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Broadband (0.3 – 7.5 THz) TeraHertz Spectroscopy of Astrophysical Ice Analogs

Despite the critical role condensed-phase species play in interstellar chemical reactions and evolution, and the wealth of observational facilities available or coming online in the THz and sub-mm that will probe them, literature spectra for such species in this spectral window are discouragingly sparse. Here, we report on the design and construction of a broadband spectrometer to study these ices in the THz and sub-mm regimes. We will present a number of the first studies enabled by recent upgrades to the system, including systematic studies of increasingly complex organic molecules, newly observed transitions of primary ice constituents (e.g., CO₂), and polycyclic aromatic hydrocarbons. We find the spectra to be extremely structure-dependent, and sensitive largely to long-range, large-amplitude motions within the ices. We will discuss the feasibility of the interstellar detection of species from these spectra, recent proof-of-concept observations with the SOFIA telescope, and the challenges associated with comparing our spectra to theoretical calculations.