Master 2 Internship

Title: Laser-triggered dynamic solitons in nematic liquid crystals

Supervisor(s): Nina KRAVETS and Etienne BRASSELET

Email(s): nina.kravets@u-bordeaux.fr

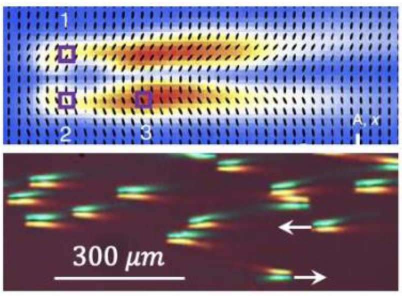
PhD funding (if any): opportunities via doctoral school or ANR (results in 2023)

Project: Solitons are localized packets of waves which are self-sustained due to a balance of dispersive and nonlinear effects. 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, generation of multidimensional solitons remains a major challenge.

Owing to their highly anisotropic and nonlinear properties, liquid crystals can host a large variety of solitonic structures: nematicons, topological solitons and dynamic dissipative solitons. In simple words, solitons in liquid crystals are localized self-sustained perturbations of its director field (local average molecular orientation). Microscopic size of solitons in liquid crystals and plethora of available optical techniques for their observation and characterization make liquid crystals prime choice for exploration of soliton structures and their potential applications.

Among mentioned solitons, we will focus our investigations around dynamic solitons [1]. First of all, to develop better fundamental understanding of their physical nature which so far remains incomplete. But also, to make a step toward their applications related to the macroscopic length scale associated with their propagation distance and a variety of their mutual interactions as well as with other kinds of liquid crystals structures or guest micro-objects. For this purpose, we suggest to get a control over targeted nucleation of individual dynamic solitons in contrast to spontaneous nucleation of solitons at sample imperfections reported so far.

In particular, this project aims at controlling the creation and launching of dynamic solitons by means of local laser-induced director perturbation. This will be done by combining the effects of a local optical stimulus (using a laser beam) with electrohydrodynamic processes (applying quasistatic electric 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 light-induced nucleation of dynamic solitons, whose spatio-temporal behavior will be also assessed using time- and space-resolved polarization microscopy.



Schematic representation of an individual dynamic solion (top) and polarized optical image of an ensemble of dynamic solitons (bottom).
Adapted from [1]

M2 internship is intended to be continued with a 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)