EVOLUTION OF DUST PARTICLES EJECTED BY CATASTROPHIC ASTEROIDAL DISRUPTIONS

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The contribution of asteroidal dust to the zodiacal cloud has previously been discussed in terms of a collisional cascade process, whereby dust is produced by the grinding down of large objects. However, there is now evidence that debris disks, such as the zodiacal cloud, are refreshed stochastically by the injection of dust produced by the catastrophic collisional breakup of a large planetesimal. Asteroid families provide dramatic proof of the occurrence of such collisions in the solar system. There are now known to be at least two examples of asteroids, tens to hundreds of kilometers in diameter, that have been catastrophically disrupted by an impact within the last ten million years. These collisional events resulted in the creation of the Veritas family and the Karin cluster. Enormous quantities of dust are injected into the zodiacal cloud following such family-forming impact events and the remnants of the collisional debris produced by these disruptions can still be observed today in the form of dust bands. Following its production, this material evolves both dynamically and collisionally, with the result that a wave of dust particles is transported from its source region in the asteroid belt into the inner solar system

Evidence shows that many asteroids are not coherent, solid bodies but are instead highly fractured, highly porous, and only loosely bound by gravity. Dust may be generated by impact processes in the regoliths of such "rubble piles" and so the contribution of asteroidal dust to the zodiacal cloud may be determined by a quite different mechanism to the collisional cascade process, with only a few rubble piles providing the majority of asteroidal dust in the solar system at any particular epoch. These asteroids appear to maintain their internal porosity despite the accumulation of fine-grained deposits on their surfaces. It has been found that the effect of friction on this material dominates over an asteroid's weak gravitational field. This effectively traps any accreted or micrometeorite-produced dust on asteroid surfaces, making it readily available for ejection into the zodiacal cloud.

We will present preliminary results from numerical simulations of the dynamical evolution of dust particles released from the regolith layers of such catastrophically disrupted rubble-pile asteroids. Estimates of the cross-sectional area of material produced and its size-frequency distribution will be constrained by comparison with models of the dust bands associated with the Veritas family and the Karin cluster.