Haonan Xiong, University of Maryland

High Coherence Fluxonium and its Two-qubit Gate Scheme

Improving control over physical qubits is a crucial component of quantum computing research. We report our recent fluxonium qubit with coherence time reaching T2*= 1.48±0.13 ms [1], which exceeds the state of the art value by an order of magnitude. As a result, the average single-qubit gate fidelity grew above 0.9999, surpassing, to our knowledge, any other solid-state quantum system. To make fluxonium-base quantum processors possible, we investigate two-qubit gate schemes in fluxonium systems. In superconducting circuits, the weak anharmonicity of transmons creates many design challenges, leading to more complex circuits and pulse protocols, slower gates, and higher gate errors. Here we describe a minimalistic scheme to control interactions between strongly-anharmonic fluxonium qubits, connected by a permanent capacitive link. The two qubit gate can be realized with near-resonant driving [2] or off-resonant driving [3] of non-computational transitions in either qubit. The same mechanism can be applied to cancel the static ZZ interaction. The measured gate error less than 0.01 is limited by decoherence, which will likely improve in the next generation devices. Our demonstration generally applies to strongly-anharmonic qubits, and it opens a new route for reducing errors and increasing circuit depth of quantum algorithms executed on fluxonium-based processors.