No. 147 THE ORBIT OF COMET HUMASON 1960e-1959X

by G. VAN BIESBROECK

ABSTRACT

Preliminary elements of this distant, faint comet were differentially corrected using 34 measures covering a period of 349 days. The orbit comes out very slightly hyperbolic but backward and forward computations show that the comet is a permanent member of the solar system.

Comet 1960*e* was discovered by M. L. Humason (1960) on a plate taken June 18, 1960, with the 48-inch Schmidt telescope of the Palomar Observatory. It appeared as a 17th magnitude centrally condensed diffuse coma with a short tail. On a 60-minute exposure on June 27 Miss E. Roemer, Flagstaff, noticed that the faint broad tail extended to 5′ southeast from the nucleus. At the time of discovery, this object proved to be at a distance of more than 4 astronomical units from both the earth and the sun and 6 months past perihelion. During the following months, the coma gradually faded while the nucleus remained sharp. Being no brighter than 18th magnitude, the comet was followed only by two observers, the writer at the Yerkes Observatory (1962) and, more extensively, Roemer (1966) at Flagstaff. She succeeded in recording the comet as long as 350 days after the first measure, when the brightness had dropped to 20th magnitude. M. P. Candy (1960) computed an orbit based on a 40-day arc which I used as a basis for the definitive orbit (Table I). Table II gives the residuals O–C for the 34 measures. These were combined in 12 normal places given in Table III.

TABLE I

Starting Ecliptical Elements

$$\begin{aligned} T &= 1959 \text{ Dec } 12.54398 \text{ ET} \\ \omega &= 46^\circ\!.7718 \\ \Omega &= 306.6347 \quad \Big\} 1950 \\ i &= 125.4774 \\ q &= 4.274397 \text{ a.u.} \end{aligned}$$

The planetary perturbations were computed in 20-day intervals and interpolated for the normal dates. All the planets except Mercury and Pluto were included. The date December 2, 1960, near the middle of the interval of observation, was chosen as the osculation point. As was to be expected from an object so distant from the sun and moving in a highly inclined retrograde orbit, the perturbations (Table III) proved to be very small.

The ecliptical elements were transformed into equatorial ones (Table IV) to compute the equations of condition in the form given by G. Stracke (1929).

Although the observations extend over nearly a year, the mean anomaly changed only from 29° to 66° and the solution from such a small arc remained necessarily not too well determined.

TABLE II

Residuals O - C

UT	Δα	Δδ	Observer	UT	Δα	Δδ	Observer
1960 June 23.20	$-0^s.29$	$+0''.5$	R	1960 Sept 25.09	$+2^s.17$	$+9''.2$	R
23.25	-0.36	+1.0	R	Sept 25.11	+2.15	+8.8	R
24.11	-0.99	-1.7	V	Oct 22.07	+2.87	+18.5	R
24.12	-0.27	-0.2	V	Dec 26.47	+5.01	+33.7	R
25.14	-0.37	-1.1	V	1961 Jan 17.40	+6.17	+35.7	R
26.15	-0.45	-2.1	V	Jan 17.47	+6.22	+37.3	R
27.24	-0.63	+0.3	R	Mar 23.27	+12.47	+37.4	R
27.25	-0.44	+0.9	R	Mar 23.34	+12.56	+33.5	R
30.30	-0.48	-0.4	R	Apr 9.15	+14.23	+42.2	R
June 30.32	-0.49	-0.5	R	Apr 9.22	+14.36	+43.0	R
July 13.22	-0.44	+0.1	R	May 9.35	+16.06	+69.8	R
21.14	-0.63	-2.7	V	May 14.39	+16.69	+72.1	R
22.12	-0.60	-1.4	V	June 7.21	+16.60	+91.2	R
24.11	-0.41	+1.5	V	June 7.31	+16.51	+92.2	R
25.16	+0.14	+3.1	V				
July 28.11	-0.34	+1.7	V				
Aug 2.28	-0.01	-0.4	R				
Aug 2.29	+0.01	+0.4	R				
Aug 17.15	+0.72	+2.3	R				
Aug 17.18	+0.78	+3.0	R				

