Ionic phases of ammonia-rich hydrate discovered at high densities

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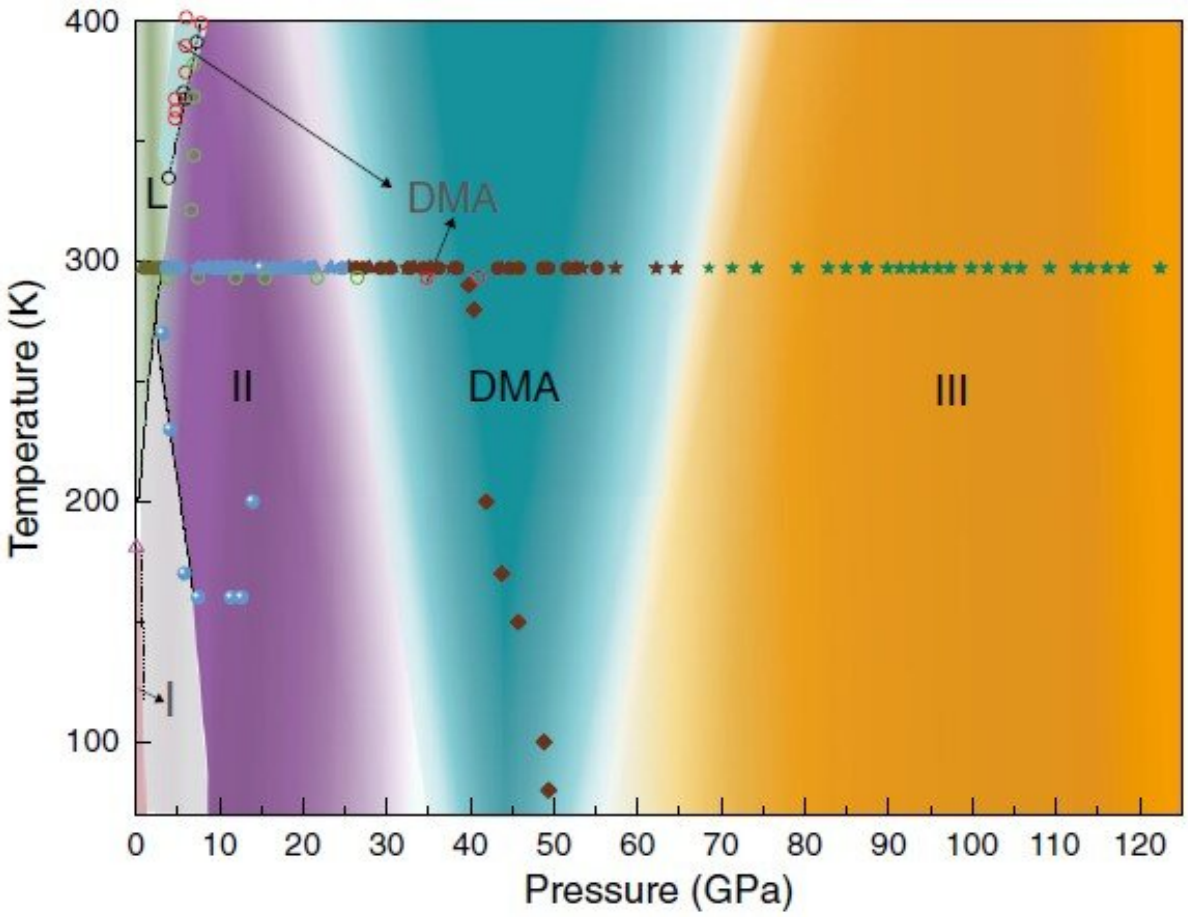

The proposed phase diagram of AHH based upon this Letter and low-pressure data from Wilson et al. For the experimental data, different colors depict different phases, and different filled symbols represent different runs. (Image by XU Wan)

A research team has studied the spontaneous ionization of ammonia hemihydrate (AHH) under compression and discovered ionic phases of ammonia-rich hydrate at high densities.

The team was consisted of researchers from the Hefei Institute of Solid-state Physics (ISSP) of the Hefei Institutes of Physical Science (HFIPS), University of Edinburgh, and the Center for High Pressure Science & Technology Advanced Research and the results of this study were recently published in *Physical Review Letters*.

Mixtures of ammonia and water are major components of the "hot ice" mantle regions of icy planets. AHH plays a pivotal role as it precipitates from water-rich mixtures under pressure.

The team compressed an exemplary ammonia-water compound to over 1.2 million atmospheres, corresponding to a depth of about 9,870/8,085 kilometers inside Uranus/Neptune, and tracked its structural and dynamical properties. The calculations demonstrated that the compressed mixture transforms into a very stable ammonium oxide, $(NH_4^+)_2O^{2-}$.

The presence of such a stable ionic compound deep inside icy planets will influence our understanding about such planets' formation and evolution to the present day. These intriguing ionic phases can exist over a considerably wide pressure region hence greatly extend the phase diagram of AHH.

More information: Wan Xu et al. Ionic Phases of Ammonia-Rich Hydrate at High Densities, *Physical Review Letters* (2021). DOI: 10.1103/PhysRevLett.126.015702