+1.7	V
Apr	5.112	+4.53	-18.4	V
	6.117	+4.46	-19.6	V
	15.836	+4.03	-36.4	A
	15.854	+5.16	-26.2	A
Apr	29.127	+2.47	-37.9	R
	29.133	+2.50	-37.8	R
May	26.151	+0.62	-18.7	R
	26.159	+0.60	-18.5	R
June	2.110	+0.68	+16.3	V
	3.135	+0.39	+22.7	V
Dec	4.463	+0.25	-53.5	R
Dec	30.399	+0.24	-52.5	R
	30.474	+0.18	-52.3	R
1960				
Jan	24.314	+0.74	-52.6	R
	30.347	+0.42	-50.4	R
	30.420	+0.51	-49.9	R
Feb	21.219	+0.35	-49.3	R
	21.290	+0.16	-48.3	R
Mar	20.142	-0.17	-40.6	R
	20.241	-0.05	-40.9	R
Apr	17.205	-0.37	-36.7	R
Apr	21.156	-0.34	-37.0	R

* Observatories and Observers:

A Skalnate Pleso - Antal
G Lowell Observ. - Flagstaff - Giclas
R Naval Observ. - Flagstaff - Roemer
V Yerkes Observ. - Van Biesbroeck
VM MacDonald Observ. - Van Biesbroeck

TABLE II

Normal Places

UT		Weight	Perturbations		To be Corrected		Final Residuals	
	$\Delta\alpha\cos\delta$	$\Delta\delta$		$\Delta\alpha\cos\delta$	$\Delta\delta$	$\Delta\alpha\cos\delta$	$\Delta\delta$	$\Delta\alpha\cos\delta$	$\Delta\delta$

UT	$\Delta\alpha\cos\delta$	$\Delta\delta$	Weight	Perturbations $\Delta\alpha\cos\delta$	Perturbations $\Delta\delta$	To be Corrected $\Delta\alpha\cos\delta$	To be Corrected $\Delta\delta$	Final Residuals $\Delta\alpha\cos\delta$	Final Residuals $\Delta\delta$
1958 Sept 16.0	- 4″.3	+ 0″.3	26	+12″.0	-1″.6	-16″.3	+ 1″.9	-0″.2	+1″.0
Oct 6.0	+ 0.9	+ 0.5	7	+10.4	-1.5	- 9.5	+ 2.0	+0.7	+1.3
Nov 3.0	+ 1.6	+ 0.2	16	+ 8.7	-1.4	- 7.1	+ 1.6	-0.9	-0.2
Nov 26.0	+ 3.2	- 0.3	8	+ 7.2	-1.4	- 4.0	+ 1.1	+1.0	-0.8
Dec 5.0	+ 5.4	- 0.2	14	+ 6.7	-1.4	- 1.3	+ 1.2	+0.9	-0.3
1959 Jan 9.5	+ 8.5	+ 2.9	7	+ 5.1	-1.7	+ 3.4	+ 4.6	-0.8	-0.7
Feb 2.4	+18.1	+ 2.8	11	+ 4.0	-2.4	+14.1	+ 5.2	+1.1	+0.8
Mar 4.0	+31.4	+ 0.7	6	+ 2.0	-2.6	+29.4	+ 3.3	+0.8	+1.2
Apr 11.1	+35.4	-25.0	4	- 0.6	-1.6	+36.0	-23.4	-0.2	2.1
Apr 29.1	+21.4	-37.8	4	- 0.8	-1.1	+22.2	-36.7	+1.1	-0.6
May 26.2	+37.8	-18.6	4	- 0.5	-0.1	+38.3	-18.5	+1.9	+0.2
Jun 2.5	+ 6.1	-19.5	2	- 0.2	0.0	+ 6.3	-19.5	-2.8	+2.1
Dec 4.5	+ 3.1	-53.5	2	- 2.3	+0.5	+ 5.4	-54.0	-0.4	-1.1
Dec 30.4	+ 3.1	-52.5	4	- 3.6	+1.1	+ 6.7	-53.6	-2.0	-1.7
1960 Jan 29.2	+ 8.4	-51.0	6	- 5.5	+1.6	+13.9	-52.6	+0.8	-1.5
Feb 21.2	+ 3.7	-48.8	4	- 7.4	+2.1	+11.1	-50.9	0.0	+1.9
Mar 20.2	- 1.1	-40.8	4	- 8.9	+2.6	+ 7.8	-43.4	0.0	+0.9
Apr 17.2	- 5.3	-36.7	2	- 8.9	+3.1	+ 3.6	-39.8	-0.5	+0.5
Apr 21.2	- 4.9	-37.0	2	- 9.0	+3.1	+ 4.1	-40.1	+0.1	-0.5

For that purpose the ecliptical elements were transformed into the following equatorial ones:

$$\left.\begin{aligned} \omega &= 86^\circ\ 43'\ 0''.92 \\ \Omega &= 327\ \ 44\ \ 24.96 \\ i &= 80\ \ 39\ \ 46.13 \end{aligned}\right\}\ 1950.0$$

The least squares solution performed on the IBM computer of the University of Arizona gave the following corrections of the equatorial elements:

$$\begin{aligned} \Delta\omega &= +9''.29 \pm 0''.21 \\ \Delta\Omega &= -5.43 \pm 0.10 \\ i &= -21.52 \pm 0.17 \\ e &= -0.0002276 \pm 0.0000030 \\ q &= -0.0001369 \pm 0.0000007 \\ T &= -0.01026 \pm 0.00014 \end{aligned}$$

The corresponding final ecliptical elements are:

$$\begin{aligned} T &= 1959\ \text{Mar}\ 11.51711\ \text{ET} \\ \Omega &= 323^\circ.07730 \\ i &= 61^\circ.25119 \\ \omega &= 100^\circ.73800 \\ e &= 0.9997724 \\ q &= 1.628243 \end{aligned}\quad \left.\right\}\ 1950.0\ (\Omega, i, \omega)$$

The last column of Table II shows the representation of the normal places. The mean error of a position of unit weight comes out 2″.7. The small mean error of the eccentricity establishes with certainty the elliptic character of the orbit, but the period comes out of the order of a million years. Backward and forward computations of the inverse major axis were performed through the kind cooperation of Dr. B. Marsden with the following result for the barycentric values of $1/a$:

1939 Apr. 7	+ 0.0001025	($r = 39.8$ a.u.)
1979 Feb. 16	+ 0.0002715	($r = 39.7$ a.u.)

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