REPRODUCTION OF THE INTERSTELLAR ICE BAND BY GRAIN MANTLE ANALOGS

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The near-infrared spectrum of many sources associated with molecular clouds shows a broad absorption feature at 3.08 μm (e.g. Merrill et al., 1976; Harris et al., 1978). This feature has usually been attributed to absorption by H_2O ice frozen on grains, but it has been impossible to satisfactorily reproduce the observed band shape (Merrill et al., 1976; Mukai et al., 1978). We have been able to obtain a complete fit of this absorption feature in the laboratory using very low temperature mixtures of H_2O with other polar molecules. The preparation of these interstellar dust grain-mantle analogs has been described elsewhere (Greenberg, 1979; Hagen et al., 1979). They are prepared by allowing a gas mixture of simple molecules (e.g. CO, H_2O, NH_3, CH_4 etc.) to condense on a low temperature (10 K) substrate. This frozen mixture can be heated and recooled. The samples are analyzed with an infrared spectrometer.

With the aim of studying the 3.08 μm band we have examined, in detail, the middle infrared spectra of mixtures of H_2O with other molecules. These samples show absorption lines centered around 3 μm corresponding to the OH stretching vibrations of H_2O monomers, dimers, polymers and complexes between H_2O and other molecules present. Warming up of the sample to about 40 K permits diffusion of the H_2O molecules and the broad band characteristic of amorphous ice appears. Its shape and peak position are dependent on the temperature and on the concentration of the other molecules present. If there are other polar molecules present this band will show a low frequency wing due to further complexing between H_2O ice and these molecules. The strength of this wing is a function of temperature and of concentration as well as polarity of the other molecules present. As an example, our laboratory spectrum of a mixture of CO/H_2O (10/1), deposited at 10 K, heated to 40 K and subsequently recooled to 10 K, is compared in Fig. 1 with the observed 3.08 μm feature associated with the BN object (Gillett et al., 1975). Also shown is the spectrum obtained at 80 K of pure amorphous H_2O ice, Ia (Buontempo, 1972). The agreement between our spectrum and the observed interstellar band with respect to peak position, width *and low frequency wing* is quite good. The satisfactory

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fit of the band, especially the low frequency wing, suggests that this is part of the long sought evidence for the existence of complex molecular mantles in interstellar grains (Greenberg et al., 1972). We are currently studying this absorption band in more mixtures and incorporating the spectrum into a detailed analysis of the infrared extinction and polarization by interstellar grains in dense clouds.

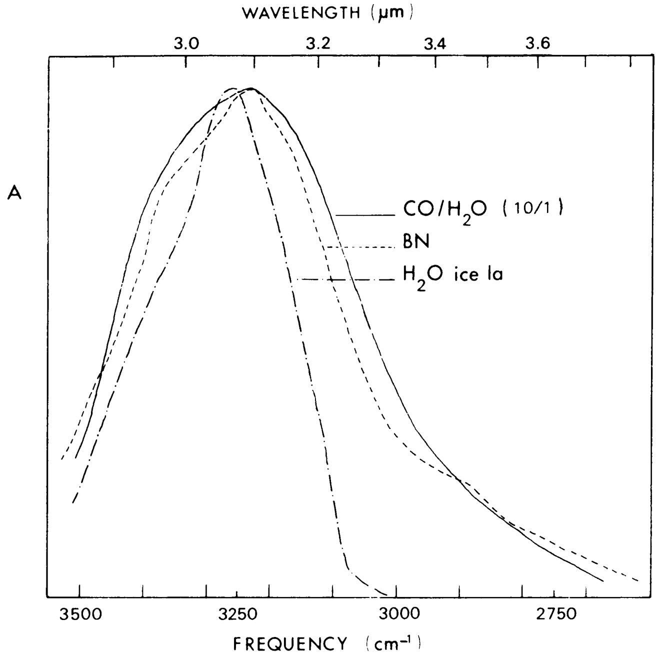

Fig. 1. The infrared spectrum around 3000 cm^{-1}; —— $CO:H_2O$ (10:1) mixture, deposited at 10 K, heated to 40 K and recooled to 10 K; --- the BN object (Gillett et al., 1975); -·-·- amorphous H_2O ice at 80 K (Buontempo, 1972).

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