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Experimental realization of qubit-state-controlled directional edge-states in waveguide QED

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We experimentally realise the theoretical proposal for in-situ tunable photonic edge states emerging from qubits coupled to a waveguide with a photonic bandgap. These edge-states are directional, exhibiting theoretically zero population in the opposite direction. Our experiment implements a tunable Rice-Mele waveguide configuration, where the directionality of edge states is controlled in-situ by varying the qubit energy. The Rice-Mele waveguide is constructed using lumped resonators coupled to an Xmon qubit. We demonstrate the existence of these edge states both actively, via waveguide transmission, and passively, through qubit emission via an edge state. We estimate a 99.4% directional fidelity, constrained by our measurement noise floor. These results hold significant promise for the development of long-range qubit couplers with effectively zero crosstalk.

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