3. – Liquid crystal microfluidics

Supervisor(s): Dr. Marco G. Mazza, Dr. David Sibley

Project details

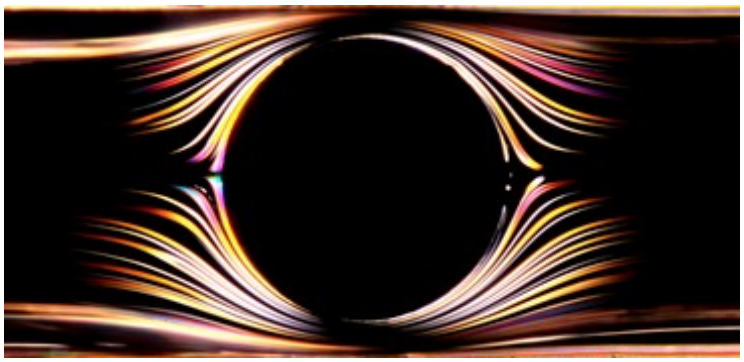
Liquid crystals (LCs) have been a source of fascinatingly abundant physics for more than a century. Because of their capacity to reorient, also in response to external fields, LCs are used in a wide range of applications: from the ubiquitous electronic displays, to microlasers and lubricants. LCs are ubiquitous in biological settings. Nucleic acids, proteins, carbohydrates and fats exhibit liquid-crystalline mesophases. Hydrodynamic flow of a LC is a fundamental perturbation of its equilibrium properties which is manifested in the interplay of preferential orientation, surface anchoring, topological defects, and flow velocity.

Microfluidics of LCs offers extraordinary possibilities for the manipulation of fluids at the mesoscale. The student will develop and apply theoretical and computational methods to study how confinement induces non-uniform orientational order, self-organization of topological defects, and interactions between defect topologies and colloids (to investigate the transport and delivery of microcargos), or the motion of microswimmers in a LC medium. This last problem has numerous important applications in biologically powered micromachines.

The student will join an interdisciplinary group that focuses on nonequilibrium statistical mechanics. We are seeking an outstanding, industrious student with a background in physics, applied mathematics, or related fields.

Entry requirements:

Applicants should have, or expect to achieve, at least a 2:1 Honours degree (or equivalent) in physics, applied mathematics, or related subjects. Some experience in programming languages like C/C++ or Python, or experience in e.g. Matlab with a desire to learn other languages, is a necessary prerequisite. Experience in one or more of the following subjects will be an advantage: mathematical modelling, Brownian motion, fluid mechanics or differential equations in various applications.



References

T. Stieger, H. Agha, M. Schoen, M. G. Mazza, A. Sengupta, "*Hydrodynamic cavitation in Stokes flow of anisotropic fluids*", Nature Commun. **8,** 15550 (2017).