Research Results

Novel scheme of manipulating topological physics by using a single degenerate cavity

Subject Code: F05

With the support by the National Natural Science Foundation of China, the research group from the Key Lab of Quantum Information (CAS) led by Prof. Guo Guangcan (**郭光灿**) at the University of Science and Technology of China proposed a new routine to manipulate topological physics using only a single optical cavity, which was published in *Physical Review Letters* (2017, 118, 083603).

As one of the most important topics in modern condensed matter physics, topological phenomena have received sustained attention not only in the material systems but also in ultracold atoms and photonics, owing to their close relation with fundamental physics and the potential applications of developing new techniques based on them.

Previously, researchers from the same group proposed a new platform to simulate 2D topological physics based on a degenerate cavity, which was published in *Nature Communications* (2015, 6: 7704). The cavity is cleverly designed so that it can support various LG modes with different optical angular momenta (OAM) l, which can be used as a synthetic 1D dimension system without boundaries. Using these settings, 2D physics can then be simulated using 1D cavity arrays.

In the present work, they make further progress by showing that topological phenomena can also be manipulated using only a single degenerate cavity, provided that the sharp boundaries in the synthetic dimension supported by photonic OAM degree of freedom can be designed. Theoretically they demonstrate that this is possible by introducing composite mode structures with modified optical loops inside the cavity. The scheme not only simplifies the simulation of topological physics within a single optical cavity, but also provides new possibilities of dynamically manipulating topological models in a much simpler way.

In principle, the scheme can be extended to explore topological physics in a high-dimensional system, or cover the effective photon-photon interactions. Therefore, it also opens up a new avenue to explore various exotic topological photonic states using a single optical cavity.

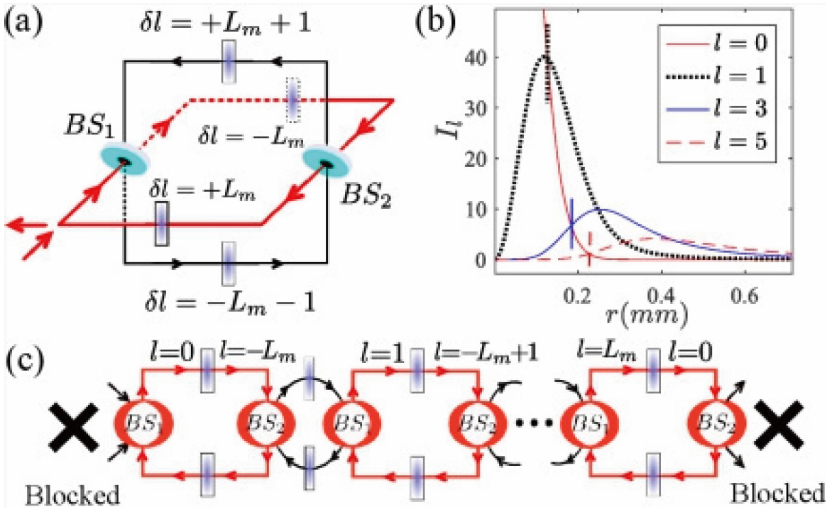

Figure (a) Proposed experimental optical loops inside a single degenerate cavity with composite optical modes to simulate 1D topological physics. (b) Optical density profiles with different optical angular momentum at beam splitters (BS_1 and BS_2) shown in (a). (c) The effective finite lattice model with sharp boundaries. (Image file from *Physical Review Letters*)