THE NATURAL THERMOLUMINESCENCE OF METEORITES AND THEIR ORBITS

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The identification of meteorite parent bodies and our current understanding of meteoroite-asteroid relationships depend on orbital theory and spectral data. Recent theoretical treatments provide a means of extracting meteorites from the asteroid belt using resonances (Wetherill, 1985), but none of the main-belt asteroids have reflectivity spectra similar to those of ordinary chondrites (Chapman, 1976). Natural thermoluminescence (TL) levels in meteorites depend on cosmic-ray dose rate and temperature, and since the latter is strongly dependent on the perihelion, orbital information may be obtained by analysis of the stored TL (Melcher, 1981; McKeever and Sears, 1980).

Simplified thermoluminescence theory predicts that meteorites with the perihelia of Pribram (0.790 a.u.) and Lost City (0.967 a.u.) should show one-to-two orders of magnitude difference in the natural TL levels (Sears and Hasan, 1986). Simonenko (1975) has calculated the orbital elements of 45 meteorites based on time and place of fall, and to test the TL theory we propose to measure the natural TL levels in these meteorites. To date we have measured the natural TL levels in 26 samples listed in Simonenko's catalogue and the data are shown in Figure 1.

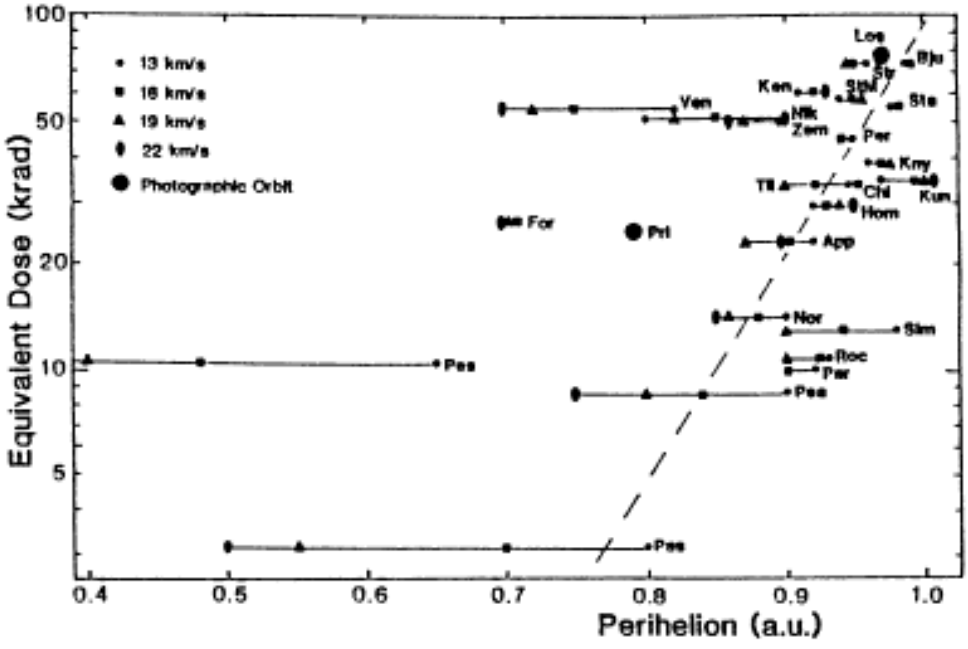

Fig. 1 Natural TL against calculated perihelion for 26 meteorites. The broken line is theoretically predicted relationship.

The calculated perihelion depends on an assumed velocity, an assumption which becomes particularly serious at small perihelia. Despite this uncertainty, there is a strong relationship between natural TL level (expressed as "equivalent dose," see Melcher (1981) and perihelion, with perihelia of 1.0 a.u. differing by factor of > 10 in natural TL compared with those with perihelia of 0.8 a.u. Data for cosmogenic isotopes may improve the correlation by enabling correction for shielding, or perhaps by other means; for example, Pesyanoe's calculated perihelion is inconsistent with $^{3}He/^{21}Ne$ data which do not indicate the gas-loss expected for such close solar passage (Ed Anders, per. comm.).

The anomalously low natural TL levels observed in several ordinary chondrites (Melcher, 1981; McKeever and Sears, 1980) can therefore reasonably be attributed to small perihelia orbits. This may have implications for studies of cosmogenic isotopes and orbital evolution studies.

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