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Title: In-situ-controllable dissipators for superconducting quantum electronics

Abstract:

For fast and accurate initialization of qubits, it is of utmost importance to be able to quickly remove any unwanted qubit excitations on demand. Furthermore, a reduction of excess photon population in qubit-coupled resonators is important in tackling shot-noise-induced dephasing. To this end, we recently introduced two devices: (i) a quantum-circuit rerigerator (QCR) [1, 2] and (ii) a tunable heat sink [3]. The QCR is a stand-alone component that can be integrated with most superconducting quantum electric devices without major compromises in their other design criteria. In our experiments, we show how we can tune the dissipation of a superconducting resonator by orders of magnitude just by applying a bias voltage on the refrigerator. The time scale for switching the dissipation on and off is in the nanosecond range. We also observe a tunable broad-band Lamb shift owing to the dissipation induced by the refrigerator. At high bias voltages, we observe that instead of refrigeration, we heat up the resonator mode up to 2.5 K providing an incoherent cryogenic microwave source [3]. For the heat sink [3], we observe that the quality factor of the resonator may be reduced from above 100,000 to a few thousand at 10 GHz in good quantitative agreement with the theoretical model. In the future, we aim to integrate these components with Xmon qubits and to demonstrate fast and accurate initialization [4].

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