No. 144 THE ORBIT OF COMET BESTER 1946k-1947I

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ABSTRACT

A discussion of the 118 measures of this comet, covering an interval of 700 days, led to a final near-parabolic orbit with a slight hyperbolic excess of eccentricity. However both original and future orbits turn out to be long-period ellipses.

This comet was found by M. J. Bester (1946) on a plate taken 1946 Oct. 31 at the Boyden Station, Bloemfontein (S.A.), with a 3-inch Ross-Fecker patrol camera. It appeared as an 11th magnitude round coma of 2′ diameter with a well-condensed nucleus.

It was immediately followed in many observatories. The brightness rose slowly. On December 19 a 20-minute exposure with the Yerkes 24-inch reflector showed a faint tail 6′ long in position angle 100°. By the middle of December, the brightness reached a maximum of 9th magnitude and slowly decreased after that. A great many measures were made from both sides of the equator in December 1946 and January 1947. As far south as Coelum, at discovery the comet moved north, crossing the equator on 1947 Feb 12, and then moved high in the northern hemisphere. It was lost in the evening sky after 1947 March 15 but was picked up again in the morning sky on June 23 when the brightness was reduced to 13th magnitude. Measures became scarce during the summer and fall 1947. By 1948 Jan 15 the comet had faded to 17th magnitude. After that there were only a couple of measures at the Lick Observatory on 1948 July 27 and two last measures on Oct 2 at the McDonald Observatory, when I estimated the magnitude as 18.5. The comet was then reduced to a very diffuse coma of 20″ diameter.

The observations were compared with L. E.

TABLE I

Residuals O - C

	UT	Δα	Δδ	Ob*
1946		s	"	
Nov.	2.92	-0.42	+3.4	J
	3.89	-0.52	-0.5	J
	4.92	-0.60	-0.2	J
	5.02	-0.55	-0.8	C
	5.33	-0.23	-2.6	Y
	5.34	-0.46	-2.2	Y
	5.42	-0.44	+3.5	F
	5.44	-0.51	+1.1	L
	6.42	-0.60	-3.1	F
	7.00	-0.38	-1.7	L
	7.42	-0.41	-1.9	Y
	10.94	-0.65	-0.2	Y
Nov.	12.33	-0.42	+1.6	F
	13.90	-0.66	+1.7	Y
	15.11	-0.39	+2.1	S
	15.38	-0.83	+3.7	L
	15.41	-0.76	+2.7	L
	16.27	-0.88	+2.9	W
	17.84	-0.62	+2.6	Y
	18.04	-0.84	+3.1	S
	19.07	-0.50	+2.3	C
	19.24	-0.77	+1.5	Y
	20.05	-0.92	+4.0	S
	20.22	-0.83	+3.3	Y
Nov.	22.04	-0.78	+6.4	S
	23.08	-0.74	+6.5	S
	23.84	-0.34	+4.7	Y
	26.28	-0.49	+2.7	F
	27.03	-0.46	+4.7	C
	28.95	-0.34	+3.5	A
	29.04	-0.49	+3.5	S
	30.04	-0.28	+3.8	S
Dec.	1.06	-0.28	+3.5	S
	1.92	-0.54	+5.1	A
	2.93	-0.51	+4.8	A
	11.22	-0.67	+5.2	F
	11.74	-0.38	+5.3	Y
	12.14	-0.07	+8.9	S
	13.03	-0.39	+6.6	C
	14.15	-0.43	+5.7	W
	15.09	-0.28	+5.3	W
	15.10	-0.43	+6.3	W
1946		s	"	
Dec.	15.79	-0.38	+8.3	Y
	16.92	-0.34	+5.6	A
	19.10	-0.29	+6.0	Y
	19.14	-0.40	+6.6	W
	20.08	-0.30	+4.2	S
	20.19	-0.26	+5.7	L
	20.20	-0.23	+4.8	L
	21.90	-0.31	+5.5	A
	22.17	-0.36	+4.7	F
	23.76	-0.16	+4.2	Y
	23.32	-0.09	+5.3	A
	23.91	-0.06	+6.9	B
	26.81	-0.18	+7.0	B
	27.76	-0.32	+7.2	Y
	28.89	-0.23	+3.9	B
1947				
Jan.	4.76	-0.24	+1.0	Y
	8.76	-0.66	+5.3	Y
	10.05	-0.29	+6.1	C
	10.05	-0.20	+5.8	C
	11.00	-0.23	+3.0	Y
	11.08	-0.52	+3.7	S
	12.06	-0.50	+3.8	S
	12.76	-0.36	+6.4	Y
	14.73	-0.29	+4.9	V
	15.00	-0.26	+3.7	Y
	15.75	-0.14	+6.3	A
	15.77	-0.24	+5.6	A
	16.70	-0.13	+6.0	A
	18.02	-0.21	+2.7	Y
	18.06	-0.21	+5.2	C
	18.77	-0.22	+5.0	A
	18.78	-0.13	+4.2	A
	20.76	-0.30	+6.1	Y
	21.79	-0.27	+3.2	T
	23.02	-0.24	+5.9	Y
	23.05	-0.27	+2.8	L
	23.16	-0.26	+3.4	L
	23.75	-0.18	+5.2	Y
	29.75	-0.10	+5.1	Y
Feb.	11.03	-0.17	+4.3	Y
	12.10	-0.28	+6.6	F
	19.04	-0.16	+6.1	Y
1947		s	"	
Feb.	19.79	-0.27	+5.6	A
	19.80	-0.26	+4.1	A
	21.83	-0.20	+4.5	A
	22.71	-0.15	+2.5	A
	22.80	-0.22	+4.0	A
Mar.	11.80	-0.28	+5.1	A
	15.22	-0.10	+3.0	F
Jun.	23.11	-1.08	-19.5	A
July	20.09	-1.50	-27.1	A
	25.35	-1.20	-26.2	Y
Aug.	20.39	-1.33	-22.3	L
	20.40	-1.30	-21.8	L
Oct.	9.0	+11.21	-9.6	V
	17.92	+11.12	-9.8	A
	18.91	+10.92	-7.0	A
	18.98	+10.04	-8.5	A
Nov.	3.05	+10.20	+7.0	Y
	3.79	+10.18	+5.0	A
	4.20	+10.00	+6.8	L
	4.22	+10.11	+6.4	L
	8.25	+9.60	+5.8	L
	8.26	+9.61	+6.6	L
	8.78	+9.84	+6.6	A
	12.78	+9.76	+9.7	A
Dec.	8.77	+9.04	+16.4	A
	9.07	+9.00	+14.6	Y
1948				
Jan.	2.77	+8.50	+12.0	A
	2.81	+8.26	+17.2	A
July	27.22	+18.49	+31.8	L
	27.26	+18.50	+33.2	L
Oct.	2.13	+11.86	+91.7	M
	2.16	+11.78	+91.6	M