TABLE III

Normal Places

UT	Residuals		Weight	Perturbations		To be Corrected		Final Residuals	
	Δαcosδ	Δδ		Δαcosδ	Δδ	Δαcosδ	Δδ	Δαcosδ	Δδ
1960 June 26.11	$-\ 4''.4$	$-\ 0''.4$	10	$+2''.4$	$-2''.0$	$-\ 6''.8$	$+\ 1''.6$	$+0''.1$	$+0''.4$
July 22.31	- 4.4	+ 0.6	6	+1.2	-1.2	- 5.6	+ 1.8	-1.3	+0.2
Aug 2.28	0.0	0.0	2	+1.0	-0.9	- 1.0	+ 0.9	-0.4	-1.1
Aug 17.16	+ 9.0	+ 2.6	2	+0.6	-0.7	+ 8.4	+ 3.3	+2.8	-0.7
Sept 25.10	+ 27.3	+ 9.0	2	+0.2	-0.3	+ 27.1	+ 9.3	+3.3	-2.4
Oct 22.07	+ 36.9	+18.5	1	+0.1	-0.1	+ 36.8	+18.6	+1.0	+0.1
Dec 26.47	+ 62.8	+33.7	1	0.0	0.0	+ 62.8	+33.7	-1.7	+0.6
1961 Jan 17.43	+ 74.9	+36.5	2	+0.1	-0.1	+ 74.8	+36.6	-0.8	+1.6
Mar 23.30	+123.8	+35.4	2	+0.5	-0.2	+123.3	+35.6	+1.4	-0.8
Apr 9.18	+135.2	+42.6	2	+0.6	-0.1	+134.6	+42.7	-0.7	-1.1
May 11.87	+152.5	+71.0	2	+0.3	0.0	+152.2	+71.0	-1.8	+1.3
June 7.26	+161.4	+91.7	2	0.0	0.0	+161.4	+91.7	+1.0	+0.6

The solution of the equations of condition was obtained on the IBM computer of the University of Arizona. The corrections to the elements and mean errors are:

$$\Delta T = -1^{d}18428 \pm 0^{d}001621$$
$$\Delta\omega = -16' 10''73 \pm 1''93$$
$$\Delta\Omega = -3' \ 21''63 \pm 0''31$$

$$\Delta i = -1' 44''72 \pm 0''12$$
$$\Delta e = +0.0000400 \pm 0.0000109$$
$$\Delta q = -0.0065290 \pm 0.0000245 \text{ a.u.}$$

The new elements, therefore, become:

T 1959 Dec 11.35975 ET
q 4.2678680 a.u.
e 1.0000400

	Equatorial	Ecliptical
ω	18°50′51″15	46°30′31″81 = 46°508837
Ω	288 8 47.95	306 34 34.38 = 306.576217
i	136 30 24.49	125 28 10.22 = 125.469506

In the last column of Table III are given the final residuals, which prove to be as satisfactory as can be expected.

The hyperbolic excess of the eccentricity comes out four times its probable error. It is of interest to find out what is the character of the original and future orbit.

Through the kind cooperation of B. G. Marsden, the past and future perturbations by the planets from Mercury to Pluto were established on the CDC 6400 computer of the Smithsonian Astrophysical Observatory in Cambridge, Mass., with the result for $1/a$:

Osculating (1960 Dec. 2)	−0.0000094 ± 0.0000026
Barycentric original 1927 Apr. 30 $r = 53.4$ a.u.	+0.0001169
Barycentric future 1985 Jan. 5 $r = 44.3$ a.u.	+0.0000733

It therefore appears that the original as well as the future orbit turns out to be slightly elliptical.

TABLE IV

Equatorial Elements

$$\left.\begin{array}{l} \Omega = 288^\circ\ 12'\ 9''58 \\ \omega = \ \ 19\ \ \ \ 7\ \ 1.88 \\ i = 136\ \ 32\ \ 9.21 \end{array}\right\} 1950$$

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