Master 2 + PhD

INTERNSHIP PROPOSAL

Laboratory name: Institut de physique de Rennes
CNRS identification code: UMR 6251
Internship director'surname: Isabelle Cantat and Arnaud Saint-Jalmes
e-mail: isabelle.cantat@univ-rennes1.fr
arnaud.saint-jalmes@univ-rennes1.fr
Phone number: 0223235628
Web page : https://perso.univ-rennes1.fr/arnaud.saint-jalmes/welcome.phtml
https://perso.univ-rennes1.fr/isabelle.cantat/

Internship location: Institut de Physique de Rennes
Thesis possibility after internship: YES
Funding: YES If YES, which type of funding: ERC

From a soap film to a 3D foam: flows between bubbles.

Context
Less raw material, less energy: aerated solids are promising eco-friendly materials. These innovative materials are initially liquid foams, and the stability and apparent viscosity of these complex fluids need to be understood and controlled.
Experimental and theoretical developments recently improved our understanding of the flows at the soap film scale. However, the link between the effective visco-elasticity observed at the foam sample scale and the flows measured at the film scale has not yet been identified. A better understanding of this multiscale problem is crucial to be able to predict the foam stability and dissipative properties as a function of the bubble size, liquid fraction and chemical formulation.

Experiments
The candidate will make the link between the macroscopic rheological properties of a liquid foam and the local flow recently described at the film scale. A direct comparison requires to use foam samples with large bubbles and a small liquid fraction. Shearing such a fragile sample at controlled stress will be a challenging but reachable aim, at the core of this project. These macroscopic measurements will allow us to address for the first time the role of the disorder in the foam mechanical properties, by direct comparison with the strain/stress relationship recently determined for a single bubble [1].

Futur developments
This project may lead to more advanced measurements, based on acoustic propagation of ultrasound in the foam [3], to obtain additional information of the film thickness distribution within the 3D sample, or to numerical and theoretical approaches to build and test a multi scale model for foam viscosity.

[1] Dynamical coupling between connected foam films: interface transfer across the menisci. A. Bussonnière, E. Shabalina, X. Ah-Thon, M. Le Fur and I. Cantat. Phys. Rev. Lett. 124 p.018001 (2020)
[2] Local origin of the visco-elasticity of a millimetric elementary foam. A. Bussonnière and I. Cantat. J. Fluid Mech. (2021)
[3] The acoustics of liquid foams. F. Elias, J. Crassous, C. Derec, B. Dollet, W. Drenckhan, C. Gay, V. Leroy, C. Nous, J. Pierre, A. Saint-Jalmes. Current Opinion in Colloid & Interface Science, Elsevier, 2020, pp.101391.

Skills : Hydrodynamics, Soft condensed matter, experimental physics