Dust Evolution in Protostellar Accretion Disks

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We calculated the collapse of a dense rotating molecular cloud core by 2D numerical radiation hydrodynamical simulations. The dynamics of the dust grains is calculated applying a multicomponent fluid model. Acceleration by the radiation field, coupling to the gas component by dynamical friction, coagulation and shattering of the grains is included. Relative velocities between the dust particles are caused by differential radiative acceleration, differential sedimentation into the equatorial plane of the accretion disk, turbulence and Brownian motion.

Dust coagulation leads to significant modifications of the dust size distribution during the collapse of a molecular cloud core and the formation of a protostellar accretion disk. Small grains < 0.1 micron are removed from the mass spectrum quickly and efficiently in the midplane of the disk. When compact spherical dust grains are assumed, large grains with sizes of several 10 microns are produced via coagulation during collapse phases. The accretion shock front leads to relative velocities of about 1 km/s between the dust grains because of size-dependent braking. Within the accretion shock and relaxation zone strong deviations from the MRN-distribution are caused by grain segregation. Large (micon-sized) grains are able to pass through the shock without significant deceleration, whereas smaller grains are slowed down or stopped.