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Bulletin of the AAS • Vol. 55, Issue 2 (AAS241 Abstracts)

JWST Ice Age First Results: Observations of Ice Inventory in a Dense Molecular Cloud

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Published on: Jan 31, 2023

URL: https://baas.aas.org/pub/2023n2i224p05

In the pre-stellar stage of dense molecular clouds, grain mantles rich in carbon, hydrogen, oxygen, nitrogen, and sulfur-containing ices (CHONS) may set the initial composition of comets and protoplanets. With JWST's superb sensitivity, spectral coverage, and resolving power, we can study these ices at unprecedented depths into molecular cores in exquisite detail. We will share here the first results of observations from the Early Release Science program "Ice Age" (PID #1309) where we study two lines of sight through the Chamaeleon I star forming region at the highest extinction ever probed in the pre-stellar stage (A_V=60 mag and A_V=95 mag). Using NIRSpec (Fixed Slit mode, 2.7 – 5.3 μm), NIRCam (Wide Field Slitless Spectrograph mode, 2.4-5.0 μm), and MIRI (Low Resolution Spectrograph mode, 5 –13 μm) we cover the vibrational modes of most ice species. We fit the profiles of the simplest ice species (H_2O, CO_2, CO, CH_4, CH_3OH) over the full 2.5 – 13 μm wavelength range using laboratory spectra. We derive ice column densities and constrain the elemental budgets. We also discuss the evidence for icy grain growth, and for the presence of ice species previously unseen in quiescent cloud material. Clearly, the JWST observations open a new window into understanding the composition and chemistry of ices before they are incorporated into protoplanetary systems.