

Laboratory measurements of band strengths and optical constants of D₂O ices along with new measurements on H₂O ices

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Water is one of the more abundant molecules in cold extraterrestrial environments, such as the interstellar medium (ISM), comets, and icy planets and moons. Water is an essential molecule for biological activity and a fundamental material for chemical evolution. Many studies have been published on gas-phase water, including observations and identifications of isotopologues such as HD and HDO in the ISM [1, 2]. Theoretical studies of solid phase deuterium chemistry in ISM have also been published [3], but few laboratory studies on solid D₂O exist [4]. For such work, infrared (IR) spectroscopy is a powerful aid to observational, theoretical, and experimental studies, as each ice component exhibits a unique spectrum.

In the present laboratory study, we prepared D₂O ices and measured their IR band strengths at 10, 70, and 155 K with 1.0-cm⁻¹ resolution, with corresponding measurements for solid H₂O. Additionally, we calculated IR optical constants for solid D₂O and solid H₂O as they are valuable for spectral modeling. This is the first study in which all of these physical properties - band strengths, refractive indices, and densities – were measured in the same laboratory.

Our new work can help to determine isotopic ratio in ices, unravel reaction chemistry, and support the analysis of observational spectra by the James Webb Space Telescope. Our study also will enable a better understanding of chemical evolution in cold extraterrestrial environments.

References

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