The next return of the comet of the Perseid meteors

B. G. Marsden

Smithsonian Astrophysical Observatory, Cambridge, Massachusetts

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The orbit of the Perseid comet (1862 III P/Swift-Tuttle) is redetermined, and backward calculation of the perturbations indicates that the comet should previously have passed perihelion during 1746–1750. No definite eighteenth-century candidate for the comet can be identified, but if the revolution period were somewhat longer, Kegler's Comet 1737 II is found to have been a rather promising one. As a by product of this investigation, an orbit is determined for Wargentin's Comet of 1750. The fact that there are no really convincing observations of P / Swift-Tuttle at its perihelion passages during the fifteenth through eighteenth centuries is then used to narrow down the search region at the forthcoming return, and it is indicated that perihelion will most probably be during March–November 1980, April–June 1981, or May–December 1982—although searches should not be entirely confined to these times and could begin as early as 1978. For this purpose, a perennial ephemeris is provided. The question of identity with comet 1737 II is further examined, with consideration made of the effects of nongravitational forces; while the possibility of identity still seems to be rather small, it is suggested that, if the comet has not been recovered by late 1983, the search should be resumed in 1992.

THE comet associated with the Perseid meteor stream, 1862 III P/Swift-Tuttle, has a revolution period of some 120 yr and thus should be returning to perihelion about a decade from now. Since, however, the "definitive" orbit by Hayn (1889) indicates that the period is uncertain by ±1.9 yr, it would seem that recovery of the comet might require a considerable effort.

Recovery would obviously be made easier if some earlier apparition of the comet could be identified. Such a circumstance made it possible to predict the recent return of P/Tempel-Tuttle, the comet of the Leonid meteors: although it had a rather similar uncertainty in its 33-yr revolution period, that 1866 comet was long ago suspected to have been a reappearance of a comet recorded by the Chinese in 1366, and after Schubart (1966) had made the calculation linking the two apparitions—at the same time identifying another observation of the comet in 1699—the successful recovery of P/Tempel-Tuttle was virtually ensured. The known associations with meteor streams imply that both P/Tempel-Tuttle and P/Swift-Tuttle can come close to the Earth, and since the latter comet was, in the 1860s, intrinsically perhaps four magnitudes brighter than the former (Vsekhsvyatskij 1958), there would seem to be a fair chance of finding ancient records of it, even though its revolution period is some three or four times longer than that of the other comet.

I. REDETERMINATION OF THE ORBIT

Accurate micrometric and meridian observations of P/Swift-Tuttle extend over 19 July–27 October 1862 (U.T.), and they were grouped by Hayn (1889) into seven normal places. Hayn's final residuals for these normal places were very good, except for the $(O-C)$ declination residual of the final normal place, which amounted to $-7''.9$. The declination of that final place is $-50°$, and the observations from which it was constructed were made almost exclusively by Maclear and Mann at the Cape Observatory.

We have now redetermined the orbit from the individual observations, although in order to simplify the task the observations and reference-star positions were taken from the publication by Hayn. Perturbations by all nine major planets have been taken into account. About half the initial 440 observations were found to be inferior and were removed at various stages of the calculation. Hayn's result—in particular, the systematic negative trend in the final declination residuals—was essentially confirmed. Reexamination of the positions of the reference stars used for the final Cape observations (which, in fact, were also determined at the Cape) indicates that in no instances were they in error by more than 1 arcsec. It was reluctantly concluded that the systematic residuals were due to problems in measuring the comet itself. The final orbital elements, based on 212 observations during 22 July–22 October 1862, were

$$\begin{aligned}
\text{Epoch} &= \text{1862 Aug. 8.0 E.T.}\\
T &= \text{1862 Aug. } 23.40971 \pm 0.00078 \text{ (m.e.) E.T.}\\
\left.\begin{aligned}\omega &= 152^\circ\!.76598 \pm 0^\circ\!.00028\\ \Omega &= 138.68489 \pm 0.00078\\ i &= 113.55963 \pm 0.00070\end{aligned}\right\} & \ 1950.0\\
q &= 0.9626380 \pm 0.0000011 \text{ a.u.}\\
e &= 0.9604272 \pm 0.0001378\\
a &= 24.326 \pm 0.085 \text{ a.u.}\\
P &= 119.98 \pm 0.63 \text{ yr.}
\end{aligned}$$

The mean residual was $\pm 1''.98$; the individual values ranged to about 4 arcsec, with the exception of that of the 22 October observation (the only one utilized after 6 October and given triple weight), which gave a declination residual of $-4''.8$. The residuals of the seven other declination measures made during 20–27 October ranged from $-6''.3$ to $-15''.1$.

Hayn's result (for a slightly different epoch of osculation) is consistent with ours to within the mean errors of the latter determination: in particular, Hayn found $P=119.64$ yr. The mean errors are not a particularly good indication of the real uncertainty, however, and we are inclined to judge the real uncertainty in P as ± 2 yr. Incorporation of five more late-October observations into the solution reduced P to 119.18 yr and improved the final residuals by about $0''.8$; on the other hand, forcing a change of more than about 2 yr in period produced unacceptable systematic trends elsewhere in the set of residuals. Another computation was made in which all the observations between 16 August and 13 September (i.e., when the comet was within 0.6 a.u. of the Earth) were omitted: this considerably improved the October residuals, but it led to values that systematically amounted to some 20 arcsec during the omitted interval—and the revolution period turned out to be practically identical with that of the orbit given above.

II. POSSIBLE EIGHTEENTH-CENTURY APPEARANCE

On its way in to perihelion in 1862 P/Swift-Tuttle had moderately close approaches to both Jupiter and Saturn, the minimum separations being 2.0 and 1.1 a.u., respectively. The resulting perturbations caused the comet's osculating period in 1862 to be some 5.5 yr longer than the actual time elapsed since the previous perihelion passage—which should therefore have taken place between early 1746 and early 1750.

The only comet appearing during this interval that could conceivably have been P/Swift-Tuttle at its previous perihelion passage is the one observed by Wargentin (1752) at Uppsala in 1750. Wargentin discovered this comet low in the west-southwestern sky soon after sunset on 21 January 1750 (Old Style: it is clear from his preceding paper, describing the lunar eclipse of December 1749, that Wargentin was still using the Julian Calendar, which in any case was not abandoned in Sweden until 1753). He saw it again the following evening; the 23rd and 24th were cloudy; he caught a glimpse of it between clouds on the 25th; but by the next clear night, the 28th or 29th, the comet had disappeared. Wargentin observed the comet with the naked eye and with two different telescopes; and the comet was also seen by a colleague.

Wargentin estimated the comet's position in relation to two stars he eventually identified as ϵ and θ Peg, although he initially supposed them to be α and γ Aqr. From the drawing he gives, it is possible to derive the coordinates of the comet, and for the record they are listed in Table I, using modern conventions and under both assumptions concerning the reference stars. On the night of its discovery the comet was as bright as the westernmost of the two stars, and its tail, judged as 2° long to the unaided eye, was directed toward that star: considering the position of the Sun, it makes sense to suppose that the star was indeed ϵ Peg, not α Aqr. Wargentin was well aware that his diagram shows the

TABLE I. Wargentin's observations of the comet of 1750.

