DYNAMICS OF ASTEROIDAL DUST PARTICLES IN THE INNER SOLAR SYSTEM.

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Abstract: A good understanding of the distribution of asteroidal dust in the inner solar system is critical for producing accurate models of the dust environment in near-Earth space. Asteroidal dust particles are injected into the zodiacal cloud following the catastrophic disruption of their parent bodies in asteroid family-forming events in the main-belt region. These asteroidal particles then evolve both dynamically and collisionally, resulting in the formation of solar system dust bands, as discovered by IRAS [1].

We investigated the migration of these particles from their source region in the main asteroid belt into the inner solar system under the effect of planetary perturbations, Poynting-Robertson (P-R) drag, solar-wind drag and inter-particle collisions, with the aim of better understanding the contribution of particles from the dust bands to the background zodiacal cloud.

Previous studies of the orbital evolution of dust from asteroidal sources have typically been limited to considering small particles (< 100 microns in diameter) because of their shorter P-R drag timescales and hence shorter integration times. With advances in both readily available processing power and numerical techniques, these computational restrictions have now been significantly reduced. Here, we present results from an ongoing investigation into the dynamical behavior of a more realistic size distribution of asteroidal dust particles (up to ~ 1 mm in diameter). These simulations have shown that, in contrast to the behavior of small particles, the orbits of large asteroidal particles (> 100 microns in diameter) are significantly affected by both secular resonances and jovian mean-motion resonances as they slowly decay towards the Sun under the effect of P-R drag. The effect of these resonances on large particles may even confuse the typical distinction made between asteroidal- and cometary-type orbits in near-Earth space.

In addition, we investigated the role of interactions with Mars on the orbital distribution of the asteroidal dust particles. Following a modified analytical approach based on the formulism developed by Öpik [2], we focused on the effect of gravitational close encounters with Mars on the dust particle orbits. This analysis showed that, while dust particles may not directly collide with Mars, a sizable fraction of the particles probably enter the martian Hill sphere and thus may suffer potentially significant perturbations to their orbits. We found that the probability of a gravitational close encounter with Mars depended upon the size of the particle, and the eccentricity and inclination of its orbit, with the likelihood of an encounter biased towards larger particles on near-circular orbits close to the orbital plane of Mars. In particular, we note that the dependency on inclination may bias the population of asteroid family particles that reach near-Earth space towards particles from higher-inclination sources. We also report on the outcome of numerical simulations undertaken to verify these analytical results. Additionally, these simulations reveal the magnitude of the effect of gravitational scattering by Mars on the orbits of the dust particles and the level of importance of trapping in martian mean-motion resonances.

We consider the implications of this work for models of the dust environment in near-Earth space and the compositional diversity of the interplanetary dust particles collected on Earth.

References: [1] Low F. J. et al. (1984) *ApJ, 278,* L19–L22. [2] Öpik E. J. (1951) *Proc. R. Irish Acad., 54,* 165–199.

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