Quantum fluids of light in semiconductor lattices

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Semiconductor microcavities appear today as a powerful platform for the study of quantum fluids of light. They enable confining both light and electronic excitations (excitons) in very small volumes. The resulting strong light-matter coupling gives rise to hybrid light-matter quasi-particles named cavity polaritons. Polaritons propagate like photons but strongly interact with their environment via their matter part: they are fluids of light and show fascinating properties such as superfluidity or nucleation of quantized vortices. Sculpting microcavities at the micron scale, we fabricate at C2N lattices of various geometries and use this photonic platform for the emulation of various Hamiltonians.

After a general introduction, I will illustrate with a few examples how we can imprint on photons physical properties originating from the geometry and topology of the considered lattice: - A photonic benzene molecule present spin-orbit coupling and allows building a microlaser emitting chiral photons. - A photonic polyacetylene chain presents robust topological edge states. - A honeycomb lattice allows emulating Dirac physics with s or p orbitals and manipulating Dirac cones.

When controlling the interplay between pump, on-site nonlinearity and dissipation, this photonic platform opens the way to the exploration of complex non-linear dynamics, non-linear topological physics and in a near future quantum many body physics with light.

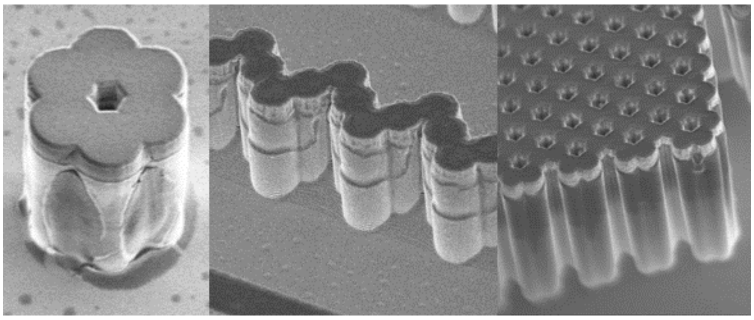

Figure 1 : Scanning electron microscopy image of semiconductor lattices where quantum fluids of light can be manipulated. (left) a photonic benzene molecule, (center) a zigzag chain of coupled resonators, (right) a honeycomb lattice of coupled resonators also named photonic graphene.