

INTERNSHIP PROPOSAL

Laboratory name: Laboratoire Léon Brillouin (CEA-CNRS), Université Paris-Saclay
CNRS identification code:
Internship director's surname: NOIREZ, Laurence
e-mail: laurence.noirez@cea.fr Phone number: 01 69 08 63 00
Web page: <https://iramis.cea.fr/pisp/laurence-noirez-fr/>
Internship location: LLB, CEA-Saclay

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

Understanding the signals emitted by moving liquids

Summary

Elasticity is one of the oldest physical properties of condensed matter. It is expressed by a constant of proportionality G between the applied stress (σ) and the deformation (γ): $\sigma = G \cdot \gamma$ (Hooke's law). The absence of resistance to shear deformation ($G' = 0$) indicates liquid-like behavior (Maxwell model). Long considered specific to solids, shear elasticity has recently been identified in liquids at the submillimeter scale [1].

The identification of liquid shear elasticity ($G' \neq 0$) is a promise of discoveries of new properties. Among them, we show that confined liquids are able to convert the mechanical energy in thermal waves [2,3]. We will exploit the capacity of mechano-thermal conversion to develop a new generation of micro-hydrodynamic tools (Patented).

At the nanoscale, we will study the impact of a liquid flow on the solid dynamics. Unique methods such as Inelastic Neutron Scattering or Synchrotron radiation will be used to show that the dynamics (phonons) of the solid is subjected to anharmonic effects when a liquid flows on its surface [4]. Proposals will be submitted to Very Large Research Facilities such as the ILL or the ESRF to gain beamtime. Finally, we will strengthen our collaborations with theoreticians.

1. "Explaining the low-frequency shear elasticity of confined liquids, A. Zacccone, K. Trachenko, PNAS, 117 (2020) 19653–19655. Doi:10.1073/pnas.2010787117
2. E. Kume, P. Baroni, L. Noirez, "Strain-induced violation of temperature uniformity in mesoscale liquids" Sci. Rep. 10 13340 (2020). Doi : 10.1038/s41598-020-69404-1.
3. L. Noirez, E. Kume, P. Baroni, Mesoscopic Liquids Emit Thermal Waves Under Shear Strain or Microflow, Liquids 2025, 5(4), 27; <https://doi.org/10.3390/liquids5040027>, L. Noirez SciPost in press 2026.
4. M. Warburton et al, "Identification by Inelastic X-Ray scattering of bulk alteration of solid dynamics due to Liquid Wetting", J. of Molecular Liquids 391 (2023) 123342202.

Keywords: Wetting, liquid transport, macroscopic thermal effects and phonon dynamics.

Experimental: 2D-microthermography, Fluidics, surface energy, neutron scattering.

Location: Laboratoire Léon Brillouin (CEA-CNRS), CEA-Saclay.

Candidates: A strong motivation for experimental physics, for innovation, and a solid knowledge in material science or liquid physics are required.

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

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