PhD: Probing the exotic properties of filled ices under HP

Department: Physics Department, EPFL, Lausanne, Switzerland.
Salary: 48000 CHF / year (average over 3 years)
Location: Physics Department, EPFL, Lausanne, Switzerland.
Duration: 4 years

Your Mission

Compressed solid water can homogeneously incorporate into its structure substantial amounts of guest species, like ions, in salty ice structures [1], or small gas molecules (such as H_2 and CH_4), in gas hydrates [2]. *Filled ices* have markedly different properties with respect to pure ice which are relevant for planetary interior modelling and for hydrogen storage applications: salt-filled ices are dense materials showing high ionic and proton conductivity, while gas-filled ices are light nanoporous materials with low thermal conductivity and extremely high gas storage capability. In this project funded by the Swiss National Science Foundation (SNSF), we want to obtain a fundamental understanding of this largely unexplored class of materials, to define their stability range under high pressure, to probe their remarkable dynamical and conductivity properties, and to explore their possible applications as solid state electrolytes and hydrogen storage materials.

[1] S. Klotz, L. E. Bove et al, Nature Mater. 8, 405 (2009) ; L.E. Bove, R. Gaal, et al., PNAS 112, 8216–8220 (2015) ; A.A. Ludl, L. E. Bove, et al., PCCP 19 1875 (2017) [2] U. Ranieri, et al., Nature Comm. 8, 1076 (2017); U. Ranieri, et al., JPC C 123, 1888 (2019) ; S. Schaack, et al., PNAS 116, 16204-16209 (2019)

Main duties and responsibilities

You will produce salty-ices by temperature annealing under HP hyperquenched saltywater solutions. You will identify the stability range of salt-filled ice structures by coupling neutron and x-ray diffraction measurements and, in the very HP regime—beyond 20 GPa—Raman scattering in diamond anvils cells (DAC). You will probe their dynamical and conductivity properties by coupling HP quasi-elastic neutron scattering and conductivity measurements. You will compare your results with advanced ab-initio and DFT molecular dynamics simulations performed in the group. You will perform experimental work, data analysis, present your results at international conferences, write publications in the peer reviewed journals and participate in beam-times at the neutron sources and synchrotrons.

Your profile

We are looking for highly motivated candidates with a Master's degree in physics, chemical physics, material science or nanoscience. Experience with some of the following domains are

of advantage but not required: neutron scattering, synchrotron x-ray scattering, Raman scattering, high-pressure techniques. A good command of both spoken and written English is essential.

We offer

We offer a 4-year PhD position, excellent research infrastructures and resources. EPFL is an excellent research institute and renowned university offering a stimulating international research environment, a competitive salary and an ideal starting point for a scientific career. The LQM (Laboratory of Quantum Magnetism) is an international, interdisciplinar and dynamic team which offers flexibility and the possibility to generate and test your own ideas.

Application process

For further information about this lab and project, please consult Dr. Livia E. Bove. For additional information about obtaining a PhD at EPFL, please consult https://www.epfl.ch/education/phd/.

To apply, please send the following documents as a single pdf file (10 MB maximum) to livia.bove@epfl.ch:

- a letter of motivation
- your CV
- the names and contact information of at least two references
- 1-2 page summary of your Master thesis
- A transcript of the grades of your Master degree

Start date: January 2023 or later (negotiable)

PhD applicants must be accepted by an EPFL Doctoral School in order to pursue a PhD. For more information, please see https://www.epfl.ch/education/phd/edpy-physics/.
Inquiries can be sent to Livia E. Bove (livia.bove@epfl.ch) before December 1st.