Doctoral positions
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Thesis topic : Interactions between nanoparticles and liquid crystal topological defects studied by advanced synchrotron experiments

Liquid crystals are interesting materials for their applications, with LCD screens being their flagship application. However, they are also interesting for their fundamental properties. In particular, they are materials capable of easily stabilising a large number of topological defects, a topological defect being characterised by the loss of order of matter within the core of the defect. These defects exist in many fields of physics, in various phases of condensed matter, in cosmology and even in biology. Liquid crystals are therefore a privileged field of study for fundamental research of interest far beyond these materials alone. In this context, smectic phases are all the more interesting in that they allow detailed synchrotron X-ray diffraction studies of liquid crystals with defects. We have recently shown that we are able to reconstruct the complete structure of thin films, making it possible to determine defect nature, size and location [1].

We are proposing a thesis focused on understanding the evolution of defects when the two external parameters of thickness and temperature are controlled and modified. Not only will this work enable us to build a complete model of the coexistence of these defects in a film, whose energy equilibrium can be calculated. It will also enable us to understand how to control the organisation of nanoparticles. We have in fact demonstrated how nanospheres or nanorods are confined in the core of topological defects, so that original optical properties are obtained thanks to the organisations induced by confinement [2]. This thesis will involve carrying out high-resolution diffraction experiments at the Soleil and ESRF synchrotrons, both in the absence and presence of gold nanoparticles and fluorescent nanoparticles. At the ESRF we will carry out nano-diffraction experiments in order, for the first time, to measure the structure at the scale of a single defect and/or a single assembly nanoparticles.

[1] D. Coursault et al., soft Matter 12 (2016) 629 ; J ; de D. Niyonzima PHD (2023) [2] S.P. Do et al. Nano Letters 20 (2020) 1598

Type of thesis: experimental.

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