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Direct Observation of Topological Invariants using Quantum Walks VINAY RAMASESH, EMMANUEL FLURIN, SHAY HACOHEN-GOURGY, LEIGH MARTIN, IRFAN SIDDIQI, NORMAN YAO, Department of Physics, UC Berkeley — Quantum walks are generalizations of the classical random walk in which the walking particle is endowed with an internal degree of freedom and can exist on a superposition of lattice sites. Initially investigated as a possible replacement for classical random walks in randomized algorithms, quantum walks have since found numerous applications, including the possibility of performing universal quantum computation and simulating interacting systems. More recently, it was realized that quantum walks also possess topological properties. Like spin-orbit coupled Hamiltonians in condensed matter physics, the effective band-structures corresponding to quantum walks feature topological invariants robust to local deformations. Here, we propose and analyze a new class of quantum walks, termed Bloch-oscillating-quantum-walks and demonstrate that such algorithms can directly probe the underlying band topology. Moreover, we present the first experimental measurement of a topological invariant in a quantum walk, performed in a cavity quantum electrodynamics architecture.

Vinay Ramasesh
Department of Physics, UC Berkeley

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