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Experimental realization of two-qubit non-Abelian geometric gates for fixed frequency superconducting qubits[1] DANIEL EGGER, MARC GANZHORN, PETER MUELLER, ANDREAS FUHRER, STEFAN FILIPP, IBM Res Lab — Fixed-frequency superconducting qubits are controlled with microwave pulses both to generate single-qubit rotations and to activate entangling interactions. A two-qubit entangling gate, needed to form a universal set of logic gates, can be created in many ways. Here we show an experimental implementation of a two-qubit non-Abelian geometric gate. These gates have the potential to be less sensitive to certain types of noise since the state vectors are swept along closed paths in Hilbert space. With two transmon qubits connected via a resonator we implement an entangling two-qubit gate by creating a lambda system using the transitions between the second excited state of each qubit and the first excited state of the resonator. The non-Abelian geometric gate is activated by simultaneously driving these two transitions. Arbitrary rotations in a two-qubit subspace can be created by changing the amplitudes and phases of the two drives. This two-qubit gate combined with non-Abelian geometric single qubit rotations completes the necessary toolbox for a quantum computer based on non-Abelian geometric gates.

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