Comet Dust, and Comet ISON, Too

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Solar system formation is an engine that simultaneously preserves and transforms interstellar medium (ISM) dust grains into planetesimals and, ultimately, planets. Comets are the preserved relics from our own solar system's formation. If comets are a mixture of ISM dust and solar nebula processed material, they would allows us to investigate both the inputs and outputs of dust transformation in the young Solar System. If, instead, ISM dust is completely processed in the disk, comets would more directly reflect the diversity of the dust forming processes and environment. Whichever the case, the diversity of dust in comets, as individuals and throughout the whole population, can be used to test dust formation scenarios and transportation throughout the disk.

Dust grains in the ISM are dominated by "amorphous" silicates, i.e., they have chemical composition (stoichiometry) similar to pyroxene ($[Mg_x,Fe_{1-x}]SiO_3$) and olivine ($[Mg_y,Fe_{1-y}]_2SiO_4$). Studies of silicates in the galaxy constrain the crystalline silicate fraction to $\leq 5\%$ by mass (Li & Draine 2001; Kemper et al. 2004). In contrast, dust ejected by comets, such as C/1995 O1 (Hale-Bopp) and 9P/Tempel 1, have significant crystalline mass fractions: 60–80% of Hale-Bopp (Harker et al. 2002; Moreno et al. 2003, Lisse et al. 2007), and ≈30% of 9P (Harker et al. 2005). Taken together, the observations of the ISM and of comets strongly suggest that amorphous ISM dust was either destroyed and re-condensed as crystals, or that it was annealed (crystallized), prior to the accretion of planetesimals in the icy outer-disk. Determining the dust composition of comet nuclei helps us understand how dust formed in the inner-Solar System, and how that dust was transported to the outer-Solar System; processes that are apparently ubiquitous in observations of external protoplanetary disks (e.g., Olofsson et al. 2010).

I have been a part of a team surveying the dust properties of comets through mid-infrared spectra of comet comae (e.g., Harker et al. 2002, 2005, 2011; Wooden et al. 2004; Kelley et al. 2006; Woodward et al. 2011). In this talk, I review the current status of our survey, and our observations of comet C/2012 S1 (ISON) from the SOFIA telescope.

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