Stabilizer quantum error correction toolbox for superconducting qubits

SIMON NIGG, STEVEN GIRVIN, Yale University — Rudimentary quantum error correction (QEC) has been achieved in a superconducting qubit circuit [1]. Realization of topological protection and QEC based on stabilizer codes will require protocols for QND measurement of multi-qubit Pauli operators on arbitrary selected subsets of qubits. Initial progress towards this goal has been achieved with four-qubit stabilizer pumping in a trapped ion system [2]. We present a general protocol for stabilizer measurement and pumping in a system of $N$ superconducting qubits. We assume always-on, fixed dispersive couplings $\chi$ to a single mode of a high-$Q$ microwave resonator in the strong-dispersive limit defined by $\chi \gg 1/T_2, \kappa$, where $T_2$ is the qubit coherence time and $\kappa$ is the cavity line width. In this limit, we show how to measure an arbitrary weight $M \leq N$ Pauli operator, by entangling the multi-qubit state with two distinguishable coherent states of the cavity. Together with a fast cavity readout ($T_{\text{meas}} \ll 1/\kappa$), which can be achieved by tunable coupling to a low-$Q$ cavity mode, this enables the efficient measurement of multi-qubit Pauli operators.


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