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Generalized Two-State Theory for an Atom Laser with Nonlinear Couplings

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Abstract: We present a generalized two-state theory to investigate the quantum dynamics and statistics of an atom laser with nonlinear couplings. The rotating wave approximate Hamiltonian of the system is proved to be analytically solvable. The fraction of output atoms is then showed to exhibit an interesting collapse and revival phenomenon with respect to the evolution time, a sign of nonlinear couplings. Several nonclassical effects, such as sub-Poissonian distribution, quadrature squeezing effects, second-order cross-correlation and accompanied violation of Cauchy-Schwartz inequality are also revealed for the output matter wave. The initial global phase of the trapped condensate, in weak nonlinear coupling limits, is found to exert an interesting impact on the quantum statistical properties of the propagating atom laser beam.

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