Internship offered in M2
2018-2019

Responsible for internship

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Internship topic: **Unveiling the properties of planetary ices in the laboratory**

Knowing the behaviour of matter at extreme states of temperature and pressure is of extreme importance to unveil the internal structure of planets. Besides its own interest, this is also critical to understand the solar system history, formation and evolution. Icy giant planets, Uranus and Neptune, remain poorly modeled mainly because of the lack of data on equations of state, chemical and transport properties of ice ($H_2O/CH_4/NH_3$ system) at their interiors conditions. This leaves several lacunae in our understanding of our icy giant planets, in which ice comprises two thirds of their mass. In particular, lack of precise information on transport properties of the ice mixture is casting serious issues in explaining Uranus and Neptune's magnetic fields and Uranus' low luminosity. Resolving this situation is even more urgent today as the discovery of exoplanets is incredibly active.

Today it is possible to bring matter to high temperature (eV) and pressure (Mbar) conditions typical of planetary interiors using static compression techniques in Diamond Anvil Cell (DAC) or dynamic loading, with laser generated shock compression. The PHYSIX team of the IMPMC at Sorbonne University, expert in the experimental determination of ices properties in DAC [1,2,3] and the PHYDHEL group at the LULI laboratory at the Ecole Polytechnique, expert in the laser generated shock compression [4,5,6], are carrying on an experimental program combining these two techniques to highlight ice properties at these extreme (P,T) conditions. The student will participate in the analysis of the experimental data. The work will include measurements of mixture optical properties and densities of statically pre-compressed samples, as well as laser shock experiments, planning permitting. This research is supported by the ANR through the SUPER-ICES grant.

[1] S. Ninet et al., *Phys. Rev. B*, 89,174103 (2014) ; [2] S. Ninet et al., *Phys. Rev. Lett*., 108,165702 (2012) ; [3] C. Liu et al., Nature Communications, 8, 1065 (2017)
[4] Bolis et al., *Geophys. Res. Lett*., 43, 9475 (2016) ; [5] Denoeud et al., *PNAS* 113, 7745 (2016) ; [6] Denoeud et al. *Phys. Rev. Lett* 113, 116404 (2014)

Techniques involved: high pressure techniques (diamond anvil cells), in-situ Brillouin and Raman spectroscopies

Paid internship: Yes
Can this internship be continued for a PhD? Yes
If yes, type of PhD funding envisaged is: Ecole doctorale