The Onset of Silicate Crystallization in the Early Stages of Star Formation

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Silicates form a common dust component in the diffuse interstellar medium, and dense molecular clouds. As star formation initiates within these dense molecular clouds, dust within these clouds are incorporated into protoplanetary disks, or the newly formed stars themselves. The mineralogy and crystallinity of silicate dust varies with its environment. Processes such as thermal annealing, grain destruction, gas phase condensation and amorphization alter the structure and composition of the dust. Infrared observations allow us to analyze dust properties. The silicate 10 micron feature is a diagnostic tool to understanding the mineralogy, crystallinity and size of dust along astrophysical sightlines. Spectra along interstellar sightlines indicate that silicates in the diffuse interstellar medium are completely amorphous (Kemper et al. 2004), while silicate dust around Herbig Ae/Be stars is shown to have a crystalline fraction of 10% (Juhasz et al. 2010). Radiative or shock heating may raise the temperature of amorphous silicate grains enough to anneal into the crystalline form.

In this work, we aim to determine the onset of silicate crystallization in the very early stages of star formation by comparing spectra along different evolutionary sightlines. We used Spitzer and ISO spectroscopy of interstellar, molecular cloud, and protostellar sightlines, showing all the silicate features in absorption. We determined the optical depth profiles and fitted them with laboratory spectra of astrophysically relevant minerals. This allows us to determine mass fractions of the mineralogical components present in these sightlines. We have determined the crystalline fraction, as well as the mineralogical properties of the silicates, as they changes with evolutionary stage. In particular, we have studied the olivine/pyroxene ratio and the Mg/Fe ratio. Regions of high mass and low mass star formation are also compared.

References

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[2] A. Juhasz et al., *ApJ.* **721**, 431 (2010).