MAR17-2016-020539
Abstract for an Invited Paper
for the MAR17 Meeting of
the American Physical Society

Faster gate operations through strong parametric coupling of superconducting circuits

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In order to realize a gate-based quantum computer, one essential factor is improving the number of high fidelity gate operations possible. A rough estimate of this number is given by the (coherence time)/(gate operation time) or the (gate speed)/(coherence decay rate). Ideally, one would like the smallest coherence decay rate and the highest gate speed. However, the difficulty is that these two quantities tend to be at odds with one another: that is to say, maintaining the coherence of qubits requires strong isolation, whereas fast gate operations requires generating strong coupling between qubits. In this talk, I will discuss the use of parametric coupling techniques as a useful tool for maintaining qubit coherence while operating gates at high speed. We rely on the use of a flux-biased direct current superconducting quantum interference device (dc-SQUID) that can provide non-resonant tunable interactions between qubit-qubit, qubit-resonator, or resonator-resonator systems. We will highlight past and present experimental work with these systems and discuss our efforts to maximize the number of gate operations