1750 U.T. (New Style)	Ref. stars ϵ and θ Peg α_{1950}	δ_{1950}	Ref. stars α and γ Aqr α_{1950}	δ_{1950}
Feb. 1.67	$21^h40^m.8$	$+5°25'$	$22^h06^m.0$	$-3°10'$
2.67	21 58.3	+2 50	22 16.0	−3 40
5.7	22.2	−1	22.4	−4
5.7	22.6[a]	−3		
8.7 or 9.7	comet no longer visible			

[a] Assuming that the single comparison star was not θ Peg, but η Aqr, the comet could presumably have been elsewhere on the arc from η Aqr ($\alpha_{1950}=22^h32^m.8$, $\delta_{1950}=-0°23'$) to or beyond this position.

comet's motion from the 22nd to the 25th to be slightly less than from the 21st to the 22nd, and he admits that the single comparison star of the 25th might not have been θ Peg: indeed for any normal comet, it would have been quite impossible. He had not noted any other stars in the vicinity on the earlier evenings, but since the comet appeared on the 25th to be, not only brighter than before, but also significantly brighter than the comparison star, we can surmise that, though cloud was prevalent, the haze near the horizon was less than on the other nights; and that the single comparison star glimpsed near the comet was perhaps η Aqr—which would give the comet a much more reasonable motion since the 22nd.

However, it is clear that Wargentin's Comet was moving some 5° per day, and although it was on its discovery night within 3° of the track of P/Swift-Tuttle, identity would have resulted in a daily motion of only some $0°.5$. Furthermore, with perihelion in February, conditions for observing P/Swift-Tuttle would have been very unfavorable, and the comet, on the far side of the Sun, could scarcely have been expected to become brighter than fifth magnitude: Wargentin's Comet was clearly a spectacular comet that would have been of second magnitude or brighter in a dark sky.

Nevertheless, it is of interest to try and determine the orbit of Wargentin's Comet. The orbit, assumed parabolic, was almost certainly retrograde and highly inclined; on the other hand, the ascending node must have been close to 300°, and that again precludes identification with P/Swift-Tuttle. The observational data in Table I (adopting ϵ and θ Peg and η Aqr as the reference stars) are most nearly satisfied by the result

$$T = 1750 \text{ Feb. } 23 \text{ (New Style)}$$
$$\left.\begin{aligned}\omega &= 285°\\ \Omega &= 303\\ i &= 132\end{aligned}\right\} 1950.0$$
$$q = 0.20 \text{ a.u.}$$

If q were as large as 0.4 a.u. (with rather small changes in the other elements, most notably a decrease of ω to 240°), the position at the time of the last observation would have been $\alpha=22^h42^m$, $\delta=-3°.9$, which is not

TABLE II. Kegler's observations of comet 1737 II.

1737 U.T.	α_{1950}	δ_{1950}
July 2.7	1h49m1	+16°45′
3.7	1 51.0	+14 34
4.7	1 52.7	+12 33
5.7	1 55.3	+10 19
6.7	1 57.3	+ 8 22
7.7	1 58.4	+ 6 15
8.7	1 59.9	+ 4 10
9.7	2 01.4	+ 1 33

particularly compatible with Wargentin's diagram and the assumption that η Aqr was the comparison star. In any case, the comet would have passed through inferior conjunction (but far to the north of the Sun) a day or so before discovery, and according to the above elements the minimum distance from the Earth would have been 0.25 a.u.: the waning moon would have made an earlier discovery of the comet in the morning sky somewhat unlikely. When Wargentin was able to look again, on 8 or 9 February (New Style), the comet would clearly have set too soon after the Sun to be observable from the latitude of Uppsala; and during the ensuing days or weeks, depending on its perihelion distance, the comet would have swung around south of the Sun and back into the morning sky, fading before it obtained a reasonable elongation again.

A far better candidate for P/Swift-Tuttle in the eighteenth century is comet 1737 II, observed by Kegler in Peking on eight consecutive nights. Although the identity would require P/Swift-Tuttle to have an osculating period in 1862 of more than 130 yr, Kegler's positions are surprisingly in accord with what would have been expected for P/Swift-Tuttle, and the brightness (third magnitude) is about right too. Lynn (1902) briefly mentions the possibility of identity; on the other hand, the orbits derived for the comet by Daussy (1810) and Hind (1874) do not bear an obvious resemblance to that of P/Swift-Tuttle—nor do they agree particularly well with each other.

Kegler's observations were listed by Zach (1810). Converted to modern style, they are given in our Table II. Although it is reasonably clear that Kegler, a Jesuit missionary, would have been using the Gregorian Calendar, it could be that the observations were made one day later than tabulated here: the observations are said to have been made at midnight or soon after on 3–10 July 1737, inclusive.

Table III contains five possible orbits for Kegler's Comet, while the corresponding $(O-C)$ residuals are given in Table IV. No particular significance should be attached to orbits A, B, and C: they are three-position parabolic solutions from the observations indicated by asterisks in Table IV, and the particular method used distributes the residuals between the first and third observations. It is clear, however, that the inclination i is very indeterminate. Quite by chance, it so happens that orbit A is rather similar to that determined by Daussy, while orbit C is amazingly similar to that of P/Swift-Tuttle. Orbit D is the result of a least-squares parabolic fit to all eight observations (note the large formal mean error for i), and it is not unlike the result by Hind. Orbit E is in fact the orbit of P/Swift-Tuttle, allowance having been made for the perturbations between 1737 and 1862 and the solution carried out only for the perihelion time T.

From the residuals of orbit D it appears that we must accept that the observational errors amount to at least 14 arcmin, and if one chooses to accept that they could be four times larger than this, the possibility that comet 1737 II = comet 1862 III becomes very real. If the observations were made one day later than we have supposed, the residuals for the P/Swift-Tuttle assumption become somewhat larger, the final $\Delta\delta$ rising to +74 arcmin. If, on the other hand, the observations had been made one day *earlier* than supposed (i.e., during 1–8 July U.T.), that final $\Delta\delta$ decreases to +38 arcmin, but the values of $\Delta\alpha \cos\delta$ are then all contained in the range +17 to +54 arcmin.

Although comet 1737 II is not known to have been observed outside China, Kegler may not have been the only observer; the comet is mentioned in the Chinese dynastic records (Ho Peng Yoke 1970), and the information supplied there seems to be independent. These records state that the comet appeared on 7 July to the east of *Yu-Keng* (o, π, η, and ρ Psc) and at the longitude (right ascension?) of the *Lou* (α, β, and γ Ari): this is reasonably consistent with Kegler's observation for July 6.7 U.T. (or earlier). The dynastic account then speaks of the comet as moving to the southwest and that it was still visible on 16 July. The southwesterly motion seems to conflict with Table II, but it can be understood if ecliptic longitude, rather than right ascension, is used, or if the right ascension is reckoned relative to the Sun. It is curious that the comet could be seen as late as 16 July, however, for

TABLE III. Orbits for comet 1737 II.

