Laboratory for Quantum Magnetism - LQM
Institute of Physics - IPHYS
Faculty of Basic Sciences - FSB

PhD: Probing the exotic properties of filled ices under HP

The Laboratory for Quantum Magnetism (LQM) is looking for a motivated candidate who wishes to perform his/her Ph.D. in a stimulating and dynamic atmosphere at the forefront of scientific research. LQM is part of the École Polytechnique Fédérale de Lausanne (EPFL), a world-renowned science and education center, offering prospective students an ideal environment to start their scientific carrier as well as an excellent connection with industry.

Project Description: 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

- Produce salty-ices by temperature annealing under HP hyperquenched salty water solutions.
- 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).
- Probe dynamical and conductivity properties by coupling HP quasi-elastic neutron scattering and conductivity measurements.
- Compare results with advanced ab-initio and DFT molecular dynamics simulations performed in the group.
- Perform experimental work, data analysis, present 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:

- Four-year PhD position.
- Excellent research infrastructures and resources.
- Competitive salary and an ideal starting point for a scientific career.
- International, interdisciplinary and dynamic team which offers flexibility and the possibility to generate and test your own ideas.

Application process

The selected PhD student will need to enroll in the Physics program of the EPFL doctoral school. After one year of successful probation, the initial contract will be extended up to a total of four years. Doctoral school information and employment conditions at EPFL are described at:

- https://www.epfl.ch/education/phd/programs/edpy-physics
- https://www.epfl.ch/education/phd/doctoral-studies-structure/doctoral-students-salary
- https://www.epfl.ch/about/working/working-at-epfl/employment-conditions

For further information about the LQM and the PhD project, please contact Dr. Livia E. Bove (livia.bove@epfl.ch).

To apply, please send the following documents as a single pdf file (10 MB maximum) to the email above:

- Letter of motivation
- CV
- The names and contact information of at least two references
- 1-2 pages summary of your Master thesis
- A transcript of the grades of your Master degree

Start date: January 2023 or later (negotiable).