

Internship proposal 2011-2012

Laboratory : Institut de Minéralogie et de la physique des milieux condensés (IMPMC) UMR 7590 Address : UPMC, Campus Jussieu, Tour 13-23, 75005 Paris Laboratory director : Bernard Capelle	<i>laboratory logo (optional)</i>
Internship supervisor : Dr. Livia E. Bove Phone : 0144275219 e-mail: bove@impmc.jussieu.fr	

Title : New exotic forms of salty ice under high pressure

Scientific project :

Water, wherever it exists in nature, contains unavoidably significant amounts of dissolved ionic species, and most of chemical reactions occurring in water, including various biological phenomena, are mediated by the presence of ions. Nonetheless, surprisingly little experimental attention has been paid on the high pressure behaviour of “salt water”. Pressure is an important thermodynamic variable which has a profound effect on the properties of materials. In consequence, there is a broad scientific and technological interest ranging from planetary interiors to the recovery to ambient conditions of non-equilibrium structures having novel structural and functional properties. In a recent study [*S. Klotz, L.E. Bove et al., Nature Materials 2009; L.E. Bove, S. Klotz et al., PRL 2011*], we discovered that a LiCl-aqueous solution crystallizes under pressure in a new and unexpectedly simple salt hydrate, which can be regarded as an ‘alloyed’ high-pressure ice phase. Up to now the presence of salts dissolved in water has been considered negligible for the various phases of ice. The belief was that freezing, either by cooling or by applying high pressure, would expel the salt ions to form a mixture of pure ice and some salt hydrate. Our study demonstrated that the situation is strikingly different if the ice phase is produced by re-crystallisation of the glassy salt solution under pressure. This discovery would be still more valuable if other electrolyte solutions of geological interest such as NaCl-water, KCl- water, or NaI-water solutions would be involved. Various studies support the presence of high- pressure ice polymorphs in the interior of Galilean satellites, and there is strong evidence of subsurface salty oceans in some of them. If ice forms highly loaded with ionic species exist in nature in significant quantity, their physical properties would be highly relevant for the understanding of icy bodies in the solar system. To probe this fascinating hypothesis we plan to perform new neutron diffraction measurements and molecular dynamics studies on NaCl-water, KCl-water solutions under high pressure. In this stage, the student will be involved in the preparation of the neutron scattering experiment, he/she will perform preliminary x-ray and/or Raman measurements. He/she will finally participate to the measurement campaign and will be tutored in the data analysis.

Techniques in use : x-ray/Raman scattering under high pressure, neutron scattering under high pressure

Applicant skills : English spoken, good experimental skills, good background in condensed matter physics and/or material science

Granted internship : yes (400€/month)

C'nano IdF laboratory (France only) : yes

Possibility for a thesis : yes (type of grant : LABEX-MATISSE or UPMC)