No. 43 THE ORBIT OF COMET 1947 VI (WIRTANEN)

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ABSTRACT

On the basis of all available observations of Cunningham's improved orbit a least-squares adjustment of the elements was made, which led to a slightly hyperbolic solution. With allowance for the planetary perturbations over the past 20 years, the original orbit was found to be slightly elliptic.

The faint comet 1947h (1947 VI) was found 1947 July 23 by C. A. Wirtanen on a plate taken with the 20-inch Carnegie astrograph of the Lick Observatory. It appeared as a well-condensed coma estimated as 13–14 mag with a 3′ tail in 175°. Preliminary parabolic orbits by A. D. Maxwell (1947) and L. E. Cunningham (1947) showed that the comet was a distant object near perihelion at discovery and that its brightness would not increase. Actually, it decreased in brightness, faster than expected, being estimated as 17 mag on September 14 (Yerkes) and as 17.5 on November 7 (Lick), when it was last recorded in 1947. It was recovered by Jeffers on 1948 May 14 as a nearly stellar object of 18.5 magnitude. When last observed by the author, 1948 October 2, with the 82-inch McDonald reflector, it was reduced to a diffuse coma only 4″ in diameter and of magnitude 20.

From the measures extending to 1948 May 14, L. E. Cunningham (1947a) derived a slightly hyperbolic orbit giving small residuals over a period of 10 months. These elements were used as a basis for the final correction:

$$
\begin{aligned}
T &= 1947\ \text{July}\ 18.35980\ \text{U.T.} \\
q &= 2.8279756 \\
e &= 1.0010446 \\
\omega &= 9^{\circ}.38386 \\
\Omega &= 311.09803 \\
i &= 97.32705
\end{aligned}
\Bigg\} \quad 1950.0
$$

The value of T given here differs from that originally published by Cunningham; the correction of –0.1 day was discovered by the author, using the uncorrected value, and was confirmed by correspondence (Cunningham, 1964). The residuals derived from the available measures are listed in Table 1, with Table 2 giving the normal places. Table 2 shows the residuals from the corrected elements.

Not utilized was an observation on 1947 August 10 in Göttingen by Haffner and Strassl (NAZ, *1*, 26) which gave an unexplained large residual of $+2^{m}.5$ and +13′.

The 1947 measures by Van Biesbroeck were made with the 24-inch reflector at the Yerkes Observatory, those for 1948 with the 82-inch reflector of the McDonald Observatory.

The residuals were grouped in 13 normal places. The planetary perturbations were computed in 20-day intervals, using 1948 February 9 as osculation date, and including all major planets except Mercury. The interpolated values for the dates of the 13 normal places are found in Table 2, in which weights are assigned to the number of measures.

I am indebted to Mr. R. I. Mitchell for the solution of the equations of condition on the IBM *7072* machine of the University of Arizona computing center.

The corrections of the equatorial elements given by the solution are shown with their probable errors in Table 3.

The final elements become:

$$T = 1947 \text{ July } 18.34942 \text{ U.T.}$$
$$q = 2.8279862$$
$$e = 1.0008356$$
$$\left.\begin{aligned}\omega &= 9°.38354\\ \Omega &= 311.09753\\ i &= 97.32676\end{aligned}\right\} \quad 1950.0$$

The value of $1/a$ becomes -0.0002954 ± 0.0000026 so that the hyperbolic excess is well established.

It is of interest to find out what the "original" value of $1/a$ has been. Using the precepts established by the Leiden investigators (Bilo and Van Houten-Groeneveld, 1960), the influence of the four major planets was computed backward for five years from the date of osculation, 1948 February 9, in 40-day steps. The inner planets were not considered in view of the large value of the perihelion distance. Next, the computation was continued in 160-day intervals back to 1927 April 30, or 20 years from the date of osculation. At that time, the integrated change in the value of $1/a$ amounted to +0.0005109 and the reduction to barycenter, –0.0001889. This gives the original value:

$$\frac{1}{a} = -0.0002954 + 0.0005109 - 0.0001889$$
$$= +0.0000266 \pm .0000026.$$

Therefore, the orbit was originally elliptic, the semi-major axis amounting to 37,600 A.U.

