Water Ice Absorption as a Probe of the Environments of Young Stars

Tracy Beck (Gemini Obs.) & M. Simon (SUNY-Stony Brook)

The dust in a molecular cloud is comprised of silicate grains and mantles of icy material. The icy material is primarily composed of water and carbon monoxide with smaller quantities of methane and ammonia ice. Ices have strong absorption bands in the 3-5 micron spectral region. Most notably, a broad absorption at 3.1 microns is caused by vibrations in the O-H bonds in water ice.

The goal for this project was to study the shape of the water ice absorption in the interstellar cloud material and in the circumstellar material which enshrouds a young star. Slight variances in the shape of the water ice absorption feature can indicate variations in the properties of the icy mantles. For example, the structure of the ice(amorphous or crystalline) or the presence of other compounds such as ammonia and hydrocarbons may differ in the interstellar and circumstellar environments.

In May 2002 we used SpeX to observe the 2-4 micron spectra of 16 stars obscured by the dark molecular cloud associated with a region of star formation in the constellation of Ophiuchus. The sample included stars that are known to be behind the dark cloud (Figure 1(a)) as well as stars that are embedded in the dark cloud (Figure 1(b)).

This set of spectra show striking differences between the absorption features in the dark cloud material and the material surrounding young stars. The absorption spectrum of the background star shows no distinct absorption bands from ices, while that of the embedded star shows strong water ice absorption. This shows clearly that the presence of icy material is enhanced in the circumstellar material surrounding young stars.

By observing disk systems at different inclinations to the line of sight, we expect to study the formation of icy material as a function of height above the disk and age of the young stellar objects. In this way we can study of the initial material that eventually leads to the formation of comets and planetesimals, and ultimately, planets.

Figure 1 caption: (a) Spectrum of a star located behind the dark cloud. (b) Spectrum of a star embedded in the dark cloud. Note the very strong water ice absorption at 3.1 microns