Adiabatic two-qubit state preparation in a superconducting qubit system

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The adiabatic transport of a quantum system from an initial eigenstate to its final state while remaining in the instantaneous eigenstate of the driving Hamiltonian can be used for robust state preparation. With control over both qubit frequencies and qubit-qubit couplings this method can be used to drive the system from initially trivial eigenstates of the uncoupled qubits to complex entangled multi-qubit states. In the context of quantum simulation, the final state may encode a non-trivial ground-states of a complex molecule, or the solution to an optimization problem in the context of adiabatic quantum computing. Here we present experimental results on a system comprising fixed-frequency superconducting transmon qubits and a tunable coupler to adjust the qubit-qubit coupling via parametric frequency modulation. We realize different types of interaction terms by adjusting the frequency of the modulation. A slow variation of drive frequency, amplitude or phase then leads to an adiabatic steering of the system to its final state showing high fidelity entanglement between the qubits.