

Internship & PhD proposal

Measurement of minute surface viscosities in soap films

Host laboratory

Location : Institut de Physique de Rennes – UMR 6251 (Soft Matter Department)

Funding M2 and PhD: yes (ANR MicroRheoFilm)

Supervision

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Sujet

Measuring the surface viscosity in soap films: development of a magnetic interfacial microrheometer

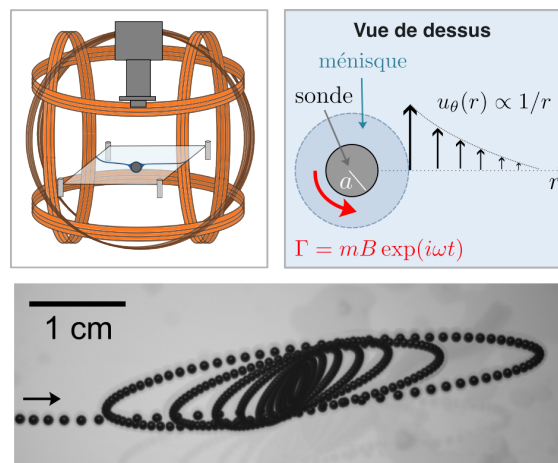
Surface viscosity is a fundamental property of fluid interfaces: it quantifies their resistance to deformation and controls many physical and industrial processes. It plays a key role in bubbles coalescence, the drainage of foams or the thickness of thin liquid coatings. Yet, despite decades of experimental efforts, measuring this property remains a real challenge. For many common surfactants — such as SDS or TTAB, found in most foaming systems — the surface viscosity is simply too small to be measured with the existing interfacial rheology methods.

As part of this project, we aim to develop a **new experimental method to measure these extremely small surface viscosities**. The idea is simple but original: we will perform the measurement **at the surface of an horizontal soap film** (see figure). In this configuration, the probe (a magnetic particle with size ranging from 10 to 500 micrometers) is in contact only with air (typically 50 times less viscous than water) and with the film surface, making this setup potentially 10 to 100 times more sensitive than conventional interfacial rheometers, where the probe is placed at the surface of a liquid bath. The motion of the probe will be controlled using a setup recently installed in the lab: triaxial Helmholtz coils, allowing a fine control of the magnetic field in 3 directions up to 250 G.

The student selected to work on this project will study the **dynamics of magnetic beads** (both translational and rotational motion) embedded in horizontal soap films of controlled composition and thickness. By accurately tracking the motion of the particle, the candidate will determine the **frictional force exerted by the interface** and extract the corresponding surface viscosity. By systematically varying the probe size and the surfactant type, we aim to obtain — for the first time — direct measurements of extremely low surface viscosities, down to 10^{-10} Pa s m, for a wide range of soluble surfactants. Beyond this first challenge, this work will give crucial insights on the flow in soap films and will help us better understand how surface viscosity affects foam drainage, bubble coalescence, and the aging of fluid interfaces.

Candidate profile:

Master's degree (or equivalent) in **soft matter physics**, **fluid mechanics**, or **physical chemistry**. Strong motivation for experimental physics, with an interest in image analysis and instrumentation.



Top: a soap film containing a magnetic probe will be placed at the center of 3D Helmholtz coils. An oscillating magnetic field induces a torque on the particle, which induces a shear of the interface.

Bottom: Translational motion of a millimeter-sized particle in a soap film