

Formation of compact solid water after cosmic ion irradiation

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Abstract. We have studied, by infrared absorption spectroscopy, the effects of ion irradiation on the morphology/porosity of amorphous water ice. Thin icy films (about $0.25 \mu\text{m}$) of amorphous water have been irradiated with 200 keV protons at 15 K. Both the behaviour of the OH dangling bond feature and the ability to trap carbon monoxide (CO) have been used to investigate the evolution of icy samples after ion irradiation. We show that the intensity of the OH dangling bond feature decreases after ion irradiation and that the amount of adsorbed carbon monoxide decreases as the fluence of impinging ions increases. The results obtained indicate that the porosity of amorphous water ice decreases after ion irradiation. Furthermore icy mixtures such as $\text{H}_2\text{O}:\text{N}_2$, $\text{H}_2\text{O}:\text{CO}_2$, and $\text{H}_2\text{O}:\text{CO}$ have been irradiated with 200 keV H^+ and 200 keV He^+ ions. Also in these cases the intensity of the OH dangling bond band decreases after ion irradiation. A recent study of the profile of the interstellar solid CO band (Pontoppidan et al. 2003; Fraser et al. 2004) as well as the non detection of the OH dangling bond feature in interstellar spectra (Keane et al. 2001) indicates that interstellar water ice is compact. On the basis of the experimental results, we suggest that cosmic ion bombardment might be well responsible for the compact structure of interstellar water ice.

Keywords. astrochemistry, molecular processes, methods: laboratory, ISM: lines and bands, techniques: spectroscopic, infrared:ISM

References

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