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Direct Measurement of Topological Phases in Discrete-Time Quantum Walks: Theory[1] VINAY RAMASESH, EMMANUEL FLURIN, IRFAN SIDDIQI, NORMAN YAO, Department of Physics, UC Berkeley — Quantum walks have been intently investigated theoretically, from initial studies motivated by their connection to classical randomized algorithms to more recent works demonstrating topological phenomena in these walks. In particular, quantum walks simulate dynamics under effective lattice Hamiltonians which feature spin-orbit coupling. Here, we demonstrate that by adding an additional coin operator which varies from step to step, one can perform a traversal of the effective Brillouin zone, analogous to a Bloch oscillation. The geometric phase picked up by the walker along the Bloch oscillation is a genuine signature of the walks topology, a quantity known in 1D as the Zak phase. Unlike previous interferometric proposals, our work requires neither spin-dependent Ramsey spectroscopy nor an external impurity with additional degrees of freedom. We develop a protocol, illustrating its use in a circuit QED system, which allows for the detection of the Zak phase.

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Vinay Ramasesh
Department of Physics, UC Berkeley

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