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Performance Gains for Superconducting Qubits by Means of Optimal Control Theory[1] ROBERT ROLOFF, WALTER POETZ, Karl-Franzens-Universitaet Graz — Superconducting circuits are promising candidates for the successful implementation of qubit–arrays and qubit–gates within solid–state systems. However, despite recent progress within coherent control of charge, phase and flux qubits, considerable improvement in gate fidelities is needed to build large–scale quantum information processing devices. We present an optimal control scheme based on process tomography, capable of taking into account relaxation, dephasing and unwanted state–leakage within the qubit (array). We apply this theory to explore the performance limits of Josephson charge qubits within current experimental means. Environmental effects, as well as state–leakage, are modeled microscopically, using a full quantum mechanical description and taking into account 1/f and Ohmic fluctuations based on experimental noise spectra. Within time–optimal control theory, we show that under typical conditions gate fidelities of $F = 1 - 10^{-3}$ should be possible for a Josephson charge qubit.

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