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Observation of a New Topological Phase of Quantum Matter : Quantum Hall-like Effect without Magnetic Field[1]

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Most quantum states of condensed-matter are categorized by the spontaneously broken symmetries. The remarkable discovery of charge quantum Hall effects (1980s) revealed that there exists an organizational principle of matter based not on the spontaneously broken symmetry but only on the topological distinctions in the presence of time-reversal symmetry breaking. In the past few years, theoretical developments suggest that new classes of topological states of matter might exist that are purely topological in nature in the sense that they do not break time-reversal symmetry hence can be realized without any applied magnetic field : "Quantum Hall-like effects without magnetic field." In this presentation, I report a series of experimental results documenting and demonstrating the existence of such a topologically ordered time-reversal-invariant state of matter and discuss the exotic electromagnetic and spin properties this novel phase of quantum matter might exhibit and outline their potential use.

[1] "A Topological Dirac insulator in a Quantum Spin Hall Phase" Hsieh et.al., NATURE 452, 970 (2008). This work is supported by DOE, NSF and Princeton University.