* Observatories and Observers:

A Algiers - Boyer & Schmidt
B Barcelona - Fabre
C Cordoba - Bobone
F Flagstaff - Giclas
J Johannesburg - Johnson
L Lick - Jeffers
M McDonald - Van Biesbroeck
S Santiago - Dujisin
T Toulouse - Prêtre
V Vienna - Krumpholtz
W Washington - Reuning
Y Yerkes - Van Biesbroeck

Cunningham's parabolic orbit:

$$\left.\begin{array}{ll} T = & 1947\ \text{Feb}\ 7.4216\ \text{U.T.} \\ \omega = & 348°.64149 \\ \Omega = & 34.86152 \\ i = & 108.16837 \\ q = & 2.407373 \end{array}\right\} \quad 1950$$

Table I gives the list of residuals for the 108 observations that were retained after omitting a few that were obviously in error.

The residuals were grouped in 15 normal places listed in Table II.

Perturbations were computed by Encke's method in 4-day intervals, the comet remaining far from all planets. Mercury and Pluto were omitted in this computation. 1947 Oct 2 was adopted as osculation date, about midway of the 699 days covered by the measures. Because of the large perihelion distance, the true anomaly varied only from −33° to +70° over these nearly two years.

The coefficients of the equations of condition were computed in the form given by Stracke (1929). For that purpose the ecliptic elements were transformed into equatorial ones:

$$\left.\begin{array}{lrrr} \omega' = & 5° & 5' & 54''.8 \\ \Omega' = & 42 & 34 & 18.8 \\ i' = & 126 & 36 & 12.5 \end{array}\right\} \quad 1950$$

The equations of condition were solved on the 7071 IBM computer of the University of Arizona. The corrections of the equatorial elements and their probable errors are as follows:

$$\begin{aligned} de &= +0.0005888 \pm 0.0000755 \\ dq &= +0.0001550 \pm 0.0000139 \\ dT &= -0.09370 \quad \pm 0.00022 \end{aligned}$$

$$\begin{aligned} d\omega' &= -1'\ 59''.82 \pm 0''.25 \\ d\Omega' &= -0\ \ 14.05 \pm 0.09 \\ di' &= +0\ \ 3.67 \pm 0.12 \end{aligned}$$

The final elements become:

$$\begin{array}{ll} T & 1947\ \text{Feb}\quad 7.32790\ \text{U.T.} \\ q & 2.407528 \\ e & 1.0005888 \end{array}$$

	Equator			Ecliptic			
ω	5°	3′	54″.98	348°	36′	33″.9	1950.0
Ω'	42	34	4.75	34	51	28.3	
i	126	36	16.17	108	10	8.5	

Osculation date 1947 Oct 2.0. Since the eccentric excess is 8 times larger than its probable error, the hyperbolic character of the solution is firmly established.

