Master 2 Internship

Title: Toward a statistical mechanics of the Marangoni effect

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PhD funding (if any):

Project:

The equilibrium properties of a liquid interface can be characterized by a single parameter: the surface tension γ. The latter is related to the microscopic properties of the liquids through standard statistical mechanics [1]. Yet, the description of a fluid interface becomes more intricate when the system is brought out of equilibrium by a temperature gradient. Indeed, because of the temperature-dependance of γ, the resulting stresses along the interface induce a fluid flow in the bulk. This is known as the Marangoni – or thermocapillary – effect.
Although thermocapillary flows have long been investigated from the point of view of fluid mechanics, little is known regarding their statistical properties [2]. The aim of this project is to study the nonequilibrium fluctuations that originate from the Marangoni effect. In a first step, we intend to study the influence of the bulk flow on the height fluctuations of the interface [3]. In practice, the candidate will develop an analytical model in order to derive a Langevin equation for the fluctuation dynamics. This study requires a taste for theoretical physics, and some basic knowledge of both (classical) statistical mechanics and (low Reynolds number) hydrodynamics.

The project will be completed in the *Condensed Matter Theory Group* (LOMA – University of Bordeaux), where several members have a strong expertise in Soft Matter theory. It is intended to be continued with a PhD.

Keywords: nonequilibrium soft matter, Marangoni flows, physics of interfaces.

Bibliography:
[1] Barrat and Hansen, *Basic concepts for simple and complex liquids*, Cambridge (2003).
[2] Clavaud, Maza-Cuello, Frétigny, Talini and Bickel, *Modification of the fluctuation dynamics of ultra-thin wetting films*, Phys. Rev. Lett. **126**, 228004 (2021).
[3] Thiébaud and Bickel, *Nonequilibrium fluctuations of an interface under shear*, Phys. Rev. E **81**, 031602 (2010).