INTERNSHIP PROPOSAL

Laboratory name: Center for Nanoscience and Nanotechnology
CNRS identification code: UMR 9001
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Internship location:
Center for Nanoscience and Nanotechnology (C2N)
10 Boulevard Thomas Gobert, 91120 Palaiseau, France
Thesis possibility after internship: YES
Funding: YES ***Type of funding:*** EU (ERC grant)

Quantum optics in lattices of microcavities

When shining classical light onto a non-linear medium, intriguing quantum states of light can be generated such as squeezed states, single photon states or complex multiphoton entangled states. In the past years, theoretical physicists have proposed to use lattices of highly non-linear resonators to engineer spatial and temporal entanglement between photons. To date, a versatile and scalable experimental platform is still missing in the optical domain, where a great variety of applications are foreseen for quantum science and quantum technology.

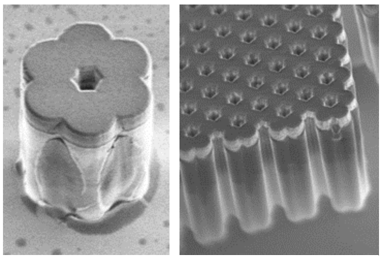

Fig. 1: *Scanning electron microscopy image showing lattices of coupled microcavities (diameter of each cavity is around 3.5 microns) emulating (left) a benzene molecule, (right) graphene.*

Our group at C2N has developed a unique expertise in designing photonic lattices of coupled non-linear semiconductor microcavities. 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].

The challenge we propose to tackle in this Internship and PhD work is to engineer interactions between photons that are strong enough (at the single photon level) to enter the quantum regime. To do so, we will optimize the non-linear medium and produce a new generation of non-linear semiconductor lattices using the state-of-the art nanotechnology tools that are available in the C2N clean room.

The applicant will contribute to the exploration of these new structures by realizing optics experiments under cryogenic conditions (4 K). The goal will be to use advanced optical measurements techniques in order to quantify photon-photon interactions in the cavities (pump-probe spectroscopy), measure the quantum correlations in trains of photons emitted through the cavity (Hanbury Brown and Twiss experiment) and evidence entanglement (measurement of the spatio-temporal correlations). 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 solid state physics.

References:

[1] A. Amo and J. Bloch, *Exciton-polaritons in lattices: A non-linear photonic simulator*, C. R. Phys. 17 (2016).

Condensed Matter Physics:	YES	Soft Matter and Biological Physics:	NO
Quantum Physics:	YES	Theoretical Physics:	YES