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Laboratory perspectives on chemistry in the outer solar system

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Many satellite surfaces in the outer solar system are known to have H₂O-dominated ices. Slow but constant chemical changes occur in these ices with time due to their exposure to the local magnetospheric and/or cosmic ray radiation environment. Our group is investigating the chemical history of ices from the laboratory perspective by examining the effects of ion-bombardment on H₂O-rich ices containing small molecules such as CO, CO₂, CH₄. This work was completed at NASA/Goddard's Cosmic Ice Laboratory where mid-IR (2.5 to 20 microns) spectra of low temperature ices were studied as a function of MeV proton bombardment simulating accumulated radiation. Spectra of irradiated H₂O-rich ices reveal IR signatures of species such as alcohols, aldehydes, and acids. It is believed that with time, similar products with volatilities lower than the H₂O matrix are preferentially retained in the upper surface layers where they can undergo additional processing. We will discuss the mid-IR spectra of H₂O-rich ices as a function of radiation history and present spectra of several likely residual species, e.g. polyoxymethylene (H₂CO)_n, carbon suboxide (C₃O₂), ethylene glycol (CH₂OH)₂, and hydrogen peroxide (H₂O₂). Our spectra of likely surface residual materials include the near-IR (1 to 5 microns) region which is most accessible to ground-based observations.

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