MAR12-2011-006635

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

How coherent are Josephson junctions?[1]

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Superconducting quantum circuits based on Josephson junctions are a promising technology to realize a electronically controlled, solid-state based large-scale quantum information processor but their future prospects rely on the intrinsic coherence of Josephson junctions and the engineering of the isolated environment for the quantum circuits. We introduce a new architecture for superconducting quantum circuits employing a single-Josephson junction in a three dimensional waveguide cavity where we carefully engineer the environment of the qubit to effectively reduce the coupling of the qubit to the environment while maintaining sufficient coupling to the control signal. With this architecture we demonstrate that Josephson junction qubits are at least an order of magnitude more coherent with $T_2^{Ramsey} \sim 10$ to 20 μs without the use of spin echo than previously reported and highly stable, enabling us to observe the physics in a Josephson junction with a unprecedented level of precision. These results suggest that the overall quality of Josephson junctions will allow error rates of a few 10^{-4}, approaching the error correction threshold. We will also discuss how to scale this architecture and perform two-qubit gates.

[1]This work was performed in collaboration with D. I. Schuster, Lev S. Bishop, G. Kirchmair, G. Catelani, A. P. Sears, B. R. Johnson, M. J. Reagor, L. Frunzio, L. I. Glazman, S. M. Girvin, M. H. Devoret and R. J. Schoelkopf