The 438th Geodynamics Seminar

Interior structure of Uranus and Neptune inferred from the melting curve of NH_3

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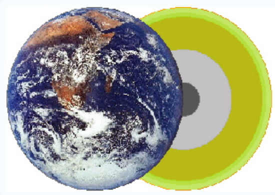

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Abstract

Molecular compounds such as H_2O, CH_4, and NH_3 are dominant constituents of an internal layer of Uranus and Neptune. In this layer, high pressure and high temperature conditions (P > 20 GPa, T > 2000 K) are supposed, and the knowledge of the phase relation of these compounds is important for understanding the observable properties (gravitational moments and magnetic field). It is known that the phase diagrams of H_2O and NH_3 are very similar. In particular, the stability of the superionic phase proposed for both compounds at high P-T conditions have wide applications (Cavazzoni *et al*. (1999)), where protons diffuse rapidly through oxygen or nitrogen sublattice. Experimental studies for H_2O have observed a kink on the melting curve at ~50 GPa (Goncharov *et al*. (2005)), suggesting the existence of the superionic phase. On the other hand, previous study for NH_3 reported no kink and negative slope on the melting curve at pressures more than 40 GPa (Ojwang *et al*., (2012)), in contrast to the theoretical predictions. Thus, the stability of superionic phase of NH_3 is still disputable. In this study, the melting temperatures of NH_3 were determined up to 60 GPa by using a diamond anvil cell (DAC) coupled with a double-sided CO_2 laser heating system.

The melting temperature was determined by observing the discontinuous change in the heating efficiency, as explained in T. Kimura *et al.* (2014). The melting temperatures up to 40 GPa are in very good agreement with the extrapolation of those of the external heated DAC experiments. At 40 GPa and 2400 K, a rapid increase in melting temperature was found. It is likely that this is caused by the transition to superionic phase in solid since this condition is in good agreement with the predicted triple point between liquid, phase III, and superionic phase (Bethkenhagen *et al*. (2013)). More than 40 GPa, the estimated melting curve on NH_3 intersects with isentropes of Neptune and Uranus, indicating the stability of the superionic NH_3 in the planetary interior.

詳細は当センターホームページ：http://www.grc.ehime-u.ac.jp/ をご覧ください
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