The 72nd GRC & The 17th MEXT Shin-Gakujutsu "Core-Mantle Coevolution"
International Frontier Seminar

Experimental Discovery of Superionic Water with dynamic compression

Dr. Marius Millot

High Energy Density Physics
Lawrence Livermore National Laboratory

2018.5.25 [Fri.]

Venue: Meeting Room #486,
Science Research Bldg 1,

The pressure-temperature phase diagram of water exhibits a striking degree of polymorphism with more than 15 polymorphs of molecular ice and the pressure-induced transition to the ionic ice X near 70 GPa. Upon further compression and at elevated temperature, several molecular dynamics studies have predicted that water becomes superionic, an extraordinary state with liquid-like hydrogen ions diffusing within a solid lattice of oxygen. The higher entropy of superionic ice is expected to rise its melting temperature to several thousand Kelvin and to favor the transition to new ice structures having a close-packed oxygen lattice.

We will report experimental evidence for superionic electrical conductivity above 100 GPa and 2000 K using velocimetry, pyrometry and optical property measurements of shock compressed water ice VII, as well as in-situ x-ray diffraction of ice up to 4 Mbar using reverberation compression showing that the superionic conduction indeed exists in the presence of a solid oxygen lattice as predicted three decades ago. The new XRD data also suggest the discovery of a new solid ice phase having a face-centered-cubic oxygen lattice.

In addition to providing new benchmarks for quantum theory of condensed matter, our laboratory experimental study suggests that Neptune, Uranus and many icy exoplanets may contain significant amount superionic water ice, in contrast with the prevalent picture of fluid interiors for these objects.

Core Mantle Coevolution

Contact: Prof. Taku Tsuchiya
tsuchiya.taku.mg@ehime-u.ac.jp

EHIME UNIVERSITY GRC GEODYNAMICS RESEARCH CENTER