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TABLE 1
RESIDUALS

U.T.			Δα	Δδ	OBSERVER
1947	July	23.45236	−0ˢ.06	+2″.4	Wirtanen
	July	24.35205	−0.06	+4.0	Jeffers
	July	24.36385	+0.03	+2.5	Jeffers
	July	25.22936	−0.19	+3.8	Reuning
	July	25.33160	+0.05	+2.5	Van Biesbroeck
	July	25.33576	−0.13	+1.3	Reuning
	July	25.39300	−0.10	+1.5	Jeffers
	July	25.39862	+0.12	−0.8	Giclas
	July	25.40411	−0.01	+1.5	Jeffers
	July	26.04944	−0.28	+2.7	Bobone
	July	26.27188	+0.10	−1.2	Reuning
	July	26.33022	+0.07	−0.1	Giclas
	July	26.98080	+0.15	−2.4	Arend
	July	27.06050	+0.12	+1.6	Bobone
	July	28.06879	−0.13	+2.0	Bobone
	July	28.30480	−0.04	+2.0	Van Biesbroeck
	July	29.43477	+0.14	+1.1	Jeffers
	July	29.44518	−0.07	+1.3	Jeffers
	Aug.	7.25375	−0.35	+2.7	Jeffers
	Aug.	7.26417	−0.29	+2.2	Jeffers
	Aug.	14.91111	−0.03	+0.2	Reinmuth
	Aug.	16.90570	−0.09	−2.0	Reinmuth
	Aug.	20.37336	+0.08	+1.3	Jeffers
	Aug.	20.38447	−0.04	+1.1	Jeffers
	Sept.	9.14201	−0.17	+0.4	Van Biesbroeck
	Sept.	14.10590	+0.02	+1.5	Van Biesbroeck
	Oct.	5.08215	+0.14	+0.1	Van Biesbroeck
	Nov.	7.12210	+0.14	0.0	Jeffers
	Nov.	7.17352	−0.08	−0.8	Jeffers
1948	May	14.41273	+0.16	−0.3	Jeffers
	May	14.46134	−0.07	+0.3	Jeffers
	June	12.35417	+0.05	+2.2	Jeffers
	June	12.40625	−0.18	+2.0	Jeffers
	July	30.23586	−0.79	−0.2	Jeffers
	July	30.29627	−0.50	−0.5	Jeffers
	Sept.	5.12618	−1.02	+0.8	Van Biesbroeck
	Sept.	6.11481	−1.36	+0.2	Van Biesbroeck
	Oct.	1.11771	−1.01	+0.8	Van Biesbroeck
	Oct.	1.20707	−1.35	−1.9	Van Biesbroeck
	Oct.	2.10360	−0.98	−2.8	Van Biesbroeck
	Oct.	2.11610	−0.86	−1.5	Van Biesbroeck

TABLE 2
NORMAL PLACES

U.T.			Δα	Δδ	WEIGHT	PERTURBATIONS		TO BE CORRECTED		FINAL RESIDUALS	
						Δα	Δδ	Δα	Δδ	Δα	Δδ
1947	July	24.91	−0″.6	+2″.1	9	+0″.6	−9″.8	−1″.2	+11″.9	−0″.1	+1″.4
	July	27.54	−0.1	+0.8	9	+0.3	−8.5	−0.4	+ 9.3	+0.5	−1.0
	Aug.	7.25	−3.8	+2.4	2	−1.0	−7.3	−2.8	+ 9.7	−2.7	+0.5
	Aug.	15.90	−0.9	−0.7	2	−1.4	−6.3	+0.5	+ 5.4	+0.1	−2.6
	Aug.	20.37	+0.3	+1.2	2	−1.7	−5.7	+2.0	+ 6.9	+1.3	−0.5
	Sept.	11.61	−1.2	+1.0	2	−1.9	−4.0	+0.7	+ 5.0	−0.8	+0.3
	Oct.	5.07	+2.1	+0.1	1	−1.3	−2.3	+3.4	+ 2.4	+1.8	−0.2
	Nov.	7.13	−0.4	−0.4	2	−0.5	−1.0	+0.1	+ 0.6	−1.7	−0.1
1948	May	14.41	+0.4	0.0	2	+0.3	+0.4	+0.1	− 0.4	+1.0	+0.4
	June	12.35	−0.7	+2.1	2	+0.1	+1.1	−0.8	+ 1.0	+1.2	+0.7
	July	30.24	−3.8	−0.4	2	−1.5	+1.6	−2.3	− 2.0	+1.5	−1.5
	Sept.	5.59	−8.8	+0.5	2	−2.9	+1.6	−5.9	− 1.1	−1.6	+0.8
	Oct.	1.60	−8.5	−1.4	4	−3.5	+1.8	−5.0	− 3.2	−0.4	−0.6

TABLE 3

SOLUTION OF EQUATIONS OF CONDITION*

ΔT	$= -0.01038 \pm 0.00054$
Δq	$= +0.0000106 \pm 0.0000032$
Δe	$= -0.0002090 \pm 0.0000073$
$\Delta \omega'$	$= 2''.97 \pm 0''.59$
$\Delta \Omega'$	$= +2''.42 \pm 0''.04$
$\Delta i'$	$= 0''.57 \pm 0''.13$

*Probable error of unit weight, ±0.26.

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