Chemical and Structural Evolution of Dust in Protoplanetary Disks

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Protoplanetary disks are not static objects, but instead evolve throughout their lifetimes. This evolution involves the transport of mass and angular momentum through the disk, feeding mass onto the central star while also pushing material outward. While much of the mass involved in this evolution is gaseous hydrogen and helium, the dust grains suspended in the gas undergo substantial migration and transport as a result. This transport pushes these grains through a variety of physical and chemical environments, each of which will lead to alteration, to some degree, of the solid grains. The final composition and structure of a given grain depends not only on the environments to which it was exposed, but also the order of the environments that it saw and the amount of time spent in each. New techniques are allowing us to explore the detailed paths that solids would take in a turbulent protoplanetary disk, which can be combined with detailed chemical and physical evolution models to determine how their chemistry and structures would change over the lifetime of these disks. Linking the observed properties of dust grains to their predicted evolution can provide new insights into protoplanetary disk dynamics and the conditions present when our own Solar System formed.