Dynamics of liquid crystal droplets

Supervisor : Sébastien Michelin (LadHyX)

sebastien.michelin@polytechnique.edu

In most common liquids, such as water and common oils, molecules arrange randomly both in position and orientation, in contrast with solid crystals where they are found along regular lattices. In liquid crystals, molecules adopt a local preferential orientation, known as the director. Liquid crystals have intrigued and fascinated scientists for more than a century now, before becoming the core of many common features of our daily life (e.g. Liquid Crystal Displays, LCD), because of the peculiar interaction of the local nematic order (i.e. the preferential molecular orientation) with light and other physical fields.

Microscopically, this introduces elastic-like stresses on the fluid to resist the nematic structure's deformation. Short-ranged molecular interactions further constrain the molecular orientation at interfaces. In confined setting, such as a small droplet, this leads to some complex ordering and the existence of topological defects, a common situation being the existence of a single central defect.

The hydrodynamics of such "nematic droplets" remain however relatively poorly investigated, most of the existing litterature focusing on the understanding of the motion of particles/drops *within* a liquid crystal phase. As a result, some fundamental questions remain open :

- What is the sedimentation velocity of a liquid crystal drop ? Is it faster or slower than that of a droplet of similar viscosity ? Is it stable ?
- Liquid jets are known to drip into a train of droplets under the effect of surface tension (Rayleigh-Plateau instability) ; is that still the case in a liquid crystal ?

The proposed internship, which will have a focus on theory and possibly numerics, will attempt to resolve one (or more) of these questions.

Note : depending on the student's interest and progress on the topic, this internship can be continued onto a PhD.

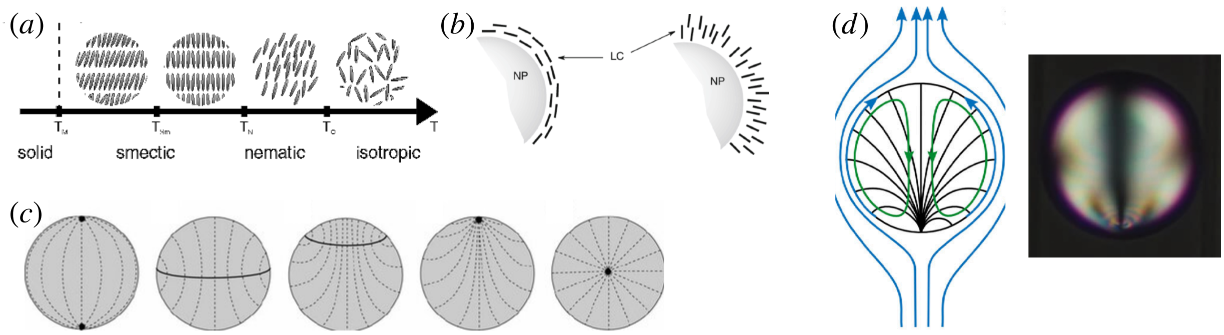

FIGURE 1 – (a) Local molecular ordering in liquid crystals. (b) Two possible types of preferred molecular orientation ("anchoring") at an interface. (c) Topological structure and defects in a nematic droplet depending on the nature of the anchoring. (d) Flow field and nematic organisation inside a moving droplet and corresponding observation in polarized light.