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Meteoroid Bulk Density and Ceplecha Types

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ABSTRACT

The determination of asteroid bulk density is an important aspect of Near Earth Object (NEO) characterization. A fraction of meteoroids originate from asteroids (including some NEOs), thus in lieu of mutual perturbations, satellites, or expensive spacecraft missions, a study of meteoroid bulk densities can potentially provide useful insights into the densities of NEOs and PHOs (Potentially Hazardous Objects). Meteoroid bulk density is still inherently difficult to measure, and is most often determined by modeling the ablation of the meteoroid.

One approach towards determining a meteoroid density distribution entails using a more easily measured proxy for the densities, then calibrating the proxy with known densities from meteorite falls, ablation modelling, and other sources. An obvious proxy choice is the Ceplecha type, K_B (Ceplecha, 1958), which is thought to indicate the strength of a meteoroid and often correlated to different bulk densities in literature. K_B is calculated using the air density at the beginning height of the meteor, the initial velocity, and the zenith angle of the radiant; quantities more readily determined than meteoroid bulk density itself. Numerical values of K_B are sorted into groups (A, B, C, etc), which have been matched to meteorite falls or meteor showers with known composition such as the porous Draconids.

An extensive survey was conducted to establish the strength of the relationship between bulk density and K_B , specifically looking at those that additionally determined K_B for the meteors. In examining the modeling of high-resolution meteor data from Kikwaya et al. (2011), the correlation between K_B and bulk density was not

as strong as hoped. However, a distinct split by dynamical type was seen with Jovian Tisserand parameter (T_J), with meteoroids from Halley Type comets ($T_J < 2$) exhibiting much lower bulk densities than those originating from Jupiter Family comets and asteroids ($T_J > 2$). Therefore, this work indicates that the dynamical classification of a meteoroid is a better indicator of the density than the strength proxy, a somewhat surprising result.

Ceplecha, Z. 1958. On the composition of meteors. Bulletin of the Astronomical Institutes of Czechoslovakia, 9:154.

Kikwaya, J.B., Campbell-Brown, M., Brown, P.G., 2011. Bulk density of small meteoroids. Astronomy & Astrophysics, 530:A113.

Comments:

(Poster)