Outward Motion of Porous Aggregates in Protoplanetary Disks by Stellar Radiation Pressure

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The Stardust mission and spectroscopic observations suggested the existence of crystalline silicates in comets(e.g., Brownlee et al. 2006). Although the comets were formed in the outer part of the protosolar nebula, these silicate grains are thought to be processed or crystallized in the inner hot region. This suggests that in the early phase of protoplanetary disks, there was a global motion that connects the inner and outer regions of disks.

We study the dust motion in a protoplanetary disk taking into account the stellar radiation pressure. Although the radiation pressure is effective only at the high latitude of the disk, the small dust grain can be stirred up to such latitude due to the turbulent mixing. We estimate the lower limit of the ratio of stellar gravity to radiation pressure, β, for porous aggregates and obtain the condition under which the aggregates in the inner disk can be carried to the comet formation region. Our calculation shows that the condition requires at least $\beta \sim 0.03$ for the aggregates with 1 micron size. Next, we investigate the optical properties of the porous aggregates and calculate β for a given incident radiation, using two different methods, the Maxwell-Garnett Mie theory and T-matrix method. Using the results, we discuss whether such outward motion is possible in the early solar system.