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Ultrastable light sources in the crossover from superradiance to lasing[1] MINGHUI XU, DAVID TIERI, MURRAY HOLLAND, JILA, NIST, and Department of Physics, University of Colorado, Boulder — We theoretically investigate the crossover from steady-state superradiance to optical lasing. An exact solution of the quantum master equation is difficult to obtain due to the exponential scaling of the Hilbert space dimension with system size. However, since Lindblad operators in the master equation are invariant under SU(4) transformations, we are able to reduce the exponential scaling of the problem to cubic by expanding the density matrix in terms of an SU(4) basis. In this way, we obtain exact quantum solutions of the superradiance-laser crossover. We use this theory to investigate the potential for ultrastable lasers in the millihertz linewidth regime, and find the behavior of important observables, such as intensity, linewidth, spin-correlation, and entanglement.

Minghui Xu
JILA, NIST, and Department of Physics, University of Colorado, Boulder

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