**DIFFERENT INITIAL CONDITIONS FOR PLANET FORMATION AROUND COOL AND SUN-LIKE STARS: DISK MASS, DISK STRUCTURE, DUST COMPOSITION, AND ORGANICS INVENTORY.**

D. Apai[1], I. Pascucci[1], Space Telescope Science Institute (3700 San Martin Drive, Baltimore, MD 21218).

**Introduction:** More than 80% of the stars in the solar neighborhood and in the Galaxy are cool, red dwarf stars. These common, low-mass, and faint stars are ideal hunting grounds for planets with most techniques, including radial velocity, microlensing, high-constrast imaging, and transit surveys. However, given their low masses and temperatures, and minute luminosity the question naturally arises: How will the conditions for planet formation differ around these stars from those around sun-like stars?

Long assumed to be stellar mass-independent, the initial conditions for planet formation – the structure, composition and evolution of protoplanetary disks – can now be compared between sun-like and cool stars [1]. We review here the key results of multiple analyses of Spitzer Space Telescope data we carried out over the past few years. In particular, we observed and compared a large number of protoplanetary disks around stars with masses ranging from the brown dwarf regime to more massive than the Sun. We used statistical methods to test whether or not disk properties differ between low- and higher-mass stars and.

In particular, we tested the stellar-mass dependence of the disk structure, dust grain growth, thermal processing/crystallization, and the gas-phase organics. We show that all of these properties have stellar-mass dependence, thus, the initial and boundary conditions for planet formation differ strongly around sun-like and cool stars.

**Methods:** We targeted large, but carefully-selected samples of coeval sun-like and cool stars with the Spitzer Space Telescope and with ground-based infrared and submillimeter telescopes. In addition, we used archival and/or published Spitzer data to expand our samples. We used statistical tests, such as the Kolmogorov-Smirnov test, to verify if the disk properties studied differ between the lower-mass and higher-mass samples.

**Results:** We identified highly statistically significant differences in multiple key disk properties between lower-mass and higher-mass (sun-like) stars. These include:

*Dust processing.* Coeval cool stars harbor dust with significantly larger grain size than sun-like stars do [2,3,4,5].

*Thermal processing/Crystallization.* Spectra of cool star disks show much more prominent crystalline silicate features than those of disks around sun-like stars. Simple spectral decomposition models support the notion that the terrestrial planet-forming (T~300 K) disk regions around cool stars contain a much higher abundance of thermally heavily processed materials than those around sun-like stars [2,4].

*Disk Structure.* We show that disks around cool stars are flatter than those around coeval sun-like stars. The flatter disk structure is consistent with an advanced stage of dust settling around these objects, an important step toward planet formation [2,6].

*Organics Inventory.* Using Spitzer spectra probing warm gas in the terrestrial planet-forming region of cool stars we show a striking difference in the presence of simple, gas-phase organic molecules, such as HCN and $C_2H_2$. The difference is consistent with the predictions of different UV-photochemistry in these disks [4,7] and suggests a N-depleted chemistry around cool stars and brown dwarfs.

*Disk Mass:* Comparing disk mass measured for the lowest-mass objects with JSCMT/SCUBA to the disk mass measurements for sun-like stars, we show that the disk mass scales approximately linearly with the stellar mass [8].

**Discussion:** These results reveal that disks around cool stars evolve very differently than disks around sun-like stars, providing a different set of initial and boundary conditions for planet formation. We discuss how the differences in disk properties are expected to influence planet formation and the emerging planet population. In particular, a higher frequency of lower-mass planets are expected that may form over a longer period of time. In addition, we predict that lower-mass planets will have a different inventory of organic molecules and some of the key ingredients to life may have strongly reduced abundances. These results suggest that planetary systems around cool stars may be more different from those around sun-like stars than usually thought.

**[1]** Apai, D. et al. 2008 in ASP Conf. Proc. 384, 383. **[2]** Apai, D. et al. 2005 *Science* 310, 834–837. **[3]** Apai, D. et al. 2002 *Astrophysical Journal* 573, L115 **[4]** Pascucci , I. et al. 2009 *Astrophysical Journal* 696, 143–159. **[5]** Apai, D. et al. 2004 *Astronomy & Astrophysics* 426, L53 **[6]** Szűcs, L. et al. *Astrophysical Journal*, in prep. **[7]** Apai, D. et al. *Astrophysical Journal*, in prep. **[8]** Klein, R. et al. 2003 *Astrophysical Journal*, 593, 57.