# INTERNSHIP PROPOSAL

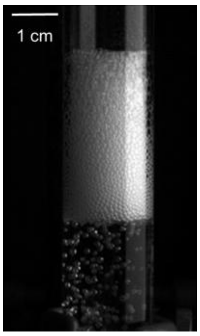
Laboratory name: SIMM
CNRS identification code: UMR 7615
Internship director'surname: Emilie Verneuil, François Lequeux
e-mail: Emilie.verneuil@espci.fr Phone number: 0140794742
Web page: https://www.simm.espci.fr/Transport-aux-interfaces-fluides.html
Internship location: Laboratoire SIMM, ESPCI Paris, 10 rue Vauquelin 75005 Paris
Thesis possibility after internship: YES
Funding: YES If YES, which type of funding: CIFRE

**Drainage of thin liquid films and lifetimes of foams (experimental and theoretical)**

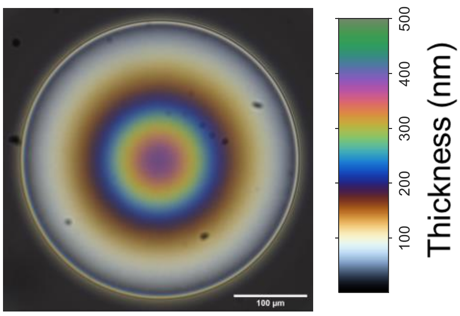
Coalescence has been widely studied in surfactant solutions[1]. Nevertheless, a quantitative prediction of the lifetimes of liquid films stabilised by surfactants is still lacking. This complex problem involves intricate couplings between the flow and concentration fields as well as the disjoining pressure associated to surfactants. Even in the absence of the latter, complexity arises in particular from the timescales of surface and bulk transfers of surfactant, which can be comparable to the drainage time[2]. As a consequence, the situation for surfactant solutions is so intricate that predicting the lifetime of a liquid film in presence of surfactants remains a challenge[3]. We have identified a very simple system in which it is possible to describe quantitatively the stability of liquid films[4]. These are liquid mixtures, such as oil mixtures, miscible in all proportions, which have the following properties: first, the disjoining pressure is always attractive and independent of local variations in composition. Second, surface/volume transfers are only controlled by diffusion of species with no adsorption/desorption delays. Third, the film lifetimes can easily be varied from about 1ms to 10 s, by changing the volume fraction of the species. Lastly, they exhibit a very low pollution sensitivity, due to their low surface energy. Consequently, the question of coalescence, and its consequences on diphasic flows is well posed in these systems.

The purpose of this internship is to further describe the physical mechanisms acting to stabilize foams of two mixed liquids[4] (Image A). To do so, we will perform experiments on single suspended liquid films (Image B) thanks to a specially designed cell. We will particularly explore the effects of the curvature which sets the capillary pressure gradients and the drainage time. These experiments will be analyzed and compared to on-going numerical simulations to improve our understanding of the stabilizing mechanisms in oil foams.

**A**




**B**




(A) *Foaming of a liquid mixture in a column by air injection from the bottom.* (B) *Observation of a thin liquid film using white-light interferometry, allowing for the reconstruction of the thickness profiles over time. Bursting is observed when the thickness decreases down to 50 nm.*

[1] Langevin, D. *Curr. Opin. Colloid Interface Sci*. 2015, 20 (2), 92–97.
[2] Petkova, B.; Tcholakova, S.; Denkov, N *Colloids Surf. Physicochem. Eng. Asp.* 2021, 626, 127009.
[3] Champougny, L.; Roché, M.; Drenckhan, W.; Rio, E. *Soft Matter* 2016, 12 (24), 5276–5284.
[4] Tran et al, *Physical Review Letters*, 2020, 125, 178002

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