PROPOSITION DE STAGE (M1 ou M2)

Title :
Brownian motion of topological elastic quasi-particles in a chiral liquid crystal

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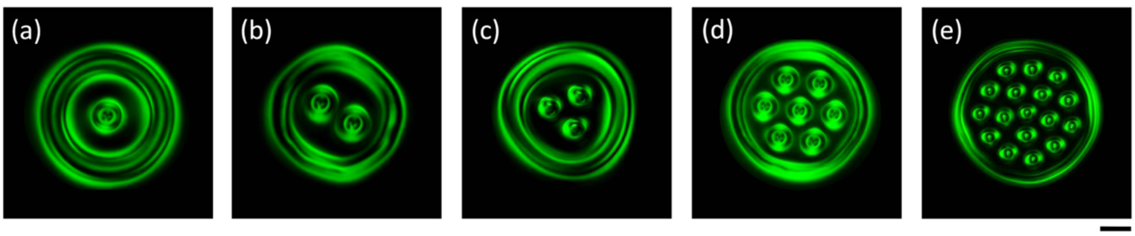
Summary

Liquid crystals are well-known viscoelastic anisotropic fluids exhibiting a wealth of topological defects studied at Laboratoire Ondes et Matière d'Aquitaine for their electromagnetic properties (generation of optical vortices) or their possible metastable character (rewritable topological memories). A striking example is the case of chiral liquid crystal films whose molecules spontaneously form a helical supramolecular order whose pitch can be controlled at will. If the pitch of this helix is adjusted to be of the order of the thickness of the film, the spatial confinement leads to a phenomenon of geometric frustration: the most stable state of the system corresponds to a completely unwound helix. However, if a large enough perturbation of the orientational ground state is provided (for example, by applying a voltage of a few volts between the walls of the film or by using a focused laser beam), the liquid crystal spontaneously forms metastable localized structures. An example is displayed in the figure below. Such localized elastic excitations correspond to liquid quasi-particles within a single and same liquid !

The proposed internship will consist of making sufficiently thin films (typically 1 µm-thick) so that these quasi-particles become Brownian and studying the Brownian motion. In particular, one wonders whether a signature of the chiral structure of these quasi-particles can be recovered from positional fluctuations that one will observe. Also, one will be interested in collective effects by considering various kinds of assemblies of these objects.



Self-assembly of 1 (a), 2 (b), 3 (c), 7 (c) and 17 (e) metastable solitonic excitations trapped within a loop in a 10 µm-thick chiral liquid crystal film. All these structures correspond to quasi-elastic particles of a single and same anisotropic fluid. These images are observations made using an optical microscope (natural light filtered at 532 nm) when the sample is placed between crossed polarizers. Scale bar: 15 µm.