Orbit	A	B	C	D	E
T (1737 E.T.)	June 9.70	June 3.77	June 16.36	June 3.53±0.56	June 15.26
ω° (1950.0)	140.31	131.81	155.54	129.96 ±0.99	152.42
Ω (1950.0)	126.55	138.69	143.38	135.99 ±2.51	138.45
i (1950.0)	36.09	75.67	113.23	63.84 ±9.41	114.02
q (a.u.)	0.8743	0.8608	1.0165	0.8381±0.0142	0.9787
e	1.0	1.0	1.0	1.0	0.9609

TABLE IV. Residuals for comet 1737 II.

Orbit	A		B		C		D		E	
1737 U.T.	$\Delta\alpha\cos\delta$	$\Delta\delta$	$\Delta\alpha\cos\delta$	$\Delta\delta$	$\Delta\alpha\cos\delta$	$\Delta\delta$	$\Delta\alpha\cos\delta$	$\Delta\delta$	$\Delta\alpha\cos\delta$	$\Delta\delta$
July 2.7	− 8′[a]	− 2′[a]	−18′	+10′	−35′	+76′	− 4′	+ 5′	− 6′	+ 1′
3.7	−10	− 2	−16[a]	− 3[a]	−27	+41	− 3	− 4	− 1	−24
4.7	−11	+ 7	−16	− 2	−20	+24	− 3	− 1	+ 7	−30
5.7	0[a]	0[a]	− 4	−12	− 3[a]	0[a]	+ 8	− 9	+24	−39
6.7	+ 3	+ 8	0[a]	0[a]	+ 6	+ 1	+11	+ 3	+30	−20
7.7	− 6	+ 3	−10	+ 5	0[a]	0[a]	+ 1	+ 6	+22	+ 1
8.7	− 8[a]	− 2[a]	−13	+15	− 1	+11	− 3	+12	+19	+37
9.7	−10	−41	−18[a]	− 3[a]	− 3[a]	− 1[a]	− 7	−12	+13	+55

[a] These observations were used for three-position orbit solutions.

Kegler remarks that bad weather prevailed in Peking from 10 July until the end of the month; and, furthermore, observations would have been difficult at and after the full moon on 12 July. According to the least-squares orbit D, the comet would have reached a declination of −12° on 16 July, and it would have continued to move southward at about 2° per day: the P/Swift-Tuttle orbit E, on the other hand, would have put the comet then at declination −22°, and moving southward at 5° per day, it is not likely to have been under observation in China for much longer.

We conclude that the main point *against* the identity of P/Swift-Tuttle with comet 1737 II is that the comet's osculating period would have to have been some 10 yr longer than is indicated by the observations in 1862. We shall return to this possibility in Sec. V.

III. POSSIBILITY OF EARLIER IDENTIFICATIONS

If we accept, for the moment, that the 2-yr uncertainty in the calculated period of P/Swift-Tuttle is realistic, and thus that there are no eighteenth-century observations of the comet, it is of interest to calculate the perturbations further back in the hope of identifying earlier apparitions. For this purpose it is convenient, and certainly adequate, to ignore the perturbations by the inner planets; we have derived from the observations a starting orbit in which the masses of these planets were added to that of the Sun, and perturbations by only Jupiter–Pluto were considered. The orbit resulting from the same 212 observations utilized earlier was

$$\text{Epoch} = 1862\ \text{Aug. } 8.0\ \text{E.T.}$$
$$T = 1862\ \text{Aug. } 23.4100\ \text{E.T.}$$
$$\left.\begin{aligned}\omega &= 152.^\circ 7661\\ \Omega &= 138.6846\\ i &= 113.5599\end{aligned}\right\}\ 1950.0$$
$$q = 0.962638\ \text{a.u.}$$
$$e = 0.969478.$$

The integration was carried out using the above elements and also the elements with e changed by exactly ±0.0002 and ±0.0004. The osculating values of P are thus 118.41, 119.30, 120.21, 121.13, and 122.06 yr, and the five orbits should more or less cover the real range of uncertainty. The results of the integration are summarized in Table V, where the perihelion dates for the five orbits are listed back to the first century B.C. For reasons that will become apparent,

TABLE V. Perihelion dates for P/Swift-Tuttle.

−1.0	−0.5	0.0	+0.5	+1.0
−60 June	−54 July	−71 Nov	−38 Feb	−55 Dec
+57 June	+58 Aug	+43 Dec	+71 Mar	+58 Apr
172 Apr	169 July	156 Feb	182 Nov	168 Oct
284 Aug	281 Nov	272 May	294 Apr	281 Aug
398 June	392 Apr	389 June	403 Sept	392 July
510 Jan	507 Jan	506 Apr	515 Dec	507 Sept
624 May	620 Mar	619 May	626 Dec	622 Apr
735 Jan	734 Oct	734 Oct	737 May	735 Apr
845 Apr	848 Apr	849 Jan	850 July	849 May
957 July	959 June	960 Apr	960 Oct	960 Apr
1067 Dec	1069 June	1071 June	1073 Apr	1071 May
1182 June 19	1183 June 27	1184 May 31	1184 Nov 4	1184 Apr 24
1293 Dec 14	1294 Aug 23	1295 July 27	1296 Jan 21	1295 Jan 24
1408 June 27	1408 Aug 31	1409 Jan 11	1409 Feb 16	1408 June 12
1520 May 11	1520 Feb 23	1520 Mar 8	1519 Dec 19	1519 Mar 10
1635 July 6	1635 Jan 15	1634 Sept 15	1634 Apr 14	1633 Aug 26
1749 Sept 4	1748 Nov 4	1748 Jan 2	1747 Feb 24	1746 Apr 15
1862 Aug 23	1862 Aug 23	1862 Aug 23	1862 Aug 23	1862 Aug 23
1979 Dec 9	1980 Oct 25	1981 Sept 16	1982 Aug 13	1983 July 13

the orbits are designated −1.0, −0.5, 0.0, +0.5, +1.0 in order of increasing period (in 1862), and the corresponding perihelion dates for the forthcoming return are also supplied; it may be noted that the comet will return after a period about 1.1 yr shorter than the osculating period in 1862. The nominal predicted elements for the 0.0 solution are

$$\begin{aligned} \text{Epoch} &= 1981 \text{ July } 15.0 \text{ E.T.} \\ T &= 1981 \text{ Sept. } 16.9305 \text{ E.T.} \\ \left.\begin{aligned} \omega &= 152^\circ\!.8753 \\ \Omega &= 138.7310 \\ i &= 113.1606 \end{aligned}\right\} & \; 1950.0 \\ q &= 0.960455 \text{ a.u.} \\ e &= 0.961598. \end{aligned}$$

Comparison of the dates in Table V with the historical records does not reveal any really promising candidates for P/Swift-Tuttle at its perihelion passage in the seventeenth century. Ho Peng Yoke (1970) mentions a comet observed in China in November 1633, but there is no information about its position in the sky; and Chambers (1910, p. 264) remarks that during that same year "a comet like a launce hung over Barcelona." The comet would seem to have gone undetected at its previous perihelion passage too: there is a rather suggestive account of a comet at the *T'ien Shih* Enclosure (the general area of Hercules, Aquila, Serpens Cauda, Ophiuchus, and Serpens Caput) in July–August 1523 (Ho Peng Yoke 1970), but no motion is indicated, and this date is outside the range given in Table V. The action of the perturbations has been not to increase, but to reduce the uncertainty in the dates of the comet's earlier passage through perihelion; although the span of possible perihelion dates amounts to 3.4 yr in the eighteenth century, it is reduced to 1.9 yr in the seventeenth century, to 1.2 yr in the sixteenth, and to only slightly more than 1.0 in the fifteenth. Before that, the span increases again, but there seems to be further focusing around the eighth ecntury.

