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Simulation of Superconducting Qubit Devices Using COMSOL

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Over the last decade, superconducting qubits have emerged as strong candidates for a scalable quantum computing architecture. These devices deliver coherence times approaching milliseconds and basic coherent quantum logic operations have been demonstrated. First order models for superconducting qubits follow lumped circuit element representations, capturing a large portion of their behavior for practical operation. Despite their continued improvement in coherence times, quality factors, and measurement techniques, the qubits and their resonant readout circuitry still suffer from environment-induced noise. Current models of noise involve phenomenological explanations where uniformly distributed harmonic oscillators and two level systems simulate thermal excitations and intrinsic defects. To further investigate the microscopic sources of noise, we are developing simulations using COMSOL Multiphysics, a finite element solver with a broad range of capabilities including high frequency electromagnetics, thermodynamics, and any arbitrary physics described by differential equations. In this talk, we discuss some of the COMSOL modeling techniques currently applied in our study and the future direction of our larger qubit modeling effort.

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