Acoustic Phonon and Dressed Polariton Interaction in Dispersive and Photonic Band Gap Materials

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Considerable attention has been paid to photonic band gap materials and dispersive (PBGAD) materials due to their unusual optical properties and potential applications [1,2]. In photonic band gap materials [1], the existence of the photonic band gap is due to multiple photon scattering by spatially correlated scatters, while in dispersive materials such as semiconductors and dielectrics, the energy gap is caused by photon coupling to an elementary excitation (excitons, optical phonons etc.) of the media [2]. Recently for the first time, Rupasov and Singh [2] have shown that a polariton-atom bound state and the suppression of spontaneous emission of polaritons exist in a system of polaritons coupled to an atom placed within a frequency dispersive medium. In this paper we study the phenomenon of resonance fluorescence which provides an interesting manifestation of quantum theory of light and has applications making different type of devices. We consider a quantum dot (acts as a two-level atom) is doped in the PBGAD materials and the system is driven by a resonance continuous-wave laser field and the spectral and quantum stastical properties of emitted polaritons by the atom are calculated by using the master equation for the density matrix in the presence of acoustic phonons and poalritons interaction. We found that at low excitation intensity the atom absorbs a polariton at the excitation frequency and remits it at the same frequency. The situation, however, become more interesting when excitation intensity increases and the Rabi frequency associated with the driving field become comparable to or larger that the atomic linewidth. The ground and the excited states of noninteracting atom and polariton split into two states respectively due to atom-field interaction. We call the split states as dressed polaritons states. At a such intensity levels,the spontaneous decay spectrum consists of four transitions lines and two of them give equal contribution. It is also found that the central peak has line width three and half times more than that of two side peaks.

[1] E. Yablonovitch, Phys. Rev. Lett. 58, 2059 (87); S. John, Phys. Rev. Lett. 58, 2486 (87).
[2] I. Rupasov and M. Singh, Phys. Rev. Lett. 77, 338 (1996); Phys. Lett. A (1996).