Post-Doctoral Position
Marangoni effects in a 2D confined droplet

Context

The surface tension between two fluid phases depends on several parameters such as temperature or surfactants at the interface. In particular, concentration gradients of chemical species induced Marangoni stresses which are, in turn, responsible for tangential stresses along the interface and eventually for flows [1]. A geometry of particular interest concerns flows in a Hele-Shaw cell, i.e. a channel whose depth is much smaller than its width and length. This classical problem has been studied in depth, both theoretically and experimentally [2-4]. While the theoretical solutions predict that the relative velocity of an inviscid bubble should be twice the velocity of the outer fluid, this is never observed in practice. Instead, bubbles travel at lower speeds than the outer fluid. Moreover, complex recirculation patterns are observed for bubbles rising in a quiescent outer fluid [5]. All of these observations point to the effect of an uneven surfactant coverage of the interface and its redistribution due to the fluid motion.

[1] V. G. Levich and V. S. Krylov, Surface tension driven phenomena, 1969, Annual Review of Fluid Mechanics.
[2] G. I. Taylor and P. G. Saffman, Q. J. Mech. Appl. Math., 1959, 12, 265–279.
[3] T. Maxworthy, J. Fluid Mech., 1986, 173, 95–114.
[4] A. R. Kopf-Sill and G. Homsy, Phys. Fluids, 1988, 31, 18–26.
[5] J. Bush, J. Fluid Mech., 1997, 352, 283–303.

Mission

In the framework of a national project untitled TRAM involving experimentalists (MMN in Paris - LAI in Marseilles), theoreticians (IPR Rennes) and numericians (IDA University Paris VI), we want to investigate local surfactants distribution at a droplet interface by direct visualization. We recently synthesize in the laboratory fluorescent surfactants. Preliminary results are promising since a gradient of surfactants concentration is observed along a trapped droplet under flow.

More precisely the aim of the project is to make a full characterization of the flow pattern around and inside an immobilized droplet in a microfluidic Hele-Shaw cell. We use a capillary trap to immobilize the droplet [1]. We will use Particle Image Velocimetry and/or Particle Tracking Velocimetry to determine the flow velocity of the outer flow and in the droplet. Epifluorescence/confocal microscopy and reflection interference contrast microscopy (RICM –IDA) will be used to determine the shape, the thickness of the lubrication film and the pressure distribution around the droplet. Fluorescence recovery after photobleaching (FRAP-IPR) coupled to our fluorescent surfactant will allow to measure the interfacial velocity. The experimental data collected will be the basis for testing and/or discriminating theoretical models with the support of our partner at IPR. Moreover experimental results will be confronted to numerical simulation of our partner from IDA.

[1] P. Abbyad, R. Dangla, A. Alexandrou and C.N. Baroud, Lab Chip, 2011, 11, 813-821.

Profile

Applicants will have a PhD in Physics or related disciplines (soft matter) and will be motivated by making experiments and confronting the results to the theory. Applicants with prior experience in microfluidics will be appreciated.

Applicants will have an experimentalist profile.
Applicants shall speak English or French, and have good communication skills.

Duration: 12 months.
For applicants eligible to Eurotalents an extension of at least 6 months should be possible.
Starting date: spring 2016
Localization: LIONS at CEA Saclay, Gif sur Yvette France

Contacts
CV, motivation letter and recommendation letter should be sent to both contacts.
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