Two-photon lasing in the dispersive regime of cavity QED

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Semiconductor nanostructures are the main candidates for being sources of special photon states. In this contribution, we consider the dispersive regime of a coherently excited quantum dot embedded in a microcavity. At certain resonant frequencies of the coherent excitation, quantum superpositions of the ground state and n-photon Fock states inside the cavity are obtained, observed as peaks in the cavity populations and the correlation functions.

We focus on the case of possible lasing emission of photon pairs by using a joint master equation description and Monte Carlo simulations. We show that the system can be brought to emit light in a regime in which the dominant emission corresponds to two correlated, successive photons (within a coherence time provided by the cavity decay rate). Such emission dominates over all other types of emission, in particular, that of single uncorrelated photons.

An analysis of the various regimes of operation around this two-photon resonance is carried out to discuss the adequacy of the standard correlation functions (such as $g^{(2)}(\tau)$) to describe the light actually emitted by the system; in particular, we show that extremely large values of bunching are not a guarantee of a useful two-photon emission.

Prospects of higher n-photon laser devices and figures of merits for technological applications, such as quantum lithography, are discussed.

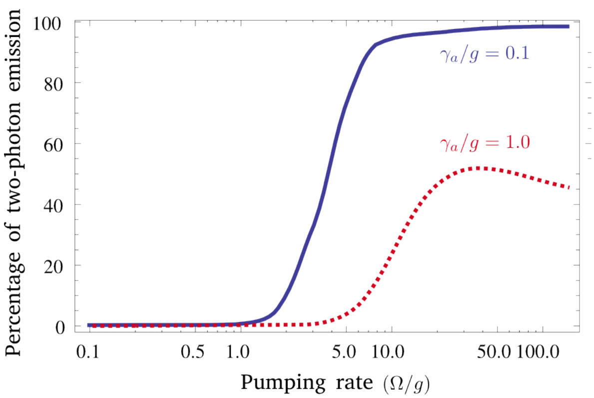

Figure 1: Fraction of two-photon emission over all other types of emission as a function of pumping in a cavity QED system with a low (dotted red) and high (solid blue) Q factor of the cavity. In a good enough system, all the light is emitted as two-photons, thereby realizing a pure two-photon laser.