Cavity polaritons in lattices.

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At the frontier between non-linear optics and the physics of Bose Einstein condensation, semiconductor microcavities opened a new research field, both for fundamental studies of bosonic quantum fluids in a driven dissipative system, and for the development of new devices for all optical information processing.

Optical properties of semiconductor microcavities are governed by bosonic quasi-particles named cavity polaritons, which are light-matter mixed states. Cavity polaritons propagate like photons, but interact strongly with their environment via their matter component.

In this talk, I will review how semiconductor microcavities can be engineered into 1D and 2D lattices allowing implementing complex Hamiltonians and progressing toward quantum simulation. I will show how we could generate polaritons in a 1D quasi-periodic Fibonacci potential and reveal features characteristic for a fractal energy spectrum. Then I will present a 2D honeycomb lattice for polaritons, which allows direct imaging of Dirac cones and opens the way to the investigation of the hydrodynamics of Dirac polaritons. Finally 1D lattices sustaining a non-dispersive band or "flat band" will be presented: condensation in localized plaquette states is evidenced with very short extension of the spatial coherence.

All these examples highlight the great potential of semiconductor cavities as a new platform to investigate the physics of interacting bosons.

[1] Spontaneous formation and optical manipulation of extended polariton condensates , E. Wertz, et al., Nat. Phys. **6**, 860 (2010)

[2] Fractal energy spectrum of a polariton gas in a Fibonacci quasi-periodic potential, D. Tanese et al., Phys. Rev. Lett. **112**, 146404 (2014)

[3] Direct observation of Dirac cones and a flatband in a honeycomb lattice for polaritons, T. Jacqmin et al., Phys. Rev. Lett. **112**, 116402 (2014)

[4] Polariton condensation in the flat band of a 1D comb lattice, F. Baboux et al., under preparation