Spécialité de Master « Optique, Matière, Paris »

INTERNSHIP PROPOSAL

(One page maximum)

Laboratory name: **Laboratoire Kastler Brossel**
CNRS identification code: **umr 8552**
Internship director'surname: **Jacquier**
e-mail: philippe.jacquier@lkb.ens.frPhone number: **+33 1 44 32 35 99**
Web page: **http://www.lkb.ens.fr/-solid-helium-**
Internship location: **24 rue Lhomond 75005 Paris**

Thesis possibility after internship: **YES**/NO
Funding: YES/**NO** If YES, which type of funding:

stimulated Brillouin scattering in super-fluid helium :
toward measuring the Equation Of State in the metastable phase

Our team is investigating the metastability of the condensate phase of helium at low temperature (~1K). Because of quantum effects, helium remains liquid (or gaseous) down to T=0K. It must be pressurized up to 25 bar to become solid. Using a focused acoustic wave created at 1MHz inside the bulk solid, which lowers the pressure locally in space and in time, we have shown that the solid phase remains (meta-)stable down to ~4 bar below the melting pressure. This is in fact much higher a pressure than what was predicted by nucleation theories. The origin and the nature of this early instability is still not understood. One way to gather informations on this phenomenon is to determine the equation of state (EOS) of the metastable solid, which is experimentally unknown. Presently, we measure the density of the solid using an interferometric time-resolved imaging technique that we have developed. In order to reconstruct the EOS, we plan to use stimulated Brillouin scattering to measure the sound velocity at very high frequency (~1GHz), which is directly related to density (that we know by our measurements) and to the compressibility. Knowing the density ρ and the derivative dρ/dP, will allow to reconstruct the EOS: ρ(P).
Doing these experiments in solid is quite fastidious, because each time we reach the instability, the crystal is broken and we must melt it and regrow it again, which takes some time.
We are now turning our attention to the nucleation of bubbles in the liquid at low (even negative) pressure. There are some mysteries around this problem as well, and we take advantage of the very rapid healing of the liquid once a bubble has occurred.

The subject of the internship will be the construction of the stimulated Brillouin scattering experiment. Brillouin scattering is the scattering of light by density fluctuations due to phonons, it explains the blue color of the sky. Stimulated Brillouin scattering occurs when a powerful enough laser pulse is sent in the liquid to both create phonons and back-scatter on them in a catastrophic auto-induced mechanism. The frequency of the reflected beam is shifted by an amount proportional to the sound velocity. As a a very first step, we will make the experiment in the static liquid, in order to validate the technique, later we will have to synchronize Brillouin scattering with the acoustic wave, this would be the subject of the second part of the internship and/or the beginning of a PhD.

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: **YES/**NO Macroscopic Physics and complexity: **YES**/NO
Quantum Physics: **YES**/NO Theoretical Physics: YES/**NO**