Direct Measurement of Topological Phases in Discrete-Time Quantum WalksTheory
for the MAR16 Meeting of
The American Physical Society

Direct Measurement of Topological Phases in Discrete-Time Quantum Walks - Experiment[1] EMMANUEL FLURIN, VINAY V RAMASESH, SHAY HACOHEN GOURGY, Quantum Nanoelectronics Laboratory, UC Berkeley, NORMAN Y YAO, Department of Physics, UC Berkeley, IRFAN SIDDIQI, Quantum Nanoelectronics Laboratory, UC Berkeley — We perform quantum walks in a cavity QED architecture. Here a transmon qubit plays the role of the quantum coin, while a set of coherent states in an electromagnetic cavity forms the walkers lattice. The strong dispersive coupling between the transmon and cavity naturally implements coin-dependent translations of the walker state. The walk is performed by applying qubit rotations at equally spaced intervals; interestingly, such systems simulate dynamics under effective lattice Hamiltonians which feature strong spin-orbit coupling, leading to non-trivial band topology. By adding an additional step-dependent coin operator, we perform the first direct measurement of a quantum walk Zak phase, delineating between topologically trivial and non-trivial walks. The geometric phase is detected by implementing the quantum walk with the initial state of the walker in a superposition of a coherent state and the vacuum state, which does not partake in the walk. The Zak phase acquired by the walker thus leaves an imprint in the interference fringes of the resulting Schrodinger cat state. We observe these fringes by directly measuring the cavity Wigner function.

[1]This research is supported by the ARO.

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Date submitted: 24 Nov 2015 Electronic form version 1.4