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Cold Atoms Inside Optical Cavity: Beyond the Semi-classical Treatment CHUANZHOU ZHU, DONG LIN, HAN PU, Rice University — The coupling between the atomic internal pseudo-spin (hyperfine) states and a cavity photon field has been extensively studied in quantum optics. We include the atomic external center-of-mass motion into this quantum optical system and consider the interplay of these three degrees of freedom, with the influences of the cavity pumping and dissipation included. The widely used semi-classical treatment, which neglects the atom-photon entanglement and assumes a coherent photon field, is usually adopted to study this type of atom-photon coupled systems. We examine the validity of the semi-classical treatment by comparing it with a quantum Master equation approach, and show that it is not valid under certain circumstances.

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