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Dissipation engineering in a coherent feedback electromechanical network[1]

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Modern superconducting microwave circuit experiments often consist of a quantum circuit under study, followed by a quantum-limited microwave amplifier. The subfield of quantum electromechanics, in which the quantum circuit is a mechanical resonator coupled to a microwave resonator, is no exception. However, a simple modification of the cables between these devices turns this open-loop, serial network into a fully-cryogenic, coherent feedback network. In effect, this easy-to-build network becomes a brand new kind of device, with useful and novel dynamics. Applied to an electromechanical context, the microwave and electromechanical dissipation is greatly modified through these closed loop dynamics, leading to dynamically tunable and phase-sensitive decay. We experimentally demonstrate that the microwave decay rate may be modulated by at least a factor of 10 at a rate greater than 10^4 times the mechanical response rate. Similarly, the mechanical state can be dynamically squeezed and unsqueezed. While we have only investigated dynamics in the classical regime, we expect analogous behavior in the quantum regime. Finally, this approach is suitable for both 3D and planar architectures. I will describe my observations of this network and the general utility of networks of modular quantum circuits to dissipation engineering.

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