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**Analytic quantum dynamics approximating a system of cavity-assisted photoassociated atom-molecule Bose-Einstein condensates** J. MAURICIO CAMPUZANO, MARKO ZIVKOVIC, CHRISTOPHER SEARCH, Stevens Institute of Technology — We explore the quantum dynamics of photoassociation of Bose-Einstein condensed atoms into molecules using an optical cavity field. Inside an optical resonator, photoassociation of quantum degenerate atoms involves the interaction of coupled atom, molecule, and photon quantum fields. Feedback created by a high-Q optical cavity causes the cavity field to become a dynamical quantity, behavior that is linked nonlinearly to the atoms inside, where vacuum fluctuations have a stronger role than in free space. We develop and compare several methods to calculate atom-molecule conversion process dynamics. Introducing an alternate operator representation for the Hamiltonian, we derive an improved mean field theory (MFT), correcting several deficiencies in traditional MFT, and approximate solutions of the Heisenberg-Langevin (HL) equation, properly accounting for cavity field quantum noise. Comparing numerical solutions of the density matrix equations to our HL equation solutions, we also see that the latter gives an accurate description of weakly or undriven cavities where the MTF breaks down. Finally, we show squeezing occurs in the system and investigate the quantum mechanical nature of the system through a comparison of classical and non-classical correlations functions.

J. Mauricio Campuzano
Stevens Institute of Technology

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