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Two Types of Loss Expected for Josephson Qubit Circuits
ARTHUR DAVIDSON, ECE Department, Carnegie Mellon University, Pittsburgh, PA 15213 — The energy of a coulomb blockade capacitor, or of a current biased Josephson junction, is known to depend on the difference between a continuous charge term and a discrete one. For example the energy in the coulomb blockade is the square of (ne-k), where n is an integer, e is the electron charge, and k is a continuous charge value. This suggests that there may be two types of quantum losses in the Schroedinger dynamics of these systems. One type would reduce k to ne to arrive at the ground state energy and would be the quantum analog of external classical resistance. The other type of loss would couple energy bands at constant k, minimizing n, and corresponding to tunnel losses. Historically, two quantum loss terms have been proposed: one due to Mortin Kostin in 1972; and another from the present author in 1990. The Kostin type of loss affects the continuous charge term, while the Davidson type affects the discrete charge term. These properties are linked to the boundary conditions of these systems. The loss mechanisms are likely to be important for understanding coherence times in Josephson qubit circuits.

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