Topological effects based on spin-orbit coupling of cavity polaritons

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We show that the TE-TM splitting is a kind of spin-orbit coupling that modifies the topology of the bands in periodic structures. Under applied magnetic field, a hexagonal lattice of coupled pillar microcavities (polariton graphene[1]) behaves as a topological insulator: an energy gap opens in the bulk, while the edge states exhibit chiral propagation properties[2]. Such chiral states can be obtained in structures based on patterned planar cavities, but also on photonic crystal slabs. Magnetic and wide-bandgap semiconductors can be explored to extend the range of operation conditions.

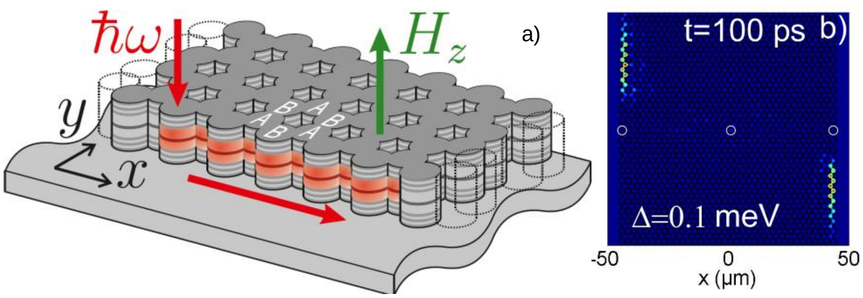

Fig. 1. a) Scheme of the polariton Z topological insulator with a chiral edge state (red). b) Spatial image of the propagating edge states.

The spin-anisotropic nature of polariton-polariton interaction and its exceptional strength due to the excitonic fraction of polaritons allow to study the nonlinear effects corresponding to the quantum fluid behavior[3] in such bosonic topological insulator. We demonstrate that the external magnetic field can be replaced by circularly polarized optical pumping (either resonant or non-resonant). We plot the phase diagram of topological transitions in polariton graphenewhich exhibits several inversions of the Chern numbers as a function of the spin-orbit coupling strength and time-reversal symmetry breaking term, allowing to control the propagation direction of the chiral states, as well as their number.

1.T. Jacqmin et al, Phys. Rev. Letters 112, 116402 (2014).
2. A.V. Nalitov, D.D. Solnyshkov, G. Malpuech, Phys. Rev. Lett. 114, 116401 (2015).
3. O. Bleu, D.D. Solnyshkov, G. Malpuech, Phys. Rev. B 93, 085438 (2016).