In fact, the only really good candidate for P/Swift-Tuttle at an earlier return is a comet observed in China in the year −68. That comet appeared northeast of *Kuan-So* (Corona Borealis) on 20 August, moved southward and entered the *T'ien Shih* Enclosure on 27 August (Ho Peng Yoke 1962). Hasegawa (1972) has also singled out this comet as a possible apparition of P/Swift-Tuttle and suggested that perihelion passage took place about 25 August. Peirce (1846) actually determined an orbit for this comet, but his calculation was based on the assumption that the comet was the same as one seen the previous month in Virgo, and that seems to be rather improbable. The date —68 does happen to correspond closely to the 0.0 column in Table V, but this is not particularly significant, and by then the possible range in perihelion time amounts to almost one-third of the comet's revolution period. If the comet of —68 were P/Swift-Tuttle, it would seem that there were 17 revolutions between then and 1862, but it is not easy to utilize this information for the purpose of making future predictions (a) because of the fact that more than one value of P in 1862 will fit the —68 date, and (b) because of the nongravitational forces that presumably act on the comet. The sense and magnitude of these nongravitational forces are, of course, unknown (and they could affect the calculated perihelion time in the first century B.C. by some years), although from a study of the Perseid meteor stream, Sekanina (1973) has suggested that the forces take the form of a secular deceleration of between 2 and 6 days per revolution per revolution.

It is in any case of some interest to compare the dates in Table V with those of the observed spectacular Perseid showers. Imoto and Hasegawa (1958) have listed possible Perseid showers in +36 and 714, a series of four between 830 and 841, again between 924 and 933, and then isolated displays in 989, 1007, 1042, 1451, and 1862. In his initial announcement of the association of P/Swift-Tuttle and the Perseids, Schiaparelli (1867) also mentioned showers in 1029, 1243, 1779, 1784, and 1789, and he deduced that the revolution period of the meteors was perhaps 105 yr. The period is ill-defined, but it should be noted from Table V that on occasions during the past millennium or so the comet's period was scarcely larger than 110 yr, and that the comet came to perihelion only a few years after the spectacular Perseid displays of the ninth century.

IV. PREDICTION OF THE FORTHCOMING RETURN

It is curious that there are no more obvious identifications of P/Swift-Tuttle in the past, for the comet was certainly a bright object in 1862—conspicuous enough, in fact, to have been recorded in the Chinese dynastic records on that occasion (Ho Peng Yoke 1970). Whenever perihelion passage occurred between late June and early September, the comet should have become at least as bright as in 1862, and one would expect this to happen during one revolution out of every five or six; near collision with the Earth would take place if the comet were at perihelion in late July. The fact that there are no obvious identifications suggests either that the past perihelion dates of the comet were not distributed very randomly throughout the year or that the comet was anomalously bright in 1862.

If we accept that the comet was not intrinsically fainter at its earlier perihelion passages, we can perhaps use the fact that it was *not* observed on these occasions to eliminate particular values of the revolution period and thereby narrow down the time interval during which searches should be made at the comet's next return.

We shall assume that the comet would have been

TABLE VI. Probable ranges for the solution.

18th century	17th century	16th century	15th century
−0.84 to −0.47 −0.24 to +0.12 +0.35 to +0.71 +0.93 to +1.0	−0.92 to −0.14 +0.36 to +0.90	−1.0 to +0.67 +0.91 to +1.0	−0.36 to +0.85

observed if it passed perihelion between early June and mid-October. We can then use Table V to specify sections of the interval −1.0 to +1.0 in which the solution should lie. The acceptable ranges are shown, for the four perihelion passages before 1862, in Table VI. It can be seen that the ranges −0.24 to −0.14 and +0.36 to +0.67 are acceptable on each occasion, and the most intensive searches at the next return should therefore be made at the times corresponding to them, i.e., perihelion will most probably be during April–June 1981 or during May–December 1982. In conjunction with this, it should be noted that Yeomans (1972) has run the orbital elements in Sec. I forward with full perturbations by all nine planets: he obtained 30 June 1981 as the date of perihelion passage, and if our formal mean error of ±0.63 yr in the period is at all valid, the earlier of the two intervals mentioned above would seem the more promising. At the opposite extreme, the absence of observations at any of the four perihelion passages shows that the solution is *least* likely to be between +0.90 and +0.91, corresponding to perihelion shortly before mid-May 1983.

But perhaps the comet did pass through perihelion during June–October and, for some reason or other, it was not observed (or not recorded). It is easier to conceive that such a situation would have arisen during the fifteenth century than during the eighteenth, and if we ignore the perihelion passage during the fifteenth century, another "window" opens: the range −0.84 to −0.47, which corresponds to perihelion during March–November 1980. Assigning to the acceptable ranges weight one during the fifteenth century, three during the sixteenth, six during the seventeenth, and ten during the eighteenth, we can build the histogram, given in Fig. 1, which shows the "most probable" values of the solution and dates for the next perihelion passage.

Fortuitously, the intervals June–October of all three years 1980, 1981, and 1982 are in regions of high probability, so the comet may well be rediscovered by accident. However, we urge interested observers to make specific searches for the comet during all times when Fig. 1 indicates a reasonably high probability (a weight greater than 13, say), and for this purpose a perennial ephemeris for the comet is given in Table VII. Observers should certainly not be discouraged from conducting less extensive searches at other times, and these could begin before the "−1.0" perihelion date of December 1979. If by some chance the comet of 1523 really were P/Swift-Tuttle, it would be returning as early as November 1978; this conclusion is not very satisfactory, however, for it would also mean that there were perihelion passages in August–September 1750 and 1636, again in June 1409, and the comet should not have gone unobserved.

V. FURTHER CONSIDERATION OF IDENTITY WITH COMET 1737 II

The calculations presented in Sec. I on the orbit in 1862 were made on the assumption that no nongravitational forces were acting on the comet. The residuals for the final observations were unsatisfactory, however, and following our experience with other single-apparition comets (Marsden, Sekanina, and Yeomans 1973), it is of some interest to attempt to solve for nongravitational parameters.

The solution, mentioned near the end of Sec. I, from 217 observations extending to 27 October gave a mean residual of 2″.16. On solving for radial and transverse parameters A_1 and A_2 in the usual way (Marsden *et al.* 1973), we obtained

$$A_1 = -2.2 \pm 1.2$$
$$A_2 = +7.8 \pm 0.7,$$

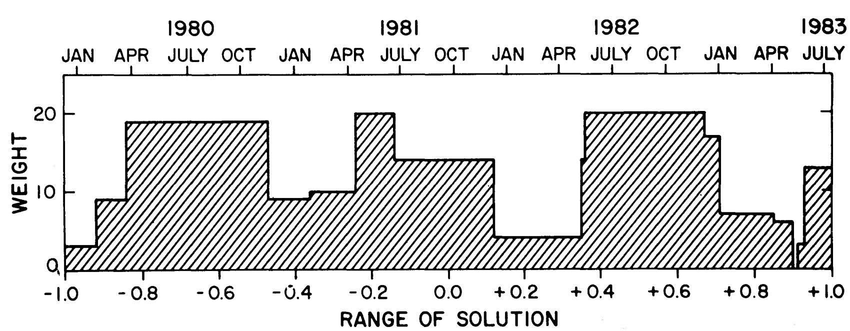

FIG. 1. The shaded area shows the weight of different sections of the range of solution, determined from the absence of observations at earlier perihelion passages as described in the text. The corresponding dates for the next perihelion passage are indicated by means of the scale at the top of the diagram.

