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Quantum Dynamics of Photoassociation of an Atomic Bose-Einstein Condensate in a Driven Optical Cavity J. MAURICIO CAMPUZANO, CHRISTOPHER P. SEARCH, Stevens Institute of Technology — We seek to compare various formulations of the quantum field dynamics for cavity assisted photoassociation of an atomic Bose-Einstein Condensates inside of a driven optical resonator. Specifically, our Heisenberg equations of motion describe the dynamics of the three coupled bosonic fields for atom, molecules, and photons in which atoms are converted to quantum degenerate molecules via two photon Raman photoassociation. To solve for the nonlinear quantum dynamics, we go beyond mean field theory (MFT) by truncating the BBGKY hierarchy of equations first at second order products of the field operators but also at fourth order products of the operators with the assistance of a pseudo-angular momentum representation (PAM). The approximate quantum dynamics of these higher order beyond-MFT equations are contrasted to exact numerical solutions of the density matrix equations. We show how the beyond-MFT equations are sufficient to describe the initial conversion of atoms into molecules via spontaneous emission of a photon into the cavity mode, which is outside of the scope of MFT. We also analyze squeezing and non-classical cross-correlations between the molecular and cavity fields.

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