# Growth and transport of dust, ice, and organics in the inner part of protoplanetary disks

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Dust grains in protoplanetary disks are the fundamental building blocks of planets. Although recent radio interferometric observations have provided us with detailed images of gas and dust in the outer part of protoplanetary disks, it is still poorly understood how solids evolve in the warmer inner regions of the disks. Understanding the physics of gas and dust evolution in the inner part of disks is thus essential to address the question of how Earth-like planets form.

In this talk, I will discuss two topics on the growth and transport of solids (silicates, ices, and organics) in inner protoplanetary disks. The first topic is related to the water content of planets in the habitable zones. Models of protoplanetary disks suggest that the snow line in the dusty disks migrates with time. In the particular case of the solar nebula, the snow line could have moved to the current orbit of Venus in a late stage of its evolution. This raises the question of why the Earth today is so "dry" with the bulk water content of much less than 1 wt%. I will present simulations of ice pebble accretion by terrestrial planetary embryos, showing that Mars-sized rocky embryos would have grown into Neptune-sized waterworlds unless either the solar nebula was compact or a gas giant's core formed early and blocked the inward flux of the ice pebbles. I will also present the results of our latest MHD simulations of protoplanetary disks that imply that the snow line can migrate much faster than expected from the classical accretion model. These results indicate that Earth-like, modestly "water-poor" planets with both oceans and continents do not necessarily form easily in habitable zones.

The second topic is related to the role of organics in the formation of rocky planetesimals. It is widely accepted that silicate grains are poorly sticky and their growth into planetesimal-sized bodies is severely hindered by collisional fragmentation. Here I propose a scenario in which the seeds of rocky planetesimals form through direct coagulation of silicates coated by an organic mantle, like those found in interplanetary dust particles. Our adhesion model for core-mantle particles show that organic-mantled grains are much stickier than bare silicate grains, in particular in warm environments, thanks to the low elasticity of organic matter. I present simulations of the collisional evolution of organic-mantled grains in the inner part of protoplanetary disks, demonstrating that aggregates of organic-mantled grains are able to overcome the fragmentation barrier and directly form km-sized bodies. These organic-rich planetesimals may further evolve into carbon-poor rocky planetesimals by accreting carbon-poor chondrules.

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