Master 2 Internship

Title: Light-induced localized structures in nematic liquid crystals
Type: experimental
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PhD funding (if any): ANR

Project: Unique properties of liquid crystals (LCs) allow to host a large variety of static and dynamic self-assembled orientational structures in their director field. The director is a unitary vector defining a local average orientation of elongated molecules of the LC. The director configuration corresponding to these states defines the range of physical parameters in which they exist, their static and dynamic properties and the laws of their pairwise interaction. These structures can be extended or localized in space. The localized states can be described using parameters normally used for particles: position, size, velocity and topological charge.

Recently great attention was dedicated to studying so called 3D dynamic solitons in LCs [1]. In simple words, solitons in liquid crystals are localized self-sustained perturbations of its director field. These intriguing structures can bring new insights to fundamental principles of condensed matter physics and open new perspectives for novel photonic devices with advanced functionalities. One of the most interesting features of solitons is their ability to propagate over long distances and recover their shape after interactions with other solitons or certain perturbations. Despite years of studies and variety of considered host media, only two types of 3D dynamic solitons were reported and their on-demand generation remains a major challenge.

During this internship we will make a step toward understanding of underlying mechanisms of solitons generation in various geometries. This will define the perimeter of their potential applications related to the macroscopic length scale of their propagation distance and a variety of their interactions with each other and other kinds of liquid crystals structures.

At larger scale, this project aims at controlling the generation and propagation of dynamic solitons in NLCs via structuring of host director field using laser beams. This will be done by combining the effects of a local optical stimulus with quasi-static external excitation (applying electric and magnetic fields). You will benefit from the longstanding expertise of the host team in the interaction of light with liquid crystals, notably in context of topological structuring of both light and liquid crystals [2]. You will determine the optical, electrical and material optimal conditions to achieve on-demand nucleation of dynamic solitons, whose spatio-temporal behavior will be assessed using time- and space- resolved polarization microscopy.

This M2 internship is intended to be continued with an ANR-financed PhD thesis.

[1] Li, B.X., Borshch, B., Xiao, R.L., et al. Electrically driven three dimensional solitary waves as director bullets in NLCs. Nature Communication 9, 2912 (2018)

[2] El Ketara, M., Kobayashi, H., and Brasselet, E. Sensitive vectorial optomechanical footprint of light in soft condensed matter, Nature Photonics 15, 121–124 (2021)

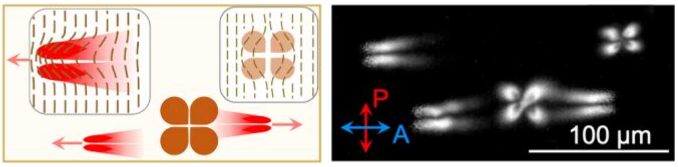

Figure 1. Left: Schematic representation of director structure of dynamic soliton (red) and its nucleation center (brown). Right: corresponding experimental polarization optical image.