Master 2 “Photonics, Complex and Quantum Systems (PhoCQS)”: Research Training 2023-2024

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Topic: Dynamics of complex systems

Measurement of the stochastic properties of liquid crystals for the simulation of optical nonlinear propagation in liquid crystals

At the time of Internet and telecommunications, high-speed networks have become a crucial issue that requires always increasing the transfer rates. To meet this challenge, the solution is to use all-optical communications that is to replace e.g. electronic operations by much faster optical operations. The way used to reach such a goal is to exploit the non-linear interactions experienced by light when it propagates trough a medium. Examples of non-linear effects are self-focusing with the creation of "optical bits", shock waves, generation of new frequencies, etc. The idea here is to take advantage of these effects to control and manipulate the trajectory of light in order to realize the "routing" of light.
The liquid crystal is one of the media with the largest existing non-linearities (times greater than in optical fibers for example). This makes it an ideal candidate for nonlinear light propagation studies.
This non-linearity is based on the reorientation of the molecules by the optical field. The thermal agitation causes the orientation of each molecule to fluctuate very slightly, which gives the medium a stochastic character.
The objective of this internship is to experimentally characterize in a quantitative way the stochastic properties of the nematic liquid crystal used in the non-linear propagation experiments of our team. These measurements will then be integrated into the numerical simulation program of optical nonlinear propagation in liquid crystals.
The internship will include the assembly and realization of optical experiments, as well as numerical simulations to understand and explain the phenomena observed experimentally.

Keywords: liquid crystals, stochasticity, nonlinear optics, propagation, photonics