Mineralogy of Interstellar and Cometary Dust inferred from Spitzer Infrared Spectroscopy

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Mid-infrared (5-40 μm) spectra contain diagnostic features of silicate and organic materials that are widespread in cosmic dust. I will describe recent observational results spanning dust evolution from freshly formed to planetary to remnant-planetary systems.

Dust formed in the ejecta in the supernova remnant Cas A show a distinct "protosilicate" mineralogy (lacking organics) with some diversity in spectral shape. The total dust mass is estimated in the range 0.02 to 0.05 solar masses from this single supernova. Other recent observations suggest dust forms around black holes at high redshift.

In the Galactic interstellar medium, organic material in the form of polycyclic aromatic hydrocarbons (PAH) dominates the spectra. The silicates are seen in absorption only and show a broad, structureless 9-11 μm feature of amorphous silicates. A study of photodissociation regions (PDRs) reveals the evolution of PAH from aggregates or "very small grains" in unilluminated molecular clouds, to cations in the diffuse interstellar medium and illuminated molecular cloud edges, to anions for the PAH that survive inside HII regions.

In comets, the spectra include a featureless continuum (possibly organics or just C) together with silicate emission features. The feature strength depends dramatically on the comet, with most naturally-produced dust being nearly featureless (large, amorphous grains) while more violent events, and possibly fresher surfaces produce structured emission features including crystalline silicates. A survey of random comets will be compared to the special ones (Hale-Bopp, 73P/S-W3, 17P/Holmes).

After a low-mass star evolves into a white dwarf, a remnant planetary system survives. An occasional comet or asteroid apparently passes with the Roche Lobe of some white dwarfs and is disrupted. I will compare the mineralogy of this remnant planetary material to the supernova, PDR, and comet dust.