Artificial matter in semiconductor lattices

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Semiconductor microcavities have recently emerged as a powerful platform to implement artificial photonic materials based on the use of exciton-polaritons [1], which are hybrid quasiparticles resulting from the strong coupling of cavity photons and quantum well excitons. Polaritons are particularly attractive since they combine the best of two worlds: (i) they are photonic excitations that can conveniently be excited and read-out using optical spectroscopy; (ii) their interactions can be tuned and reinforced *via* their matter component. Moreover, at C2N, we are able to sculpt the microcavities into micron-scale photonic materials with a great variety of geometries, in order to emulate different Hamiltonians.

After a general introduction, I will describe two examples that illustrate the potential of this non-linear photonic platform to address diverse physical questions. (i) We recently explored the localization properties of waves in synthetic quasiperiodic lattices [2]. Using both a theoretical analysis and experiments on our devices, we evidenced the existence of a series of delocalization-localization transitions in a novel family of quasiperiodic chains. (ii) In another study, we investigated the nonlinear properties of polaritons in the gapped flatband of a 1D Lieb lattice [3]. We observed the formation of gap solitons with quantized size and abrupt edges, a signature of frozen propagation due to the quenching of kinetic energy in a flatband. Our experiments also reveal a complex multistable behavior, which is a direct consequence of the driven-dissipative nature of the platform. I will finally discuss perspectives of this work for quantum simulation.

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[3] V. Goblot, B. Rauer, F. Vicentini, A. Le Boité, E. Galopin, A. Lemaître, L. Le Gratiet, A. Harouri, I. Sagnes, S. Ravets, C. Ciuti, A. Amo, J. Bloch, "Nonlinear Polariton Fluids in a Flatband Reveal Discrete Gap Solitons", Phys. Rev. Lett. **123**, 113901 (2019).