TABLE VII. Search ephemeris.*

t -T (days) r (a.u.)	-100 1.85	-90 1.73	-80 1.61	-70 1.50	-60 1.38	-50 1.27	-40 1.17	-30 1.09	-20 1.02	-10 0.98	0 0.96	+10 0.98	+20 1.02	+30 1.09	+40 1.17	+50 1.27	+60 1.38	+70 1.50	+80 1.61	+90 1.73	+100 1.85	t -T (days) r (a.u.)
Jan. 1	17 56 +68.9	18 36 +63.7	19 04 +57.5	19 25 +50.5	19 40 +42.9	19 51 +34.8	19 59 +26.5	20 04 +18.1	20 08 + 9.8	20 10 + 1.6	-	-	-	-	-	-	-	-	19 31 -51.9	19 22 -55.5	19 11 -58.8	Jan. 1
Jan. 11	19 09 +69.7 1.54, 9.6	19 36 +63.7 1.50, 9.3	19 54 +57.0 1.48, 8.9	20 07 +49.8 1.47, 8.6	20 16 +42.1 1.47, 8.2	20 22 +34.2 1.49, 7.9	20 27 +26.2 1.53, 7.6	20 30 +18.1 1.58, 7.4	20 32 +10.0 1.64, 7.2	-	-	-	-	-	-	-	-	-	-	19 50 -54.7 2.47, 10.4	19 41 -58.1 2.55, 10.7	Jan. 11
Jan. 21	20 23 +69.8	20 34 +63.4	20 42 +56.6	20 47 +49.4	20 50 +41.8	20 52 +34.1	20 54 +26.3	20 54 +18.5	20 54 +10.7	-	-	-	-	-	-	-	-	-	-	20 17 -53.9	20 10 -57.4	Jan. 21
Jan. 31	21 31 +69.1 1.62, 9.7	21 28 +62.9 1.59, 9.4	21 26 +56.2 1.58, 9.1	21 24 +49.2 1.57, 8.7	21 23 +41.9 1.58, 8.4	21 21 +34.5 1.60, 8.1	21 20 +26.9 1.64, 7.8	21 18 +19.3 1.69, 7.5	21 17 +11.8 1.75, 7.3	-	-	-	-	-	-	-	-	-	20 48 -49.0 2.37, 10.0	20 43 -53.0 2.44, 10.3	20 38 -56.8 2.51, 10.7	Jan. 31
Feb. 10	22 32 +68.1	22 17 +62.3	22 07 +56.0	22 00 +49.3	21 54 +42.4	21 49 +35.3	21 45 +28.0	21 42 +20.6	-	-	-	-	-	-	-	-	-	-	21 13 -48.1	21 10 -52.3	21 06 -56.1	Feb. 10
Feb. 20	23 25 +66.9 1.76, 9.9	23 03 +61.7 1.73, 9.6	22 47 +55.9 1.71, 9.2	22 34 +49.8 1.70, 8.9	22 25 +43.2 1.70, 8.6	22 17 +36.4 1.71, 8.2	22 10 +29.3 1.74, 7.9	22 05 +22.1 1.77, 7.6	-	-	-	-	-	-	-	-	-	21 39 -42.6 2.24, 9.5	21 37 -47.2 2.29, 9.9	21 35 -51.5 2.35, 10.2	21 33 -55.5 2.42, 10.6	Feb. 20
Mar. 2	0 12 +65.8	23 45 +61.3	23 24 +56.1	23 07 +50.4	22 54 +44.3	22 43 +37.8	22 35 +31.0	22 28 +23.9	-	-	-	-	-	-	-	-	22 02 -36.5	22 01 -41.7	22 01 -46.5	22 00 -50.9	22 00 -55.0	Mar. 2
Mar. 12	0 54 +64.8 1.93, 10.1	0 24 +61.0 1.89, 9.8	23 59 +56.4 1.85, 9.4	23 39 +51.3 1.83, 9.1	23 23 +45.6 1.81, 8.7	23 10 +39.4 1.80, 8.3	22 59 +32.9 1.80, 8.0	22 50 +26.0 1.81, 7.7	-	-	-	-	-	-	-	22 23 -29.8 2.03, 8.6	22 23 -35.5 2.07, 9.0	22 23 -40.9 2.12, 9.4	22 24 -45.8 2.17, 9.8	22 26 -50.4 2.22, 10.1	22 28 -54.7 2.28, 10.5	Mar. 12
Mar. 22	1 33 +64.0	1 01 +60.8	0 34 +56.9	0 11 +52.3	23 52 +47.1	23 36 +41.3	23 23 +35.0	23 12 +28.3	-	-	-	-	-	-	-	22 43 -28.7	22 44 -34.7	22 45 -40.2	22 48 -45.3	22 51 -50.1	22 55 -54.5	Mar. 22
Apr. 1	2 10 +63.3 2.11, 10.3	1 37 +60.8 2.05, 9.9	1 08 +57.5 1.99, 9.6	0 42 +53.4 1.94, 9.2	0 21 +48.7 1.90, 8.8	0 02 +43.3 1.87, 8.4	23 47 +37.3 1.84, 8.0	23 34 +30.8 1.82, 7.7	-	-	-	-	-	23 02 -14.1 1.82, 7.7	23 02 -21.1 1.84, 8.0	23 03 -27.8 1.87, 8.4	23 05 -34.0 1.91, 8.8	23 08 -39.8 1.95, 9.2	23 11 -45.1 2.00, 9.6	23 16 -50.0 2.06, 10.0	23 22 -54.5 2.12, 10.3	Apr. 1
Apr. 11	2 44 +62.8	2 12 +60.8	1 41 +58.1	1 14 +54.6	0 50 +50.4	0 29 +45.5	0 11 +39.8	23 56 +33.4	23 45 +26.4	-	-	-	23 21 - 4.8	23 20 -12.6	23 21 -20.0	23 23 -27.0	23 26 -33.5	23 30 -39.6	23 35 -45.1	23 42 -50.2	23 50 -54.8	Apr. 11
Apr. 21	3 18 +62.4 2.28, 10.5	2 46 +60.9 2.19, 10.1	2 15 +58.8 2.11, 9.7	1 45 +55.9 2.04, 9.3	1 19 +52.2 1.97, 8.9	0 56 +47.7 1.90, 8.4	0 36 +42.4 1.84, 8.0	0 19 +36.2 1.79, 7.6	0 05 +29.4 1.74, 7.3	23 55 +21.8 1.71, 7.1	23 47 +13.8 1.67, 6.9	23 42 + 5.5 1.65, 7.0	23 39 - 2.9 1.64, 7.2	23 38 -11.1 1.64, 7.4	23 40 -19.0 1.65, 7.8	23 42 -26.5 1.67, 8.2	23 47 -33.4 1.70, 8.6	23 52 -39.7 1.75, 9.0	0 00 -45.5 1.81, 9.4	0 08 -50.7 1.87, 9.7	0 19 -55.4 1.94, 10.1	Apr. 21