It is of interest to find out what was the nature of the original orbit and what it will become in the

TABLE II

Normal Places

UT				Weight	Perturbations		To be Corrected		Final Residuals	
		Δαcosδ	Δδ		Δαcosδ	Δδ	Δαcosδ	Δδ	Δαcosδ	Δδ
1946	Nov 6	- 3″.8	- 0″.4	12	- 6″.4	+21″.0	+ 2″.6	-21″.4	+0″.5	+1″.0
	Nov 18	- 7.0	+ 2.6	12	- 0.5	+19.7	- 6.5	-17.7	-1.8	-1.4
	Nov 27	- 5.5	+ 4.5	11	+ 3.0	+17.8	- 8.5	-13.3	+0.9	-0.8
	Dec 19	- 4.0	+ 5.9	22	+10.0	+ 8.2	- 14.0	- 2.3	+1.1	+2.2
1947	Jan 16	- 4.2	+ 4.7	22	+ 9.8	+ 4.4	- 14.0	+ 0.3	-1.3	-2.1
	Feb 19	- 3.7	+ 4.7	8	+ 6.2	+ 0.5	- 9.9	+ 4.0	+0.2	-1.1
	Mar 13	- 2.3	+ 4.0	2	+ 4.8	- 0.6	- 7.5	+ 4.6	+1.7	-0.7
	June 23	- 12.3	+19.5	1	+ 1.0	- 0.9	- 13.3	-20.4	+1.5	-3.2
	July 23	- 12.1	-26.7	2	+ 0.8	- 0.6	- 12.9	-26.1	-2.7	+2.8
	Oct 18	+ 94.6	- 8.7	4	+ 0.1	0.0	+ 94.5	- 8.7	+0.5	-0.7
	Nov 7	+ 94.6	+ 7.1	4	+ 0.2	+ 0.1	+ 94.4	+ 7.0	-1.4	+2.9
	Dec 9	+ 96.6	+15.5	2	+ 0.5	+ 0.3	+ 96.1	+15.2	+3.3	-2.6
1948	Jan 3	+ 93.8	+14.6	2	+ 0.9	+ 0.5	+ 92.9	+14.1	0.0	+1.3
	July 27	+ 99.4	+32.5	2	+ 2.8	+ 7.4	+ 96.6	+25.1	-1.6	+3.1
	Oct 2	+116.7	+91.6	2	+ 0.8	+ 8.7	+117.5	+82.9	+1.9	-1.0

future. Dr. B. G. Marsden of the Smithsonian Astrophysical Observatory in Cambridge (Mass.) kindly offered to compute the effect of all the planets on the reciprocal value of the semi-major axis. This was done on the IBM 7094 computer of the Harvard University, using an integration program written by J. Schubart and P. Stumff of Heidelberg.

The final values of $1/a$ come out as follows:

Osculating value 1947 October 2	− 0.0002446
Perturbations 1947–1920	+ 0.0004755
Reduction to barycenter	− 0.0001342
Original value at 48 a.u. 1920 April 26	+ 0.0000967
Osculating value 1947 October 2	− 0.0002446
Perturbations 1947–1975	+ 0.0003928
Reduction to barycenter +	− 0.0000242
Future value at 50 a.u. 1975 March 9	+ 0.0001240

Both the original and future orbits therefore become clearly elliptical, but the period is of the order of a million years.

Note. After this work was completed E. Roemer called my attention to the fact that I had omitted the observations 1947 Jan 23 to 1948 May 11 in L.O.B. 520. The corresponding residuals in Table I are:

1947	Jan 23.15	− 0^s.34	+ 4″.3	L
	23.16	− 0.34	+ 4.2	L
	Aug 20.39	− 1.28	−22.4	L
	20.40	− 1.26	−22.6	L
	Nov 4.21	+10.0	+ 6.2	L
	4.22	+10.02	+ 6.6	L

Since they fall within the ones that I used, their inclusion would hardly have changed the normal places. Hence a new solution was not attempted.

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