Collective effects in nanolasers: Steady-state characteristics and photon statistics

In the traditional rate equation-approach to nanolasers, the active material is modelled as a collection of independent emitters [1], but in recent years it has become increasingly clear that radiative coupling of the emitters in the cavity can significantly change the characteristics of a (nano)laser under certain conditions [2-5]. The collective effects arising as an emitter-emitter coupling are known to cause a reduction in the steady-state intensity for small values of the pump rate [2, 3], which means the effective jump at threshold becomes larger. As a result, the fraction \(\beta\) of spontaneous emission going into the lasing mode, usually associated with the inverse of the height of this intensity jump, is potentially underestimated in a model neglecting collective effects. Additionally, recent experiments and numerical models [3, 5] show that the inclusion of collective effects leads to super-thermal values of the photon auto-correlation function \(g^2(0)\), i.e. values larger than \(g^2(0) = 2\) associated with thermal radiation.

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