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MODERATE SPECTRAL RESOLUTION OBSERVATIONS OF 3 MICRON ABSORPTION FEATURES IN HIGHLY OBSCURED OBJECTS

Robert G. Smith, Kris Sellgren, and Alan T. Tokunaga
Institute for Astronomy, University of Hawaii

The 3μm absorption spectra of sources seen in or behind molecular clouds generally show a variety of absorption features which have been explained by three separate absorptions:

(1) A broad absorption feature at 3.08μm which is attributed to water ice particles.
(2) An absorption between 3.3 and 3.6μm which appears as a long wavelength wing to the 3.08μm ice band. This has been attributed to scattering by large water ice particles (Leger et al. 1983) and to absorption by $NH_3.H_2O$ complexes in the ice (Knacke et al. 1982).
(3) A narrower absorption at 3.4μm superimposed on the long wavelength wing. This feature is generally believed to be due to the stretching vibration of CH which occurs near 3.4μm, although the exact nature of the molecule is unknown.

Using the cooled-grating array spectrometer (CGAS) at the NASA Infrared Telescope Facility, we have begun a program aimed at providing high quality spectra at moderate resolution ($\lambda/\Delta\lambda \sim 200$ at 3.0μm) of a wide range of objects known to exhibit these features. We hope to provide a good sample of spectra for comparison with theoretical and experimental work on the constituents of grains in the interstellar medium.

As a representative sample of the spectra obtained so far, we present in Fig. 1, spectra of the late-type mass-loss star OH 0739-14 and the protostars Mon R2 IRS-2 and IRS-3 (solid circles). These spectra are in the form of optical depths, obtained by fitting a blackbody of the appropriate temperature between points of the spectrum which lie beyond the influence of any of the strong 3μm absorption features. As an illustration of the differences between the spectra, the solid line in each diagram shows the results of a calculation of the absorption profile of particles with a silicate core and ice mantle, using Mie theory. Following the work of Leger et al. 1983, the optical constants of amorphous water ice at 77K were used in the calculation with a grain-size distribution similar to that deduced by Mathis et al. 1977. Note that our current intent is not a rigorous modelling of the absorption profiles but rather an attempt to clearly show the distinct differences between the spectra. For example, the work of Hagen et al. 1981, 1983 and van de Bult et al. 1985 has shown that amorphous ice at 10K provides a better fit to the short wavelength side of the 3.08μm feature although alternate explanations may be NH_3 ice absorption (Knacke et al. 1982) or scattering by ice particles (Hanner 1984).

Several important points can be made regarding the spectra of Fig. 1:

(1) A simple amorphous ice model provides a reasonable fit to the spectrum of OH 0739-14 but cannot explain the short wavelength absorption of the Mon R2 sources without going to ice at a much lower temperature.
(2) Both the Mon R2 sources show a long wavelength wing to the 3.08μm ice feature and some indication of an absorption feature at 3.4μm although this may in fact be part of the long wavelength wing.
(3) Mon R2 IRS-3 appears to have another absorption feature at about 3.25μm.

These initial results provide an additional impetus to continue this study in an attempt to understand the considerable differences between these spectra. In particular, it may be possible to relate the shape of some of these absorption features to physical conditions in protostellar clouds by observing a large sample of protostars.

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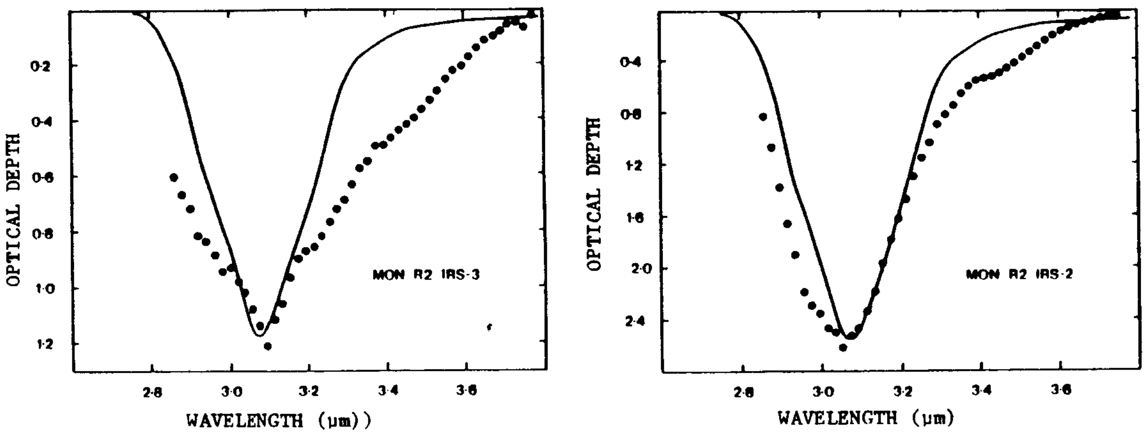

FIGURE 1.