Investigation of Giant Planets Interior Structure by Laser Driven Shock Wave

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The equation of state (EOS) of pure hydrogen at ultra high pressure is very important for the investigation of the interior structure of giant planets such as Jupiter and Saturn. However, the standard model for hydrogen EOS is absent theoretically and experimentally at this moment. Especially, the uncertainty in the EOS at the transition region from molecular hydrogen to metallic hydrogen is a significant problem in constructing a theoretical model of the Jupiter interior structure. The main reason why the mass of the solid core at the center of Jupiter is not decided yet is this uncertainty. The mass of the solid core is the important physical quantity for understanding how the planets in our solar system were formed. The Jupiter interior structure consists of the rock or ice core at the center and the outer envelope of hydrogen and helium. Although the hydrogen is in the molecular form near the surface, at high pressure region near the center, it is predicted that the hydrogen becomes metallic due to the pressure ionization. The transition condition from the molecular hydrogen to the metallic one is that the pressure is about 2 Mbar and the temperature is about 6000 K.

The purpose of this research is to experimentally measure the EOS of hydrogen at ultra high pressure and high temperature conditions. We have started an experiment on the GEKKO-XII laser system at Institute of Laser Engineering, Osaka University to produce the physical condition of the transition region in the experimental laboratory. We will present the method of our experiment and preliminary results of the measurement for the EOS of cryogenic hydrogen.