Dynamical Simulations of the Interplanetary Dust Cloud Complex

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In order to understand physical basis for the symmetry plane deduced from observations of the zodiacal light and zodiacal emission, we have followed orbital trajectories of some ten thousand massless particles by integrating numerically the equation of motion, which takes into account essentially all the major forces subjecting to the interplanetary dust particles(IPDs) in the Solar system. Included are Earth and Jupiter as gravitational perturbation sources, radiative perturbations due to the sunlight, and also the Solar wind drag.

Here are some of the findings from the trajectory simulations: First, the model IPD cloud demonstrates warping of the symmetry plane, or maximum density plane, as such the HST has delineated in the β Pictoris circumstellar disk. The plane of our model cloud exhibits a marked change in its inclination near the Earth's orbit. This is suggestive an existence of embedded planet(s) in the β Pictoris disk. Second, the model cloud accompanies with dust bands around at latitudes ±10°, as such the IRAS has observed from the zodiacal emission. It should be pointed out that the IPDs of our model simulations are not associated with any specific family or families of asteroids. Thus the previous identification of the 10° band with the Eos (Grogan et al., 1997; Grogan and Dermott, 2001) needs an additional scrutiny. Third, about 20% of the model IPDs are locked in the Earth's mean motion resonances, forming circumsolar dust ring just outside the Earth's orbit. We tried to find observational means for identifying orders of resonance from the ring, but faced many practical difficulties.