DUST SETTLING AND DUST PROCESSING IN PROTO-PLANETARY DISKS AROUND COOL STARS

D. Apai and I. Pascucci. Steward Observatory. E-mail: apai@as.arizona.edu

Introduction: Disks around cool stars and brown dwarfs offer a unique laboratory to study how the early phases of planet formation are affected by disk mass, stellar luminosity and orbital period. Infrared excess measurements demonstrate that dust disks around cool stars live longer [e.g. 1] and may be more flatten [2,3] than those around Sun–like stars. We present here results from ongoing Spitzer Space Telescope infrared spectroscopic (IRS) campaigns to characterize dust composition and disk flaring in large sets of co–eval brown dwarf disks in the Rho Oph, Cha I and Taurus star–forming regions. Using semi–analytical disk structure, dust composition and dust settling models we seek to explain the prolonged lifetime of the disks and establish its connection to the flatter disk structure.

Results: The mid–infrared continuum slopes of brown dwarf disks reveals a dominantly flattened disk structure, with only a few objects consistent with the spectral energy distributions expected from classical flared disks [4]. Different analytical methods of the fine structure of the 10–micron silicate emission feature consistently demonstrate a wide–spread dust processing in these disks. In particular, we find evidence for both silicate grain growth (from submicron to ~2 micron sizes) and significant contribution from crystalline silicates [4,5].

Discussion: Our observations are consistent with an evolutionary sequence of dust processing from small (submicron–sized) amorphous grains toward larger amorphous grains with increased crystalline silicate content. These large grains fasten dust settling leading to flatter disk structures. The presence of these processes in disks around cool stars and brown dwarfs demonstrates that neither low disk masses, nor low stellar luminosity or long orbital periods slow wide–spread dust processing, the earliest steps of planet formation. Interestingly, several questions remain open: May the presence of crystals around such cool objects be explained via thermal annealing in the inner disk and subsequent outward mixing, or are other processes, such as shock–heating, required? What is the casual relation, if any, between the flatter disk structures around cool stars and the prolonged disk lifetimes? What is the impact of this different dust disk evolution on the emerging planetary systems?

References: [1] Carpenter J. et al. 2006. *Astrophysical Journal* 651:L49. [2] Apai D. et al. 2002. *Astrophysical Journal* 573:L115. [3] Apai D. 2004. *Astronomy & Astrophysics* 426:L53. [4] Apai D. et al. 2005. *Science* 310:834. [5] Pascucci I. et al. 2007. *Astrophysical Journal* in prep.