Polaritons in lattices: from flatbands to Dirac physics in a photonic system

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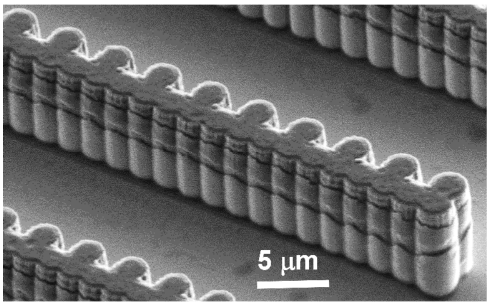
Exciton polaritons are mixed light-matter particles arising from the strong coupling of quantum well excitons and cavity photons in semiconductor microcavities. Thanks to the at-will design of the photonic potential landscape and to the direct visualisation of polariton eigenfunctions in luminescence experiments, microcavities provide an extraordinary photonic platform to emulate 1D and 2D nonlinear Hamiltonians: Polaritons allow transposing to the photonic world some of the properties of electrons in solid state systems, and to engineer Hamiltonians with novel transport properties.



1D Lieb lattice of micropillars containing a flatband for polaritons.

In this presentation we will address the physics of two Hamiltonians of particular interest. First we will show a honeycomb lattice of coupled micropillars [1]. Its band structure emulate for photons the π and π* bands of graphene. The direct access to the wavefunctions allows studying of the edge states expected in graphene nanoribbons [2]. In addition, our system permits exploring orbital degrees of freedom, inaccessible in actual graphene, which give rise to a novel kind of edge states.

The second kind of Hamiltonian that we will explore is that of a 1D Lieb lattice (see figure), which contains a flatband. We will show that polaritons get critically localised by disorder in the flatband [3].

Our system presents interesting perspectives in view of studying nonlinear excitations in engineered photonic Hamiltonians owing to polariton-polariton interactions.

1. T. Jacqmin et al., *Direct Observation of Dirac Cones and a Flatband in a Honeycomb Lattice for Polaritons.* Phys. Rev. Lett. 112, 116402 (2014).
2. M. Milićević et al., *Edge states in polariton honeycomb lattices.* 2D Mater. 2, 034012 (2015).
3. F. Baboux et al., *Bosonic Condensation and Disorder-Induced Localization in a Flat Band.* Phys. Rev. Lett. 116, 066402 (2016).