Abstract Submitted
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Controlling the temperature and chemical potential for light with laser-cooled motional modes in an optomechanical system[1] CHIAO-HSUAN WANG, JQI, QuICS, and University of Maryland, JACOB TAYLOR, JQI, QuICS, University of Maryland, and National Institute of Standards and Technology — Massless gauge bosons, including photons, do not exhibit particle conservation and thus have no chemical potential. However, in parametrically driven systems, near equilibrium dynamics can lead to equilibration of photons into a thermodynamic ensemble with a finite number of photons. This Gibbs-like ensemble then has an effective chemical potential. Here we build upon this general concept with an optomechanical implementation appropriate for a nonlinear photonic or microwave quantum simulator, as well as a parallel neutral atom approach. We consider how laser cooling of a narrow mechanical mode or atomic motion can provide an effective low frequency bath for other photon modes. In the optomechanical approach, the parametric interaction between the optical system and the low frequency bath is mediated through a beam-splitter coupling between the optical system and another laser-driven photonic mode, which can be potentially realized in a Michelson-Sagnac interferometry design. The engineered matter-light interaction enables control of both the chemical potential – by drive frequency – and temperature – by the effective temperature of the motional mode induced after laser cooling – of the resulting photonic grand canonical ensemble.

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