Spitzer Spectra of Jupiter-Family Comets

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Introduction: Mid-infrared spectra and thermal emission models of Jupiter-Family comet (JFC) dust comae are diagnostic of important dust grain properties: composition, size, and structure. The sensitivity and observing efficiency of the Infrared Spectrograph (IRS) on the *Spitzer Space Telescope* allows us to study the dust properties of JFCs in a survey setting. We present mid-IR spectra and thermal emission models of JFCs from our *Spitzer* comet survey.

Weak Silicate Emission in JFCs: Broad emission features attributable to silicate dust are apparent in many mid-IR spectra of JFCs [1]. We have 33 JFC spectra, of varying quality, in our survey. Most spectra have the broad silicate emission feature at 10 μm. Examples of our JFC silicate features are presented in Fig. 1.

We find that JFC silicate emission features in our survey have strengths of $F_{sil}/F_{cont} \lessapprox 1.25$, where F_{sil} is the flux, including the silicate feature, and F_{cont} is the underlying continuum flux, both evaluated at 10–11 μm (see Fig. 1). These silicate strengths are comparable to the lowest values found in Oort Cloud (OC) comets [2], but much larger values have been observed in some OC comet spectra, e.g., comet C/1995 O1 (Hale-Bopp) had a silicate emission feature strength of 2–3.

The cause of weak silicate features in Jupiter-Family comets has not been determined. Models of light scattered by comet dust suggest grain structure (porosity) plays a dominate role [3], meanwhile comet 2P/Encke appears to be deficient in silicate dust ($< 31\%$ by mass in sub-micron grains [4]). Comet grain size may also be important, as larger grains have weaker 10 μm silicate emission features. We present thermal emission models of our best JFC spectra to help determine the physical differences between spectra with weak or strong silicate emission.

Mg and Fe in Crystalline Silicates: The Mg and Fe content in crystalline silicate comet dust is diagnostic of the grain formation environment in the inner-solar system. Crystalline silicates have been previously detected in a few JFCs, including 9P/Tempel and 81P/Wild. The silicate crystals in 9P and 81P have a distribution of Mg and Fe content [5, 6], in contrast with the distinctly Mg-rich dust in comet Hale-Bopp [7]. Crystalline silicates are apparent in a few of our JFC spectra (Fig. 1), and we discuss their Mg and Fe content.

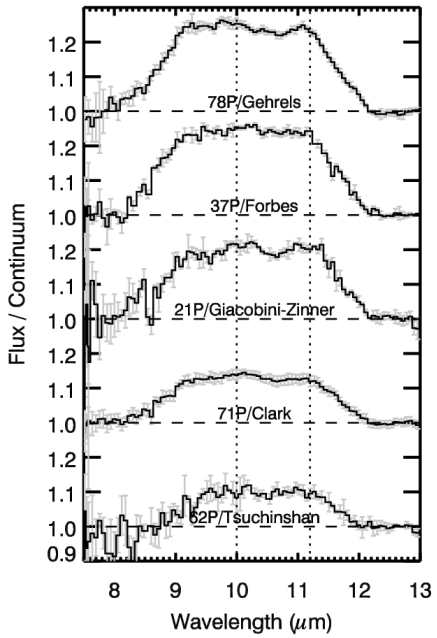

Figure 1: Spectra, normalized by a scaled Planck function, of 5 JFCs selected to show the silicate emission features observed in our survey. Horizontal dotted-lines at 10.0 and 11.2 μm mark the nominal wavelengths of emission peaks from Mg-rich crystalline olivine (forsterite). Crystalline silicates may be present in the comae of 21P, 71P, and 78P.

References:

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