Topological Phases of Quantized Light

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Topological photonics is an emerging research area that focuses on the topological states of classical light. Here we reveal the topological phases that are intrinsic to the particle nature of light, i.e., solely related to the quantized Fock states and the inhomogeneous coupling between them. The Hamiltonian of two cavities coupled with a two-level atom is an intrinsic one-dimensional Su-Schriefer-Heeger model of Fock states. By adding another cavity, the Fock-state lattice is extended to two dimensions with a honeycomb structure, where the strain due to the inhomogeneity of the coupling strengths induces a Lifshitz topological phase transition between a semimetal and three-band insulators within the lattice. In the semimetallic phase, the strain is equivalent to a pseudomagnetic field, which results in the quantization of the Landau levels and the valley Hall effect. We further construct a Haldane model where the topological phases can be characterized by the topological markers. This study demonstrates a fundamental distinction between the topological phases of bosons and fermions and provides a novel platform for studying topological physics in dimensions higher than three.

References

[1] H Cai and D-W Wang, Nat. Sci. Rev. **8**, nwaa196 (2021)