NÉEL INSTITUTE Grenoble

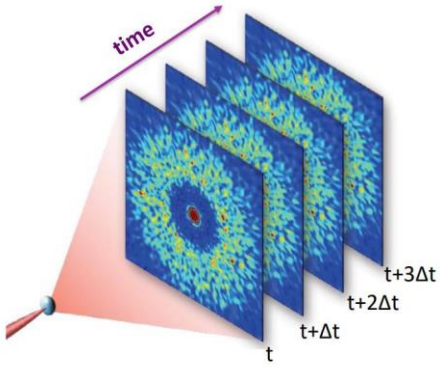
Topic for Master 2 internship – Academic year 2023-2024

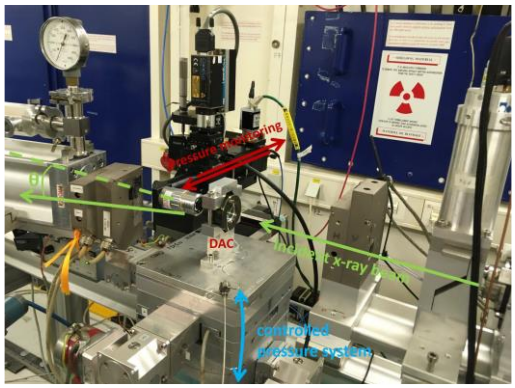
Combining coherent X-rays and nano-calorimetry to study the atomic motion and relaxation processes in glass-formers at high pressures

General Scope :
Glasses are mysterious materials. Fundamental blocks in many natural and technological processes, still, their properties keep puzzling a large community of scientists nowadays. Albeit the apparent differences, materials as diverse as emulsions, gels, pharmaceutical compounds, plastics, and windows do share common features. Following different experimental routes, like decreasing the temperature in a molecular glass-former or increasing the packing fraction in a colloidal suspension these materials can be driven in an out-of-equilibrium configuration which features many intriguing phenomena.
Within the large family of disordered systems, metallic glasses (MGs) play a key role being often considered as archetypes of out-of-equilibrium materials. Discovered in the sixties, MGs have outstanding mechanical and elastic properties with respect to their crystalline counterparts which makes them among the most studied materials nowadays. In our group we have performed the first worldwide studies able to follow the atomic motion in glasses by using the coherent X-rays available in Synchrotron Radiation facilities. Our results have allowed us to unveil a complex dynamical pattern at the atomic level which controls the evolution of many outstanding macroscopic properties of MGs.

Research topic and facilities available :
To further understand the microscopic mechanism controlling the properties of glasses, the student will study the effect of high pressure compression on the atomic motion and stability of metallic glasses. For this purpose, he/she will combine high pressure set-ups (Belt, diamond anvil cell) with the X-ray Photon Correlation Spectroscopy technique available at European synchrotrons. The results will be complemented by standard and chip calorimetry measurements available in our laboratory to obtain a detailed investigation of the relation between kinetics and dynamics under hydrostatic compressions.

References in our group: V. Giordano and B. Ruta, *Nature Commun.*, 6, 10344 (2016); X. Monnier et al. , *Science Adv.* 6 eaay 1454 (2020) ; A. Cornet et al., *Acta Mat.* 255, 119065 (2023).





Possible collaboration and networking : This project will be carried out between the institute Néel and the European Synchrotron ESRF in Grenoble. The group is working on a European ERC-Stg project on the same topic. The student will work in an international environment and collaborate also with the University Politecnica of Barcelona in Spain and the University of Saarbrucken in Germany.

Possible extension as a PhD : Depending on the ongoing funding applications.

Required skills: Master 2 (or equivalent) with good knowledge in solid state physics or material science and light matter interaction.

Starting date : March 2024 (flexible)
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More information : http://neel.cnrs.fr