May 1	3 51 +62.0	3 20 +61.1	2 48 +59.5	2 18 +57.2	1 49 +54.0	1 24 +50.0	1 01 +45.1	0 42 +39.2	0 26 +32.4	0 14 +24.8	0 06 +16.6	0 00 + 7.9	23 57 - 1.0	23 57 - 9.8	23 59 -18.3	0 02 -26.3	0 08 -33.6	0 15 -40.3	0 25 -46.3	0 36 -51.6	0 50 -56.3	May 1
May 11	4 23 +61.6 2.41, 10.6	3 53 +61.2 2.31, 10.2	3 22 +60.2 2.21, 9.8	2 51 +58.4 2.10, 9.4	2 21 +55.9 2.01, 8.9	1 53 +52.4 1.91, 8.5	1 27 +47.9 1.82, 8.0	1 06 +42.3 1.73, 7.6	0 48 +35.7 1.64, 7.2	0 34 +28.1 1.57, 6.9	0 24 +19.6 1.50, 6.7	0 18 +10.4 1.45, 6.7	0 15 + 0.9 1.42, 6.8	0 15 - 8.7 1.40, 7.1	0 18 -17.9 1.41, 7.4	0 23 -26.5 1.43, 7.8	0 30 -34.4 1.48, 8.2	0 39 -41.5 1.53, 8.7	0 51 -47.7 1.60, 9.1	1 06 -53.1 1.68, 9.5	1 23 -57.7 1.77, 9.9	May 11
May 21	4 55 +61.3	4 27 +61.3	3 57 +60.8	3 25 +59.6	2 54 +57.6	2 23 +54.7	1 55 +50.8	1 30 +45.6	1 10 +39.2	0 54 +31.6	0 43 +22.8	0 36 +13.0	0 33 + 2.7	0 33 - 7.8	0 37 -17.9	0 43 -27.4	0 53 -35.9	1 05 -43.3	1 20 -49.6	1 38 -55.0	1 59 -59.4	May 21
May 31	5 26 +60.9 2.51, 10.7	5 01 +61.3 2.38, 10.3	4 32 +61.2 2.26, 9.8	4 01 +60.7 2.14, 9.4	3 28 +59.3 2.01, 8.9	2 55 +57.1 1.89, 8.4	2 24 +53.7 1.76, 7.9	1 57 +49.0 1.63, 7.4	1 33 +42.9 1.51, 7.0	1 15 +35.3 1.40, 6.6	1 02 +26.3 1.30, 6.4	0 54 +15.9 1.21, 6.3	0 51 + 4.5 1.16, 6.4	0 52 - 7.2 1.13, 6.6	0 57 -18.6 1.14, 7.0	1 05 -29.0 1.18, 7.4	1 17 -38.2 1.24, 7.9	1 32 -45.9 1.32, 8.3	1 51 -52.3 1.41, 8.8	2 13 -57.4 1.51, 9.3	2 39 -61.5 1.62, 9.7	May 31
June 10	5 57 +60.5	5 34 +61.2	5 08 +61.6	4 38 +61.6	4 05 +60.9	3 30 +59.3	2 56 +56.6	2 25 +52.6	1 58 +46.9	1 36 +39.5	1 21 +30.1	1 12 +18.9	1 09 + 6.3	1 11 - 7.1	1 17 -20.1	1 28 -31.8	1 43 -41.6	2 02 -49.5	2 26 -55.7	2 54 -60.4	3 25 -63.8	June 10
June 20	6 27 +60.1 2.56, 10.7	6 07 +61.1 2.42, 10.3	5 44 +61.9 2.28, 9.9	5 16 +62.3 2.14, 9.4	4 44 +62.3 1.99, 8.9	4 09 +61.5 1.83, 8.4	3 32 +59.6 1.68, 7.8	2 56 +56.3 1.52, 7.3	2 25 +51.2 1.36, 6.7	1 59 +44.1 1.20, 6.3	1 41 +34.5 1.06, 6.0	1 31 +22.4 0.94, 5.8	1 27 + 7.9 0.86, 5.8	1 30 - 7.9 0.83, 6.0	1 38 -23.0 0.86, 6.4	1 53 -36.1 0.92, 6.9	2 12 -46.4 1.02, 7.4	2 38 -54.2 1.13, 8.0	3 08 -59.8 1.26, 8.6	3 42 -63.6 1.39, 9.1	4 18 -66.1 1.53, 9.6	June 20
June 30	6 57 +59.6	6 40 +60.8	6 20 +62.0	5 55 +62.9	5 25 +63.5	4 50 +63.4	4 11 +62.4	3 32 +60.1	2 55 +55.8	2 24 +49.2	2 02 +39.7	1 49 +26.5	1 45 + 9.4	1 49 - 9.9	2 01 -28.1	2 21 -42.5	2 48 -52.8	3 21 -59.7	4 00 -64.2	4 41 -66.9	5 20 -68.2	June 30
July 10	7 26 +59.1 2.56, 10.7	7 12 +60.5 2.41, 10.3	6 56 +61.9 2.26, 9.8	6 35 +63.3 2.10, 9.4	6 09 +64.4 1.93, 8.8	5 36 +65.2 1.76, 8.3	4 57 +65.2 1.57, 7.7	4 14 +63.9 1.38, 7.1	3 30 +60.8 1.19, 6.5	2 52 +55.2 1.00, 5.9	2 25 +46.0 0.81, 5.4	2 08 +31.6 0.65, 5.0	2 04 +10.6 0.55, 4.8	2 10 -14.5 0.53, 5.0	2 27 -36.4 0.59, 5.6	2 56 -51.4 0.72, 6.3	3 34 -60.6 0.87, 7.1	4 20 -65.8 1.02, 7.8	5 08 -68.6 1.19, 8.4	5 52 -69.6 1.35, 9.0	6 30 -69.8 1.51, 9.6	July 10
July 20	7 55 +58.5	7 45 +60.1	7 32 +61.7	7 16 +63.4	6 55 +65.1	6 27 +66.6	5 51 +67.6	5 06 +67.7	4 16 +66.2	3 28 +62.1	2 50 +54.0	2 28 +38.8	2 22 +11.4	2 33 -24.3	3 01 -49.7	3 46 -62.8	4 45 -69.0	5 45 -71.5	6 36 -71.9	7 16 -71.4	7 45 -70.5	July 20
July 30	8 23 +57.9 2.52, 10.7	8 16 +59.6 2.36, 10.3	8 08 +61.5 2.20, 9.8	7 57 +63.4 2.03, 9.3	7 43 +65.4 1.85, 8.7	7 23 +67.5 1.66, 8.1	6 55 +69.5 1.46, 7.5	6 16 +71.1 1.25, 6.8	5 23 +71.7 1.03, 6.2	4 20 +70.1 0.80, 5.4	3 24 +64.7 0.58, 4.6	2 49 +50.7 0.36, 3.7	2 41 +10.8 0.21, 2.7	3 04 -46.0 0.27, 3.5	4 03 -67.9 0.45, 4.9	5 30 -74.6 0.64, 6.1	6 52 -75.8 0.84, 7.0	7 48 -74.9 1.03, 7.8	8 22 -73.4 1.22, 8.5	8 44 -71.9 1.39, 9.1	8 58 -70.3 1.57, 9.7	July 30

