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Simulating Anderson localization via a quantum walk on a one-dimensional lattice of superconducting qubits.

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Quantum walk (QW) on a disordered lattice leads to a multitude of interesting phenomena, such as Anderson localization. While QW has been realized in various optical and atomic systems, its implementation with superconducting qubits still remains pending. The major challenge in simulating QW with superconducting qubits emerges from the fact that on-chip superconducting qubits cannot hop between two adjacent lattice sites. In this talk, I discuss how to overcome this barrier and develop a gate-based scheme to realize the discrete time QW by placing a pair of qubits on each site of a 1D lattice and treating an excitation as a walker. It is also shown that various lattice disorders can be introduced and fully controlled by tuning the qubit parameters in our quantum walk circuit. We observe a distinct signature of transition from the ballistic regime to a localized QW with an increasing strength of disorder. Finally, an eight-qubit experiment is proposed where the signatures of such localized and delocalized regimes can be detected with existing superconducting technology.

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