Abstract

We have explored different nonclassical and nonlinear effects in optical and optomechanical systems. The possibility of various nonclassical effects such as squeezing, collapse-revival, antibunching, entanglement and EPR steering are reported in different systems. These properties have potential utility in quantum computation technique and information processing. The optomechanical systems are studied here single cavity with mechanical membrane, two coupled cavities with mechanical resonator and optical system having two micro-cavities. The system Hamiltonians are considered here totally quantum mechanical. These Hamiltonians are solved both analytically and numerically. Due to nonlinear interaction systems exhibit different nonclassical effects which are quantified by different nonclassical criteria. The nonclassicalities are studied both in lower as well as higher order for different system parameters such as optomechanical coupling strength, photon hopping strength, weight factor and phase of the input etc. For higher order the degree of nonclassical effects are enhanced. The possible utility of different nonclassical effects via low noise signal, entangled state generation, mechanical squeezing (macroscopic), state transfer, phase precision etc. are reported for different optomechanical systems. The effect of PT-symmetry on different nonclassicalities is illustrated in micro-cavity system. The influence of EP on different nonclassical effects is also reported.

The possible applications of optical system are reported via controlled optical bistability and optically induced transparency. The bistability effect may be explained via

hysteresis of the cavity photon number. The switching characteristics of cavity photon number useful for designing efficient optical switch, optical memory element and optical sensor. The power spectrum of the output field is described via fast Fourier transform. Number of side band may be tuned via different system parameters. The optically induced transparency effect reveals that the system exhibits tunable transparency window. The forward transmission spectra show asymmetric Fano-line profile, which is useful for telecom system.