TABLE VII (*continued*)

t -T (days)	-100	-90	-80	-70	-60	-50	-40	-30	-20	-10	0	+10	+20	+30	+40	+50	+60	+70	+80	+90	+100	t -T (days)
r (a.u.)	1.85	1.73	1.61	1.50	1.38	1.27	1.17	1.09	1.02	0.98	0.96	0.98	1.02	1.09	1.17	1.27	1.38	1.50	1.61	1.73	1.85	r (a.u.)
Aug. 9	8 51	8 48	8 44	8 39	8 32	8 23	8 09	7 49	7 15	6 18	4 49	3 19	2 55	5 38	9 04	9 50	10 02	10 05	10 06	10 05	10 04	Aug. 9
	+57.4	+59.1	+61.1	+63.2	+65.4	+67.9	+70.6	+73.4	+76.2	+78.5	+79.0	+74.2	- 5.8	-82.6	-82.3	-79.5	-76.9	-74.7	-72.8	-71.1	-69.6	
Aug. 19	9 19	9 19	9 19	9 20	9 22	9 25	9 30	9 42	10 08	11 15	13 31	15 13	15 24	14 46	13 50	12 58	12 19	11 50	11 30	11 15	11 03	Aug. 19
	+56.9	+58.7	+60.6	+62.8	+65.1	+67.7	+70.6	+73.7	+77.0	+79.7	+78.8	+62.7	-26.5	-64.6	-71.6	-73.1	-72.9	-72.0	-70.9	-69.6	-68.5	
	2.44, 10.6	2.28, 10.2	2.11, 9.7	1.93, 9.2	1.74, 8.6	1.55, 8.0	1.34, 7.3	1.13, 6.6	0.90, 5.9	0.67, 5.0	0.43, 4.0	0.21, 2.5	0.13, 1.6	0.32, 3.9	0.54, 5.4	0.75, 6.4	0.95, 7.3	1.15, 8.1	1.34, 8.7	1.52, 9.3	1.69, 9.8	
Aug. 29	9 46	9 50	9 55	10 02	10 12	10 27	10 51	11 31	12 36	13 58	15 06	15 40	15 42	15 23	14 51	14 13	13 35	13 02	12 35	12 13	11 55	Aug. 29
	+56.4	+58.2	+60.1	+62.2	+64.5	+66.9	+69.3	+71.4	+72.1	+69.1	+57.5	+26.1	-23.1	-50.0	-60.9	-65.8	-67.8	-68.5	-68.4	-67.9	-67.2	
Sept. 8	10 14	10 21	10 30	10 43	11 02	11 28	12 06	12 59	14 03	15 02	15 43	16 02	16 02	15 49	15 26	14 57	14 25	13 54	13 26	13 02	12 40	Sept. 8
	+56.1	+57.8	+59.6	+61.5	+63.5	+65.3	+66.7	+66.8	+64.0	+55.8	+38.2	+ 8.4	-22.8	-42.8	-53.8	-60.0	-63.4	-65.2	-66.0	-66.3	-66.1	
	2.31, 10.5	2.15, 10.1	1.98, 9.6	1.81, 9.0	1.63, 8.5	1.44, 7.8	1.25, 7.2	1.05, 6.5	0.84, 5.7	0.65, 5.0	0.49, 4.3	0.41, 4.0	0.46, 4.4	0.61, 5.3	0.78, 6.2	0.97, 7.0	1.16, 7.7	1.34, 8.4	1.52, 9.0	1.69, 9.5	1.85, 10.0	
Sept. 18	10 41	10 52	11 06	11 25	11 51	12 26	13 11	14 05	14 59	15 43	16 10	16 23	16 23	16 12	15 54	15 30	15 04	14 36	14 09	13 44	13 22	Sept. 18
	+55.8	+57.5	+59.1	+60.8	+62.2	+63.2	+63.1	+60.8	+54.8	+43.0	+23.8	- 0.7	-23.1	-38.9	-49.1	-55.6	-59.8	-62.4	-63.9	-64.7	-65.1	
Sept. 28	11 09	11 24	11 43	12 08	12 40	13 20	14 08	14 57	15 42	16 15	16 35	16 44	16 43	16 35	16 20	16 00	15 37	15 13	14 48	14 23	14 00	Sept. 28
	+55.8	+57.3	+58.7	+60.0	+60.7	+60.6	+58.8	+54.2	+45.7	+32.2	+13.9	- 6.1	-23.5	-36.6	-45.9	-52.4	-56.9	-60.0	-62.1	-63.4	-64.2	
	2.16, 10.3	2.00, 9.9	1.84, 9.4	1.68, 8.9	1.52, 8.3	1.35, 7.7	1.18, 7.1	1.02, 6.4	0.87, 5.8	0.75, 5.3	0.69, 5.0	0.71, 5.1	0.79, 5.6	0.92, 6.2	1.07, 6.8	1.23, 7.5	1.40, 8.1	1.56, 8.7	1.72, 9.3	1.88, 9.8	2.03, 10.2	
Oct. 8	11 38	11 57	12 21	12 51	13 28	14 11	14 58	15 41	16 17	16 43	16 59	17 06	17 05	16 57	16 44	16 27	16 07	15 45	15 22	14 59	14 36	Oct. 8
	+56.0	+57.3	+58.4	+59.1	+59.0	+57.6	+54.0	+47.5	+37.4	+23.5	+ 7.0	- 9.6	-23.9	-35.1	-43.6	-50.0	-54.7	-58.1	-60.6	-62.3	-63.4	
Oct. 18	12 08	12 31	13 00	13 35	14 16	15 00	15 42	16 20	16 49	17 10	17 23	17 27	17 26	17 19	17 08	16 53	16 36	16 16	15 55	15 33	15 11	Oct. 18
	+56.5	+57.5	+58.2	+58.2	+57.0	+54.2	+49.1	+41.2	+30.2	+16.8	+ 2.1	-11.9	-24.1	-34.0	-41.9	-48.0	-52.8	-56.5	-59.2	-61.3	-62.8	
	1.98, 10.2	1.84, 9.7	1.70, 9.2	1.56, 8.7	1.42, 8.2	1.29, 7.6	1.16, 7.0	1.06, 6.5	0.98, 6.0	0.94, 5.8	0.94, 5.7	1.00, 5.9	1.10, 6.3	1.21, 6.8	1.35, 7.3	1.49, 7.9	1.64, 8.5	1.78, 9.0	1.92, 9.5	2.07, 10.0	2.20, 10.4	
Oct. 28	12 39	13 08	13 42	14 21	15 03	15 45	16 23	16 55	17 19	17 36	17 46	17 49	17 47	17 41	17 31	17 18	17 03	16 45	16 26	16 06	15 45	Oct. 28
	+57.4	+58.0	+58.1	+57.2	+54.9	+50.8	+44.3	+35.5	+24.3	+11.7	- 1.3	-13.5	-24.2	-33.2	-40.5	-46.5	-51.2	-55.1	-58.1	-60.4	-62.2	
Nov. 7	13 13	13 47	14 25	15 07	15 49	16 28	17 01	17 28	17 47	18 01	18 08	18 11	18 09	18 03	17 55	17 43	17 30	17 14	16 57	16 38	16 18	Nov. 7
	+58.5	+58.7	+58.1	+56.2	+52.8	+47.4	+39.9	+30.5	+19.6	+ 7.9	- 3.7	-14.6	-24.1	-32.4	-39.3	-45.1	-49.9	-53.8	-57.1	-59.7	-61.7	
	1.80, 10.0	1.68, 9.5	1.57, 9.1	1.46, 8.6	1.36, 8.1	1.27, 7.6	1.20, 7.1	1.15, 6.7	1.13, 6.3	1.15, 6.2	1.19, 6.2	1.27, 6.4	1.37, 6.8	1.48, 7.2	1.60, 7.7	1.72, 8.2	1.85, 8.7	1.98, 9.2	2.10, 9.7	2.23, 10.1	2.35, 10.5	
Nov. 17	13 51	14 30	15 12	15 55	16 34	17 09	17 37	17 59	18 15	18 25	18 31	18 33	18 31	18 26	18 18	18 08	17 55	17 42	17 26	17 09	16 50	Nov. 17
	+60.1	+59.7	+58.2	+55.2	+50.5	+44.1	+36.0	+26.5	+16.0	+ 5.2	- 5.3	-15.1	-23.9	-31.6	-38.2	-43.9	-48.6	-52.7	-56.1	-58.9	-61.3	
Nov. 27	14 33	15 17	16 01	16 42	17 18	17 48	18 11	18 28	18 41	18 49	18 54	18 54	18 52	18 48	18 41	18 32	18 21	18 09	17 55	17 39	17 22	Nov. 27
	+62.0	+60.8	+58.2	+54.1	+48.4	+41.2	+32.7	+23.3	+13.3	+ 3.3	- 6.3	-15.3	-23.5	-30.8	-37.1	-42.7	-47.5	-51.6	-55.2	-58.2	-60.8	
	1.65, 9.8	1.56, 9.4	1.47, 8.9	1.40, 8.5	1.34, 8.0	1.30, 7.6	1.27, 7.2	1.27, 6.9	1.30, 6.7	1.35, 6.5	1.42, 6.6	1.51, 6.8	1.60, 7.1	1.70, 7.5	1.81, 8.0	1.92, 8.5	2.03, 8.9	2.14, 9.4	2.25, 9.8	2.36, 10.2	2.47, 10.6	
Dec. 7	15 20	16 08	16 52	17 30	18 01	18 25	18 43	18 57	19 06	19 13	19 16	19 16	19 14	19 09	19 03	18 55	18 46	18 35	18 23	18 09	17 54	Dec. 7
	+64.1	+61.9	+58.2	+53.0	+46.4	+38.7	+30.1	+20.9	+11.5	+ 2.2	- 6.8	-15.2	-22.9	-29.9	-36.1	-41.5	-46.3	-50.6	-54.2	-57.5	-60.2	
Dec. 17	16 16	17 05	17 45	18 17	18 41	19 00	19 14	19 24	19 31	19 36	19 38	-	-	-	-	-	-	19 01	18 50	18 38	18 25	Dec. 17
	+66.3	+62.9	+58.0	+51.9	+44.7	+36.7	+28.2	+19.3	+10.4	+ 1.6	- 6.9							-49.5	-53.3	-56.7	-59.7	
	1.56, 9.6	1.49, 9.3	1.43, 8.9	1.39, 8.5	1.37, 8.1	1.36, 7.7	1.38, 7.4	1.41, 7.1	1.47, 6.9	1.53, 6.8	1.61, 6.9							2.25, 9.5	2.34, 9.9	2.44, 10.3	2.54, 10.7	
Dec. 27	17 19	18 04	18 37	19 02	19 20	19 34	19 44	19 51	19 56	19 58	-	-	-	-	-	-	-	-	19 17	19 07	18 55	Dec. 27
	+68.1	+63.5	+57.7	+50.9	+43.4	+35.3	+26.9	+18.4	+ 9.8	+ 1.5									-52.4	-55.9	-59.1	

