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Quantum Coherence of Optomechanical Systems in the Single-photon Strong Coupling Regime[1] DAN HU, School of Natural Sciences, Univ of California, Merced, SHANG-YU HUANG, Dept. of Physics, National Taiwan Univ., JIE-QIAO LIAO, CEMS, RIKEN, Japan, LIN TIAN, School of Natural Sciences, Univ of California, Merced, HSI-SHENG GOAN, Dept. of Physics, National Taiwan Univ. — Optomechanical systems with ultrastrong coupling could demonstrate nonlinear optical effects such as photon blockade. The system-bath couplings in these systems play an essential role in observing these effects. In this work, we use a dressed-state master equation approach to study the quantum coherence of an optomechanical system. In this approach, the system-bath couplings are decomposed in terms of the eigenbasis of the optomechanical system, where the mechanical state is displaced by finite photon occupation. Compared with the standard master equation often seen in the literature, our master equation includes photon-number-dependent terms that induce dephasing. We calculate cavity dephasing, second-order photon correlation, and two-cavity entanglement using the dressed-state master equation. At high temperature, our master equation predicts faster decay of the quantum coherence than with the standard master equation. The second-order photon correlation derived with our master equation shows less antibunching than that with the standard master equation.

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