Snowlines in embedded disks

D. HARSONO[123*], S. BRUDERER[4] AND
E. F. VAN DISHOECK[14]

[1]Leiden Observatory, PO Box 9513, NL-2300 RA Leiden, The Netherlands (*correspondence: harsono@strw.leidenuniv.nl)
[2]SRON Netherlands Institute for Space Research, PO Box 800, NL-9700 AV Groningen, The Netherlands
[3]Heidelberg University, Institute of Theoretical Astrophysics, Albert-Ueberle-Straße 2, 69120 Heidelberg, Germany
[4]Max-Planck-Institut für extraterrestrische Physik, Giessenbachstrasse 1, 85748, Garching, Germany

Young solar nebula models suggest that the disk is initially hot enough such that the chemical complexities inherited from the collapsing cloud have been reset out to distances as large as 30 AU [1] [2]. The disk then cools reforming ices. Observations and models of protoplanetary disks do not show such high temperatures unless accretion rates are extremely high, which only occurs during the deeply embedded phase ($M_{env} > M_{disk}$). Two-dimensional physical and radiative transfer models were used to calculate the temperature structure of embedded disks. The solid and vapor fractions of H_2O, CO_2, and CO were determined by considering the density dependent thermal desorption. The water snowline is a strong function of stellar accretion rate once the accretion energy is greater than the protostellar luminosity as shown in the figure below. The location of the water snowline can be up to 60 AU depending on the stellar accretion rate. Through such an analysis, most of the observed water emission [3] [4] is found to be due to the warm inner envelope ($T_{dust} > 100$ K). Our results suggest that large hot disks can only be found during the embedded phase of the star and planet formation.

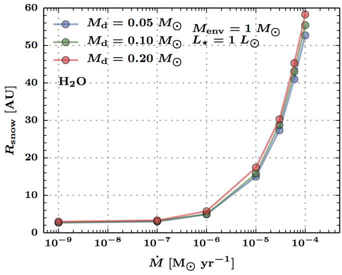

Figure 1: Water snowline as a function of accretion rate for the given envelope mass (M_{env}), stellar radiation (L_*), and disk masses (M_d).

[1] Scott (2007) *AREPS* **35**, 577-620. [2] Pontoppidan *et al.* (2014) *PPVI*, 363-385. [3] Jørgensen & van Dishoeck (2010) *ApJ* **710**, L72-L76. [4] Persson *et al.* (2012) *A&A* **541**, A39.