Diffusion measurements of methane in amorphous water ice

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Icy mantles covering dust grains in dense clouds of the interstellar medium are known to be responsible of the large molecular complexity of our universe. Within those mantles atoms and molecules can meet and react with larger probablility than in the gas phase. The chemical reactivity of interstellar ice is limited by the diffusion of reacting atoms or molecules in water ice, its major component. For this reason the knowledge of diffusion coefficients of different molecules in water ice is of great astrophysical interest.

In this work we have designed an experiment to determine the thermal diffusion of CH_4 in amorphous water ice at 50 K. In a high vacum chamber methane ice layers covered by water ice layers were grown by vapor deposition at 30 K. Then, the two-layered system was warmed to 50 K and kept at that temperature while the diffusion of CH_4 molecules was monitored by means of FTIR spectroscopy. The decay of intensity with time of the strong IR absorption asociated to the ν_3 mode of methane (see Figure1) is a measure of the number of methane molecules that have moved through the whole water ice layer and left the sample. Diffusion coefficients were extracted from the isothermal experiments usign Flick's second law of diffusion [1,2].

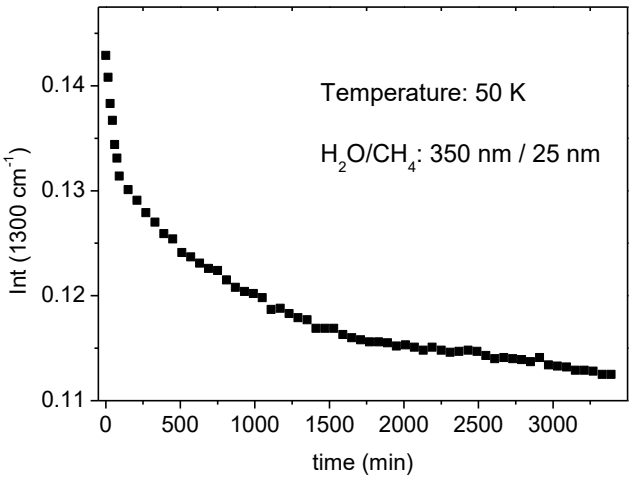

Fig.1. Integrated intensity of the 1300 cm^{-1} CH_4 IR band of methane versus elapsed time at 50 K. The system consists on a 350 nm layer of amorphous water ice grown on top of a 25 nm methane layer.

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