

D29

N86 - 23522

Interstellar Grain Mantles

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Interstellar molecular ("icy") grain mantles are an important component of the interstellar dust inside dense molecular clouds as evidenced by the detection of absorption bands at 2.97, 3.08, 4.61, 6.0 and 6.8 microns. They may also be the precursors of more-complex grain mantles in the diffuse interstellar medium.

We have calculated the molecular composition of these "icy" grain mantles employing gas phase as well as grain surface reactions. The calculated mixtures consist mainly of the molecules H_2O , H_2CO , N_2 , CO , O_2 , H_2O_2 , NH_2 , and their deuterated counterparts in varying ratios. The exact compositions depend strongly on the physical conditions in the gas phase. The absorption spectra of H_2O with other molecules have been studied in the laboratory. Optical constants have been determined for a few selected mixtures. Extinction and polarization cross sections across the 3um ice band have been calculated. A comparison with the observations towards BN shows that the low frequency wing observed on this feature is due to absorption by a mixture of H_2O and other molecules rather than scattering by large, pure H_2O ice grains.

Recently, high signal to noise (5-8um) spectra have been obtained of several component sources embedded in dense molecular clouds. The observed absorption features at 6.0 and 6.8um show variation from source to source. The 6.0um feature is attributed to the OH bending mode in H_2O , in line with the identification of the 3.08um band as the OH stretch in H_2O . A varying contribution of the C=O stretch in ketones, aldehydes, esters or carboxylic acids may be responsible for the observed variations in this band. The 6.8um band is due to the CH deformation mode probably in alcohols. The variations observed in this band are probably due to the presence of unsaturated hydrocarbons or saturated hydrocarbons with strongly electro negative groups in some of the sources as well. The observed variations imply a very rich chemistry, suggesting that energetic processing of grain mantles, such as UV photolysis, may be important.