

The effect of salt on the high-pressure ice phase

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Icy moons such as Europa, Callisto, and Ganymede are believed to have subsurface oceans beneath an outer ice shell. At greater depths, increasing pressure leads to the formation of high-pressure ice phases like ice VI and even ice VII. Understanding these ice phases is essential for constructing accurate models of planetary interiors. On the other hand, Galileo probe magnetometer observations have suggested dissolved salt in the deep icy Moon. Cassini spacecraft revealed sodium-rich ice particles of a plume emerging from warm fractures in Enceladus. These findings highlight the critical role of dissolved salts in shaping the internal dynamics of icy moons.

Here we use molecular dynamics to study the crystallization of NaCl-water solutions at high-pressure, high-temperature conditions. We track the crystalline sites where Na and Cl ions occupy in the ice VII structures. We also run large-scale simulations with machine learning potentials fitted on the ab initio data to understand the formation of salty ice VII. We examine how dissolving salts affects the density and melting behavior of ice VII, and put our results in a planetary perspective. Such studies contribute to developing more precise models of icy moon interiors and large icy exoplanets.