DAMOP19-2019-020056

Abstract for an Invited Paper
for the DAMOP19 Meeting of
the American Physical Society

Bosonic Codes for Continuous Variable Quantum Information Processing: Theory and Experiment[1]

STEVEN GIRVIN, Yale Univ

Continuous variable (CV) quantum information processing requires universal control of the quantum states of harmonic oscillators. It is not a trivial task to carry out arbitrary unitary operations in the high-dimensional joint Hilbert space of these oscillators. Circuit QED uses artificial atoms constructed from Josephson junctions to achieve enormous transition dipole moments and hence strong coupling to microwave photons. The strong-dispersive regime of circuit QED is ideally suited for achieving the kind of universal control required for CV quantum information processing. Recent theoretical and experimental progress in developing and realizing new bosonic codes has allowed us to achieve a long-sought milestone: quantum error correction that reaches and exceeds the breakeven point at which the coherence time of a logical qubit exceeds that of the best physical qubits from which it is constructed. I will also describe other recent experimental progress in execution of new gate operations that entangle logical states in separate cavities. These gates [SWAP, c-SWAP (deterministic Fredkin), and exponential-SWAP] have the remarkable feature that they are universal in the sense that they do not depend on the particular bosonic encoding used to store quantum information in the cavities. These new tools could be the foundation of a modular photonic-based architecture that would be highly advantageous for quantum error correction and fault tolerance.

[1]This work was supported by the Army Research Office under Grant Number W911NF-18-1-0212 and by the National Science Foundation under Grant Number NSF DMR-1609326.