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A dissipative quantum reservoir for microwave light using a mechanical oscillator LASZLO DANIEL TOTH, NATHAN BERNIER, Ecole Polytechnique Federale de Lausanne, ANDREAS NUNNENKAMP, University of Cambridge, ALEXEY FEOFANOV, TOBIAS KIPPENBERG, Ecole Polytechnique Federale de Lausanne — Isolation of a system from its environment is often desirable, from precision measurements to control of individual quantum systems; however, dissipation can also be a useful resource. Remarkably, engineered dissipation enables the preparation of quantum states of atoms, ions or superconducting qubits. Here we realize a dissipative quantum reservoir for microwave light in a circuit electromechanical system. Coupling to this reservoir enables to manipulate the susceptibility of a microwave cavity, corresponding to dynamical back-action control of the microwave field. Additionally, we observe the onset of parametric instability, i.e. the stimulated emission of microwaves (masing). Equally important, the reservoir can function as a useful quantum resource. We evidence this by employing the engineered cold reservoir to implement a large gain (above 40 dB) phase preserving microwave amplifier that operates 0.87 quanta above the limit of added noise imposed by quantum mechanics. We also analyse the system as a frequency converter. Such a dissipative cold reservoir, when coupled to multiple cavity modes, forms the basis of microwave entanglement and squeezing schemes, recently predicted non-reciprocal devices and the study of dissipative quantum phase transitions.

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