Edge states in polariton honeycomb lattices

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The experimental study of edge states in atomically-thin layered materials remains a challenge due to the difficult control on the geometry of the sample terminations, the stability of dangling bonds and the need to measure local properties. In the case of graphene, localised edge modes have been predicted in zig-zag and bearded edges, characterised by flat dispersions connecting the Dirac points. Due to the above mentioned difficulties, their energy-momentum distributions have not been directly measured.

Polaritons in semiconductor microcavities have recently emerged as an extraordinary photonic platform to emulate 1D and 2D Hamiltonians, allowing for the direct visualisation of their dispersion and spatial wave functions in photoluminescence experiments [1, 2, 3]. Here we report on the observation of edge states in a honeycomb lattice of coupled micropillars [4] as the one showed on figure 1. The lowest two bands of this structure arise from the coupling of the lowest energy modes of each micropillar, and emulate the π and π^* bands of graphene [2].

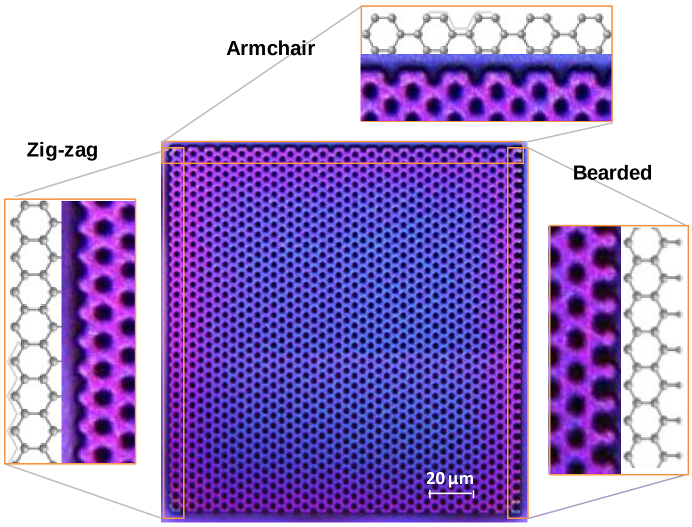

Figure 1 Optical microscope image of a polariton honeycomb lattice containing zig-zag, bearded and armchair edges.

We show the momentum space dispersion of the edge states associated to the zig-zag and bearded edges, holding unidimensional quasi-flat bands (see figure 2 (a)). Intensity of the emission in real space reveals the localized character of the edge states. Even more, novel edge states are found when considering the bands arising from the coupling of the first excited states in the micropillars. In this case we find that, apart from those associated to zig-zag and bearded edges, edge states are also present in armchair edges. Taking advantage of the significant polariton-polariton interactions, our system presents interesting perspectives in view of studying nonlinear excitations in these quasi 1D edge modes, and show the feasibility of studying topological edge state physics, as recently suggested [5, 6].

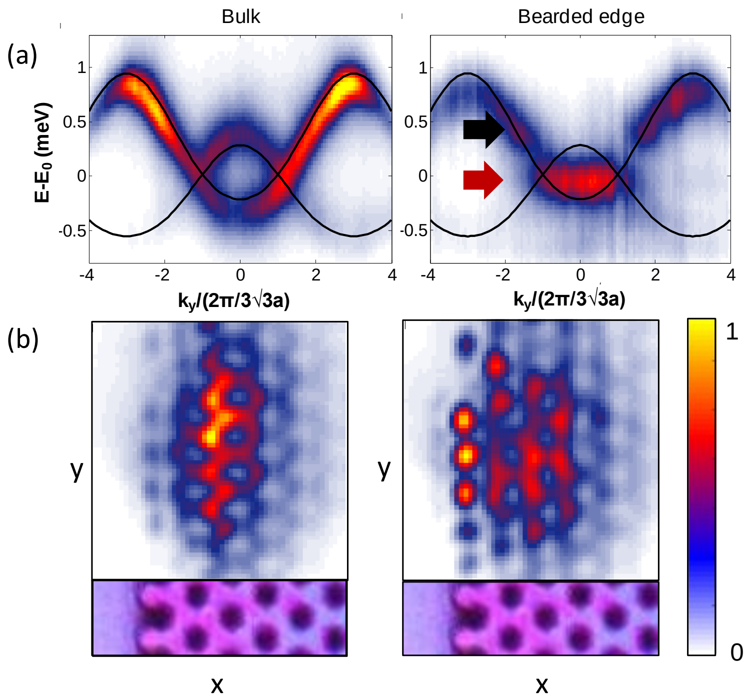

Figure 2 (a) Measured dispersion of the edge of the Brillouin zone probed in the bulk of the lattice and on the bearded edge, showing the flat dispersion characteristic of edge modes (marked with the red arrow). (b) Intensity of the real space emission measured at the energy of the bulk modes (marked with the black arrow in (a)), and at the energy of the edge state (marked with the red arrow in (b))

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