Title: Dust Aggregation in Circumstellar Shells around Oxygen-rich Asymptotic Giant Branch Stars

Authors: J.A. Paquette[1] (presenter), F. T. Ferguson[2], and J.A. Nuth[3]

Abstract: The aggregation of dust in circumstellar shells around oxygen-rich Asymptotic Giant Branch stars has often been considered to be of negligible importance, because the aggregation process is strongly dependent on particle density. The number density of dust grains was thought to be too low for aggregation to have any significant effect. Recent work (Kimura et al., 2022) shows that the assumed perfectly efficient grain growth is unrealistic, with most monomers that strike a grain failing to adhere. This tends to lead to a larger number of smaller grains. In addition, the grains that form under these conditions should be very open, with a fractal-like structure, so fractal aggregation rather than Euclidean coagulation should be considered. A third item that must be taken into account is the near ubiquity of planetary systems (Batalha, 2014; Ford, 2014; Marcy et al., 2014). The presence of a planetary system will likely increase the SiO concentration in a star's outer envelope as Poytning-Robertson drag causes dust to drop into the star and evaporate. In this work we begin with nucleation of SiO dust as described by classical nucleation theory (Becker & Döring, 1935), using a simple model (Paquette et al., 2011) and compare the resulting density distributions assuming no coagulation, or Euclidean coagulation with both efficient and inefficient grain growth and inefficient grain growth with fractal aggregation. Cases with increased SiO mass fraction (to model the effects of a planetary system) are also considered. Far from being negligible, we show that under conditions of inefficient grain growth and fractal aggregation the dust number density distribution is dramatically changed, in a way that potentially promotes acceleration of dust grains by radiation pressure.

---

[1] NASA-Goddard Space Flight Center, Solar System Exploration Division, Code 690, Greenbelt MD 20771, USA

[2] Catholic University of America, 620 Michigan Avenue, Washington DC 20064 USA

[3] NASA-Goddard Space Flight Center, Solar System Exploration Division, Code 690, Greenbelt MD 20771, USA