*Each entry gives the right ascension (in hours and minutes, equinox 1950.0) and declination (in degrees, equinox 1950.0). For the alternate dates also given are the geocentric distance, $\triangle$ (in a.u.) and the total magnitude, calculated from $6.0+5\log\triangle+10\log r$. The comet might be as much as two magnitudes brighter than predicted. If the comet is at perihelion within ±100 days of the dates specified, it should on those dates be generally within about $\pm1°$ of the arc passing through the various positions given. In early August, the middle part of the track becomes less certain, but the comet should then be a naked-eye object (and moving quite rapidly).

and the residuals were substantially improved, the mean value becoming 1″.92. The improvement of the residuals is evidently due mainly to A_2, although the value obtained is completely out of line with what has been found for other comets, and it is hence scarcely of any physical significance: we must accept, as suggested earlier, that the systematic residuals are due to problems in the measurement.

From the point of view of demonstrating possible identity with comet 1737 II, however, it is the radial component A_1 that is of the greater importance. Furthermore, as suggested by Marsden *et al.* (1973), in order to make the comet's revolution period longer, a more *negative* value of A_1 is required. Ignoring A_2 and the perturbations by the inner planets, we found it necessary to take $A_1=-7.656$. The resulting osculating elements for 1737 are precisely those labeled orbit E in Table III; the osculating value of P is 125.04 yr. The 217 observations in 1862 are satisfied with mean residual 2″.19, and the corresponding osculating elements are not greatly different from those given earlier, except that $e=0.9630$, $P=132.80$ yr. The osculating elements for the next return would be

$$T=1992 \text{ Nov. } 25.85 \text{ E.T.}$$

$$\left.\begin{aligned} \omega &= 153^\circ.05 \\ \Omega &= 138.74 \\ i &= 113.45 \end{aligned}\right\} 1950.0$$

$$q = 0.9582 \text{ a.u.}$$

$$e = 0.9633$$

$$P=133.38 \text{ yr.}$$

Our procedure for forcing the linkage of the 1737 and 1862 observations is certainly open to question, and these resulting 1992 predicted elements are consequently somewhat uncertain. One would feel more convinced of the identity if it were necessary to make A_1 positive, as has been found for so many other comets. The point is, of course, that if the comet has not been found before late 1983, it would certainly be desirable to start thinking about searching according to the above elements in 1992, although by that time we should know more about cometary nongravitational forces, and it may well be possible to refine the prediction.

A final point concerns the resulting data for the comet's earlier passages through perihelion. If the identification with comet 1737 II is correct, the previous perihelion dates would have been around March 1610, December 1479, September 1348, and August 1213. The comet should have been easily observable on the two last-named occasions; the records do not show that it was, although there is a Japanese account of a comet in September 1348 (Hasegawa 1972).

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