

Master 2: International Centre for Fundamental Physics

INTERNSHIP PROPOSAL

Laboratory name: Center for Nanoscience and Nanotechnology

CNRS identification code: UMR 9001

Internship advisors: Sylvain Ravets, and Jacqueline Bloch

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Internship location: C2N, 10 bd Thomas Gobert, 91120 Palaiseau

Thesis possibility after internship: YES

Funding: YES

Type of funding: ANR projects

Quantum fluids of light in arrays of photonic resonators

Photonic resonators, coupled within periodic arrays, have appeared in the recent years as a powerful synthetic platform to imprint on light some of the fascinating physical properties that can emerge in condensed matter, or even to go beyond what exists in nature. For instance, light can become superfluid, propagate like electrons in graphene or undergo spin-orbit coupling. Such features are not only interesting from a fundamental point of view, but also inspire innovative photonic devices.

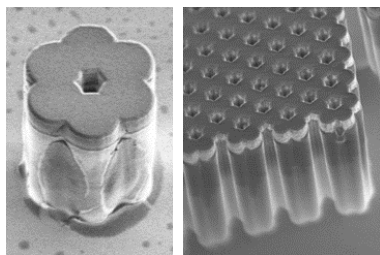


Fig. 1: Scanning electron microscopy image showing lattices of coupled microcavities (diameter of each cavity is around 3.5 microns) emulating (left) a benzene molecule, (right) graphene.

Our group at C2N has developed a unique expertise in designing photonic arrays of coupled non-linear resonators. We show, in Fig. 1, some examples of assemblies of coupled microcavities where light emulates the properties of electrons in a benzene molecule or in graphene [1].

Several recent theoretical proposals show the way to emulate the physics of charged particles submitted to a magnetic with photons in specifically designed photonic resonator arrays. Novel conduction channels are predicted at the edge of the array, and are immune to scattering by impurities. The challenge we propose to tackle in this Internship and PhD work is to

implement these ideas and demonstrate how these concepts of condensed matter physics can be transposed to light.

The applicant will contribute to the exploration of new structures by realizing optical spectroscopy experiments under cryogenic conditions (4 K) and magnetic field (up to 7T). Analysis of the experimental data will be supported by theoretical modeling developed by the applicant in collaboration with theoretician collaborators through our large network of international collaborators.

We are looking for a candidate with skills and interest in experimental work, as well as solid knowledge in quantum optics and condensed matter physics.

References:

[1] A. Amo and J. Bloch, *Exciton-polaritons in lattices: A non-linear photonic simulator*, **C. R. Phys.** **17** (2016); [2] S. Ravets et al, *Thouless Pumping in a Driven-Dissipative Kerr Resonator Array*, **Phys. Rev. Letters** **134**, 093801 (2025); [3] M. Guillot et al., A sublattice Stokes polarimeter for bipartite photonic lattices, **arXiv:2507.16446** (2025); [4] M. Guillot et al., Measuring non-Abelian quantum geometry and topology in a multi-gap photonic lattice **arXiv:2511.03894** (2025)

Condensed Matter Physics: YES

Quantum Physics: YES

Soft Matter and Biological Physics: NO

Theoretical Physics: YES