LIFE ON THE EDGE – FORMATION OF CAIS AND CHONDRULES AT THE INNER EDGE OF THE DUST DISK.
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Introduction: CAIs and chondrules formed during transient heating events in the early solar system while gas and dust coexisted. CAIs probably formed close to the sun at a very early stage and within a very limited period of time. Chondrules formed further out from the Sun over an extended period of time. The heat source responsible for the transient heating events remains unknown although several possible mechanisms have been suggested. The difference in age between chondrules and CAIs require that the CAIs can remain in the nebula for long periods of time despite predictions that they would quickly spiral into the Sun. A previously overlooked effect, photophoresis, has been shown to be able to prevent mm-sized particles from spiralling into the Sun \([1, 2, 3]\). Photophoresis exerts a force on particles, embedded in a thin gas, that are exposed to sun light.

Concentration of dust at the inner edge: A significant consequence of photophoresis on the evolution of the disk is a strong concentration of dust and particles along the inner edge of the dust disk. Particles inside the edge will be pushed toward the edge due to photophoresis whereas particles outside the edge will be shielded from the Sun and therefore spiral inward due to classical gas drag. This leads to the formation of a sharp inner edge of the dust disk. An enhanced dust density results in more rapid accretion and since accretion is the only process that can remove dust from the edge we infer that the dust density at the edge will be controlled by accretion of planetesimals.

Transient heating events at the edge: Isotopic differences between chondrules from different groups of chondrites imply that chondrule formation was local to the environment where size sorting and accretion took place. The rapid change in dust:gas ratio, opacity, and gas temperature across the edge makes it a highly turbulent and very energetic environment. A high dust density would enhance lightning activity and is also consistent with chondrule heating through nebula shocks.

Size sorting and source regions: The combination of turbulence, which tend to lift small particles above the midplane, and photophoresis which provides a size dependent force pushing the particles away from the Sun results in a size variation of particles close to the edge. Also the transition from the optical thin front side of the edge to the optical thick part of the dust disk results in size sorting with smaller particles being closest to the Sun.

Conclusions: Photophoresis results in a concentration of solids at the inner edge of the dust disk. The enhanced concentration of solids facilitated very early growth of achondrite parent bodies close to the Sun. As dust and particles accreted to planetesimals the edge moved outward from the Sun. We suggest that chondrule heating, size sorting and accretion took place along the inner edge of the outward migrating dust disk.