MAR12-2011-003468

Abstract for an Invited Paper
for the MAR12 Meeting of
the American Physical Society

Realization of Three-Qubit Quantum Error Correction with Superconducting Circuits

MATTHEW REED, Yale University

Quantum computers promise to solve certain problems exponentially faster than possible classically but are challenging to build because of their increased susceptibility to errors. Remarkably, however, it is possible to detect and correct errors without destroying coherence by using quantum error correcting codes. The simplest of these are the three-qubit codes, which map a one-qubit state to an entangled three-qubit state and can correct any single phase-flip or bit-flip error of one of the three qubits, depending on the code used [1]. The fidelity of a process in which errors can occur on all qubits, where there is the possibility of an uncorrectable double or triple error, should therefore decrease only quadratically with error probability. I will first introduce how the three-qubit encoded state can be produced in our superconducting architecture by employing interactions with non-computational qubit states, as previously demonstrated [2]. I will then discuss how these non-computational interactions can be generalized to produce a novel three-qubit conditional-conditional NOT (CCNot) or Toffoli gate, which implements the correcting step of an error correction algorithm. Finally, I will explain how, by combining these ingredients, we have performed a single pass of both quantum bit- and phase-flip error correction and have demonstrated the predicted first-order insensitivity to errors.

[1] M. A. Nielsen and I. L. Chuang, Cambridge University Press, 2000.
[2] L. DiCarlo, et al. Nature 467, 574 (2010).