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Simulation Framework for Non-equilibrium Mode-resolved Phonon-mediated Quasiparticle Poisoning in Superconducting Qubits

Superconducting qubits are susceptible to non-equilibrium phonon excitations which incite chip-wide quasiparticle burst events responsible for the energy relaxation and dephasing of the qubit states. In this work, we demonstrate a phonon-mode resolved simulation framework governed by *ab initio* data (force constants, phonon lifetimes, electron-phonon coupling matrix, etc.) to describe phonon-mediated quasiparticle poisoning initiated by the absorption of an impinging gamma photon in the device substrate. The critical steps are electron ionization and thermalization which give the initial excited phonon population, non-equilibrium phonon transport in the millikelvin thermal bath, interfacial phonon transmission across the superconductor-substrate interface, and finally, non-equilibrium phonon-quasiparticle dynamics in the superconductor.

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