COMET TEMPEL-TUTTLE AND THE LEONID METEORS

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The annual November Leonid meteor showers and the occasional Leonid meteor storms (e.g. 1833, 1966) are far better known than is the Leonid parent body, comet 55P/Tempel-Tuttle. Since A.D. 902, enhanced Leonid meteor showers have been recorded around the time of the parent comet's returns to perihelion (Yeomans 1981). To date, the parent comet itself, however, has not been seen for more than a few days at any apparition except in late 1865 and early 1866. The impending perihelion return of comet Tempel-Tuttle again raises the possibility of strong meteor displays in 1998-99 as well as a chance to observe the elusive parent comet.

Until the recent 1997 recovery observations (Hainaut, 1997), comet Tempel-Tuttle had been observed only during its 1366, 1699, 1865-66, and 1965 apparitions. J.R. Hind (1873) first pointed out that the comet seen by the Chinese in 1366 may have been an earlier apparition of the 1865-66 return of P/Tempel-Tuttle. Rough Chinese observations were used by Kanda (1932) to determine an approximate orbit for the comet's return in 1366. The work of Schubart (1965) allowed the recovery of the comet in 1965. By adjusting the comet's assumed period, Schubart computed an orbit based upon the 1865-66 observations that was also able to represent the 1366 observations. As a result of this process, he also identified a single 1699 cometary observation made by Gottfried Kirch (1737) as being due to comet Tempel-Tuttle. Schubart was able to provide a search ephemeris for the comet's expected return in 1965 and while the observing geometry was very poor, a few successful observations of the comet were made in mid-1965.

Yeomans (1981) used 1865-66 and 1965 astrometric data to compute an orbit for comet 55P/Tempel-Tuttle and then numerically integrated the comet's motion back to the early tenth century. By comparing the orbital circumstances of the parent comet near the times of the observed Leonid displays over the 902 - 1969 interval, criteria were established for significant Leonid displays to occur: displays are possible roughly 2500 days before or after the comet reaches perihelion but only if the comet passes closer than 0.025 AU inside or 0.010 AU outside the Earth's orbit. Yeomans et al. (1996) improved the comet's orbit by using the 1965, 1865-66 observations as well as the 1699 observation in the solution. In an effort to identify early Chinese observations, they numerically integrated the comet's motion back in time for two millennia. Possible (but not definite) observations of the comet were identified in October 1234 and January 1035.

For the most recent orbit of comet 55P/Tempel-Tuttle, we employed five 1997 recovery observations, three 1965 observations, and 48 observations from 1865-66. The derived orbital elements are given below.

Epoch 1998 Mar 8.0 (TDB)
Perih. time 1998 Feb 28.069183 (TDB)
e 0.9055089
q 0.9765989 AU
Arg. Perih. 172.49491 deg.
Lng. Asc. Node 235.25791 deg.
Inc. 162.48607 deg.
A1 -1.6608E-9 AU/(day**2)
A2 8.5150E-11 AU/(day**2)

The rms unweighted residual was 3.7 arc seconds, and while the observation residuals were noisy, no obvious systematic residual trends were evident. The perihelion passage time differs by

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only -0.02 day from the prediction by Yeomans et al. (1996). While the radial nongravitational parameter (A1) is not well determined, the transverse nongravitational parameter (A2) has a value within 4A2 and the 1998 orbital elements are also similar to those given by Nakano and Hasegawa (1995); their orbit is based upon 59 observations over the 1366-1965 interval.

The success with which the orbital extrapolations matched the recently computed 1997 perihelion passage time gives us confidence in the conclusions reached by Yeomans et al. (1996). No Leonid meteor showers should have been observable prior to the eighth century. It is important to take advantage of the expected 1998-99 displays because it will be another century after these events before significant meteor displays are once again likely. After the 22nd century, the precession of the comet's orbit will prevent future Leonid meteor displays.

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