Master 2 "Systèmes Complexes, Optique, Lasers (SCOL)": Research Training 2022-2023
Master 2 "Matter Molecules and their Environment(MME)": Research Training 2022-2023

Appel à sujet de stage recherche / Call for research training subject

Laboratory: PhLAM

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Collaborator(s): Pierre Suret

Topic: Nonlinear optics, polaritons

Master 2: select the master and the most appropriate option

X Master 2 SCOL	□ Master 2 MME (GP-SCP)
X Option Complex Systems (GP-IKS)	X Option Condensed Matter
	□ Option Condensed Matter/Pharma
	X Option Dilute Matter and Spectroscopy
	□ Option Atmospheric Sciences
	□ Option Modeling at the molecular & atomic scales

Flying in a superfluid of light

Semiconductor microcavities are two-dimensional semiconductor structures with remarkable nonlinear properties. Their eigenstates are polaritons, half-light, half-matter quasiparticles with giant nonlinearities and they behave as a dense fluid of light. For instance, they show superfluid propagation [1]. With an external laser it is possible to control the photon fluid properties, and to ovbserve the nucleation of vortices, solitons and other turbulent phenomena.

The goal of this internship is to experimentally investigate the turbulent properties of a fluid of light when passing and obstacle. In particular, **we will address the question of whether a plane can fly in a superfluid**. Indeed, the motion and lift of the wing of an airplane in air is intimately related to the generation of vortices. In a superfluid, not only friction is strongly reduced, but vortices have very special properties: their circulation is quantised, and it can only take some integer values. Recent theoretical works have suggested that the lift of a wing in a superfluid is possible [2], but an experimental study is missing. We will use cutting-edge time resolved spectroscopic techniques to observe the emergence of vortices and other turbulent phenomena generated by an obstacle with the form of a wing in a superfluid of light.

We plan to extend this master internship into a PhD thesis by addressing other turbulent and nonlinear phenomena in superfluids of light. The project is part of the European ERC grant EmergenTopo recently awarded to Alberto Amo, and it will be developed in collaboration with the Center for Nanosciences and Nanotechnologies in Palaiseau (where the microcavities are fabricated) and with theory groups from UK and Italy. More information: http://honeypol.eu/.

[1] *Superfluidity of polaritons in semiconductor microcavities*, A. Amo et al., Nat. Phys. 5, 805 (2009).
[2] *Starting Flow Past an Airfoil and its Acquired Lift in a Superfluid*, Musser et al., Phys. Rev. Lett. 123, 154502 (2019).

Key words: nonlinear optics, superfluidity, quantum fluids of light