Topological effects based on spin-orbit coupling of cavity polaritons

D. Solnyshkov¹, O. Bleu¹, A. Nalitov¹,², G. Malpuech¹

¹ Institut Pascal (CNRS/University Blaise Pascal), Clermont-Ferrand, France
² University of Southampton, Southampton, UK

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 graphene¹) behaves as a topological insulator: an energy gap opens in the bulk, while the edge states exhibit chiral propagation properties². 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 behavior³ 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 graphene which 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.