INTERPLANETARY DUST FLUX TO URANUS AND NEPTUNE: IMPLICATIONS FOR ATMOSPHERES, RINGS, AND SATELLITES.

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Introduction: Objects in the outer solar system, including Uranus, Neptune, and their moons and ring systems are constantly bombarded by an influx of interplanetary dust grains (IDPs) with as-of-yet poorly constrained fluxes. Knowledge of the IDP influx is critical to understanding several physical processes that occur at Uranus and Neptune including ablation of IDPs, deposition of external material, and alteration of atmospheric photochemistry in the planet's atmospheres [1], the surface evolution of the planetary satellites including impact gardening and ice annealing [2], and the generation of tenuous dust rings via impact ejecta production [3]. We report here on a modeling and data comparison effort to constrain the distributions of micron-sized dust grains in the outer solar system and their influx into the uranian and neptunian systems and discuss implications thereof.

Model: We use a dynamical model to calculate the spatial, velocity, and size evolution of dust grains launched in the outer solar system [4]. The code tracks individual grains including the effects of gravitation, solar wind and Poynting-Robertson drag, and the electromagnetic Lorentz force. The code also includes the effects of solar wind sputtering and sublimation on the instantaneous grain size. Dust grains are started in the simulation with orbital parameters characteristic of their parent bodies, including Edgeworth-Kuiper Belt (EKB) objects, Jupiter-family comets (JFC), and Oort Cloud comets (OCC) [5,6], and are traced until they are either ejected from the solar system, are sputtered or sublimated away, or enter the extreme inner solar system (< 1 AU). The dust grain trajectories are then run through a collisional algorithm (as developed by [7,8]) to incorporate the critical effect of grain-grain collisions on the equilibrium IDP density distribution. A typical, pre-collisional dust density is shown in Figure 1 for 10 μm EKB grains with the orbits of the giant planets marked.

In-situ Constraints: The New Horizons and Pioneer 10/11 spacecraft have reported in-situ density measurements of dust grain densities in the outer solar system for grains at 0.5, 3, and 5 μm radius, respectively [9-11]. In order to absolutely constrain the density of the model, we trace the trajectories of all three spacecraft through the model and calculate production rates for each family of dust grains necessary to reproduce the in-situ data. Following this, we calculate the flux of IDPs to the uranian and neptunian systems taking into account local gravitational focusing by the planetary mass. We compare this flux to previous methods of estimating the IDP flux to Uranus and Neptune and discuss the necessity of further in-situ measurements of IDP flux in the outer solar system.

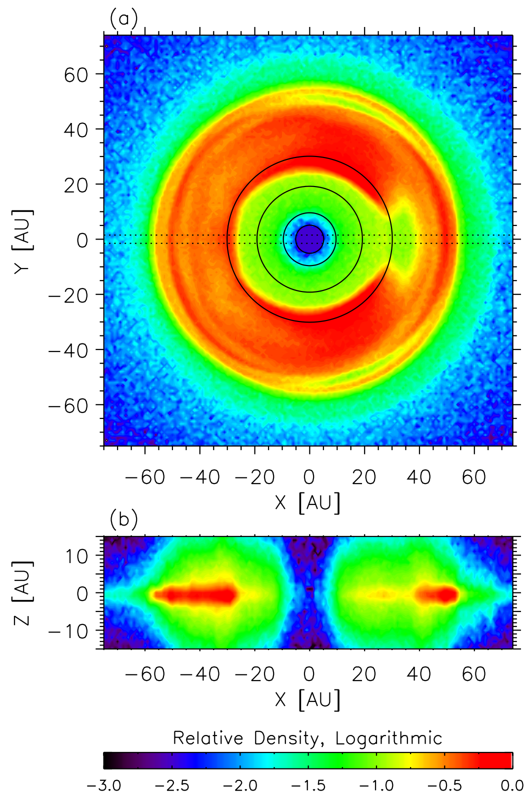

Figure 1: The equilibrium, pre-collisional, density of 10um EKB grains throughout the solar system in (a) the ecliptic plane and (b) a vertical plane.

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