Topologically protected interface states induced by spin-orbit coupling in liquid crystal microcavity

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Liquid crystal optical microcavities are a novel platform for achieving adjustable synthetic Hamiltonians with Rashba-Dresselhaus spin-orbit interactions [1].

In this work, we study the topological properties of light within a one-dimensional photonic lattice featuring spin-orbit coupling. To investigate the topological properties of our system, we propose a two-band tight-binding Hamiltonian in momentum space, treating spin-orbit coupling as a perturbation. We prove that topological properties of the considered system are characterised by a winding number $\mathcal{W}$. This topological invariant counts the number of times the eigenstates wind around the origin in momentum space when the wave vector runs through the Brillouin zone, $k = 0 \to 2\pi$. Compared to the well-known Su-Schrieffer-Heeger (SSH) model of a topological insulator, our one-dimensional lattice, allows for both negative and positive values of the topological invariant. This property enables us to investigate topologically protected states at the interface between lattices with a different sign of a winding number, schematically illustrated in Figure 1. We demonstrate that this leads to qualitatively new topological interface states that are absent in the SSH model.

Our theoretical analysis provides a promising perspective for realising a new class of topological lasers based on liquid-crystal optical microcavities. Furthermore, our results can be extended to a broad range of one-dimensional topological Hamiltonians with spin-orbit coupling or internal degrees of freedom [2].

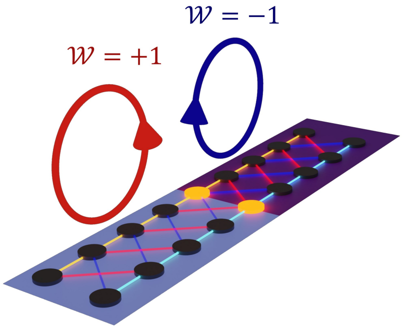

Figure 1 – Schematic illustration of a topologically protected interface state in the basis of vertical and horizontal polarization eigenstates.

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[2] A. Manchon, H. C. Koo, J. Nitta, S. M. Frolov, R. A. Duine. *Nature Mater.* **14**, 871–882 (2015).