UNIVERSITÉ CÔTE D'AZUR

INPHYNI INSTITUT DE PHYSIQUE DE NICE

Master degree internship position

Laboratory name: Institut de Physique de Nice (INPHYNI)
CNRS identification code: UMR 7010
Internship directors:
Claire Michel — claire.michel@univ-cotedazur.fr
Matthieu Bellec — matthieu.bellec@univ-cotedazur.fr
Aurélie Jullien — aurelie.jullien@univ-cotedazur.fr
Web page: inphyni.univ-cotedazur.fr
Intership location: INPHYNI, 17 rue Julien Lauprêtre, 06200 Nice, FRANCE

PhD thesis possibility after internship: **YES**

Requested funding: **Doctoral School EDSFA**

Multi-scale temporal nonlinear optical response of a biased crystal

Merging nonlinear optics and quantum hydrodynamics, quantum fluids of light have gained great interest in the past few years. Indeed, in properly engineered experimental optical devices, photons can acquire an effective mass and be in a fully controlled effective interaction. Merging nonlinear optics and quantum hydrodynamics, quantum fluids of light have gained great interest in the past few years. Indeed, in properly engineered experimental optical devices, photons can acquire an effective mass and be in a fully controlled effective interaction. They behave collectively as a quantum fluid, and share remarkable common features with other systems such as superfluidity and quantum turbulence. Quantum fluids of light have been investigated mainly in one and two dimensions in various photonic platforms. At INPHYNI, in the Waves in Complex Systems group, we have implemented an experimental platform which basically consists in propagating a continuous laser beam in a nonlinear biased photorefractive crystal (Strontium Barium Niobate, SBN) [1]. In such a configuration, the evolution of the transverse optical field along the propagation axis is analogous to a 2D quantum fluid evolving in time. A major challenge in the field of quantum fluids of light is to increase its dimensions. An interesting strategy [2] is to consider ultrashort pulses rather than continuous propagation and combine both the instantaneous electronic Kerr effect with the slow photorefractive nonlinear effect [3].

In this context, the goal of this internship is two-fold. The first part will be to characterize the slow photorefractive response of the biased SBN crystal [4], the second part will be to accurately measure its instantaneous nonlinear optical response. To do so, in collaboration with the Materials and Complex Photonic Systems group, we aim at exploiting the nonlinear chirped interferometry method they recently developed. The method is an ultrafast time-resolved spectroscopy setup. It consists in monitoring the optical group delay variations induced on a probe by an intense pump pulse, by spectral interferometry, giving access to the nonlinear $\chi^{(3)}$ tensor terms of the medium [5, 6].

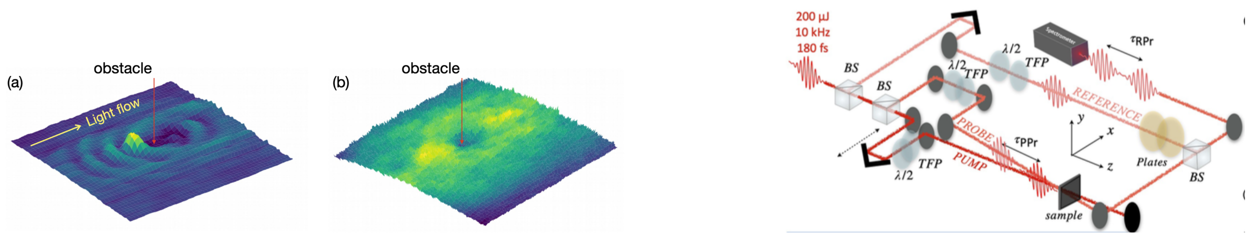

Fig. 1 – (left) Experimental images of the intensity of a laser beam passing an obstacle in the normal (a) and superfluid (b) regimes, (right) Fast nonlinear response measurement principle based on the nonlinear chirped interferometry method [5].

Profile.— We are looking for candidates with a broad outlook and a strong interest in **experimental nonlinear optics**. The candidate will have the opportunity to work in collaboration with two teams of INPHYNI (Waves in Complex Systems and Materials and Complex photonic systems). The internship gratification is about 580 € net/month. The candidate will have the opportunity to apply to the École Doctorale Sciences Fondamentales et Applications (EDSFA) for a PhD thesis grant.

[1] C. Michel et al, Nat. Commun. **9**, 2108 (2018).
[2] P.-É. Larré et al, Phys. Rev. A **92**, 043802 (2015).
[3] O. Lahav et al, Phys. Rev. X **7**, 041051 (2017).
[4] O. Boughdad et al, Opt. Express **27**, 21, 30360 (2019).
[5] E. Neradovskaia et al, APL Photonics **7**, 116103 (2022).
[6] B. Maingot et al., Opt. Lett. **48**, 3243 (2023).

Condensed matter physics: YES
Soft matter and biological physics: NO
Quantum physics: YES
Theoretical physics: YES