Concurrent fermionic simulation gates for superconducting qubits

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Most quantum computation architectures rely on a single specific type of two-qubit gate to form a universal gate set. However, having flexible native entanglement gates can help to reduce circuit complexity, which is highly relevant for the performance of NISQ devices. Here, we propose a scheme to implement a continuous fermionic simulation gate (fSim gate) for superconducting qubits. We simultaneously apply two parametric drives with different frequencies targeting two different transitions. iSWAP-type and CPhase-type of operations can be realized at the same time in one single gate round with tunable angles controlled by drive amplitudes and frequencies. We give analytical formulas of effective coupling strengths covering from dispersive regime to strong drive regime. Our study opens up new possibilities for more versatile gate schemes.

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