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Stably stratified layer formed by superionic NH_3 in Uranus and Neptune

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Non-dipolar planetary-magnetic fields observed at Uranus and Neptune are considered to be generated by a geometry composed of a convective region surrounding a stably stratified interior (Stanley and Bloxham, Nature, 2004). However, the formation mechanism and composition of the deep-stable layer has been a big puzzle since static experiments provided the melting curve of H_2O, which is the most conceivable component to form the layer, not so high compared with the planetary isentropes (Kimura et al., J. Chem. Phys. 2014). We determined melting temperatures of NH_3, another main component of the icy giants, up to 60 GPa by using the laser-heated diamond anvil cell coupled with Brillouin scattering measurements. A kink was found in the melting curve at 40 GPa due to the phase transition to the superionic phase, and the rapid increase in the melting temperature resulted in the intersection of the melting curve with isentropes of Uranus and Neptune at 46 and 43 GPa, respectively, indicating that the superionic NH_3 stably exists in the icy planets. Taking into account the dynamo model, NH_3 is required to be more abundant in the deep interior than H_2O to form the stably stratified layer, unlike the composition ratio estimated based on the solar abundance.

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