INTERNSHIP PROPOSAL

Laboratory name: Laboratoire Kastler Brossel
CNRS identification code: UMR 8552
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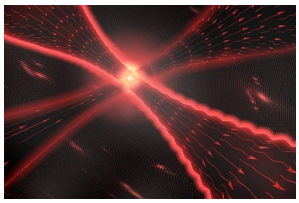
Web page: https://www.lkb.fr/polarisedhelium/research/research-topics/cavitation-in-4he/
Internship location: LKB 24 rue Lhomond 75005 Paris
Thesis possibility after internship: YES Funding: NO

Brillouin gain spectroscopy of liquid and/or solid helium-4

Low temperature helium 4 is a model system for the study of condensed matter because quantum effects play an important role and because it can be prepared experimentally with remarkable purity. A consequence of this last property is that one can achieve metastable states of helium-4 very far from thermodynamic equilibrium. The Quantum Liquid and Solid Group of Laboratoire Kastler Brossel has developed an experimental set-up to produce metastable states of liquid and solid helium-4 using focused acoustic waves and to measure the density and the compressibility of the helium in the metastable state. The compressibility measurement is a measurement of the speed of sound and is done using a Brillouin pump/pulse laser spectroscopy technique. If the frequency of the probe laser and that of the pump laser are shifted by the "Brillouin frequency", energy from the pump laser is transferred to the probe laser.



Till now, the compressibility measurement is performed with two independent lasers. The purpose of this M2 internship is to develop a Brillouin gain spectrometer based on a single laser. The idea is to take advantage of the particularly low value of the speed of sound in liquid or solid helium-4 (~ 250 m/s) corresponding to a Brillouin shift being quite small (~350 MHz). This allows, from a single laser, to produce both the pump beam and the probe beam by shifting a part of the laser using an acousto optic modulator. One advantage of this configuration is that, as the probe and the pump beams originatedfrom the same laser, the beat note spectral width is considerably lowered with respect to one of a Brillouin spectrometer with two independent lasers.

This M2 internship could be extended by a PhD thesis whose goal will be to provide the first experimental measurement of the elastic constants of solid helium in a metastable (low density) state. Those constants are directly linked to the propagation speeds of the different acoustic modes and therefore accessible by rillouin spectroscopy. Our group has discovered an unexpected instability in depressurized solid helium (for a review see J. Grucker JLTP 197, 149 (2019)) and the behavior of the elastic constants when approaching it could certainly teach us more about the link or the absence of link between this instability and a potential supersolid state of helium-4 at low pressure.

Condensed Matter Physics: YES Soft Matter and Biological Physics: NO
Quantum Physics: YES Theoretical Physics: NO