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Collisional and orbital evolution of dust particles in protoplanetary disks

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Collisional growth of dust particles is the first step of the formation of solid bodies in protoplanetary disks. Dust growth is also a key to understand observational appearance of disks since the disk opacity depends on the dust size distribution. However, collisional evolution of protoplanetary dust is poorly understood because of the complexity of aggregate collision. In addition, it has been theoretically suggested that dust particles can experience significant radial migration, which further complicates the pathway of dust evolution in the disks.

In this talk, I will present a current theoretical picture of dust evolution in protoplanetary disks. Recent laboratory and numerical collision experiments have revealed how the outcome of aggregate collisions depends on the collision velocity and internal structure of the aggregates. At the same time, theoretical tools have been also established for treating the evolution of radial size distribution and aggregate porosity simultaneously. With the experimental and theoretical progress, we have performed the first global simulation of dust evolution including collisional porosity evolution. We find that, at distances of a few to 10 AU from the central star, dust particles grow into planetesimal-mass objects on a timescale of 10000 years without experiencing radial drift. Further out the disk, dust particles are found to undergo significant radial inward migration, leading to the pileup and mixing of dust materials in inner disk regions on a longer timescale.

Keywords: dust, collision, protoplanetary disks