

# Observing The Topological Invariant of Bloch Bands Using Quantum Walks in Superconducting Circuits

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The direct measurement of topological invariants in both engineered and naturally occurring quantum materials is a key step in classifying quantum phases of matter. Here we motivate a toolbox based on time-dependent quantum walks as a method to digitally simulate single-particle topological band structures. Using a superconducting qubit dispersively coupled to a microwave cavity, we implement two classes of split-step quantum walks and directly measure the topological invariant (winding number) associated with each. The measurement relies upon interference between two components of a cavity Schrödinger cat state and highlights a novel refocusing technique which allows for the direct implementation of a digital version of Bloch oscillations. Our scheme can readily be extended to higher dimensions, whereby quantum walk-based simulations can probe topological phases ranging from the quantum spin Hall effect to the Hopf insulator.