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Steady-State Superradiant Laser with an Atomic Beam Source[1]
HAONAN LIU, SIMON JGER, JOHN COOPER, ATHREYA SHANKAR, University of Colorado, Boulder, TRAVIS NICHOLSON, National University of Singapore, MURRAY HOLLAND, University of Colorado, Boulder — Steady-state superradiant lasers based on incoherent pumping have been shown to be promising candidates for coherent light sources of ultra-narrow linewidth. However, the incoherent pumping process can lead to many experimental difficulties due to radiative heating and other adverse effects. Here we propose a new type of superradiant laser based on a hot atomic beam. This design may be more straightforward to realize in experiments than in situ repumping, but is also rich in novel collective quantum physics. Specifically, we consider three models of the superradiant beam laser in this work. We first study a benchmark "tight collimated model" and show, both theoretically and numerically, that the superradiant beam laser is indeed a *superradiant laser* in terms of first and second order temporal correlations and superradiant emission. We then explore a mono-velocity model to show quantum phase synchronization as the transverse velocities of atoms decrease below a phase transition point. Finally we show that with a hot atomic beam, the system will recover the benchmark superradiance below the phase transition point.

[1]DARPA Extreme Sensing Program

Haonan Liu
University of Colorado, Boulder

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