QUANTUM KINETICS OF SPIN-POLARIZED POLARITONS IN MICROCAVITIES

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A remarkable peculiarity of exciton-polaritons in microcavities consists in a possibility of final state stimulation of their scattering that makes both energy and spin relaxation subject to non trivial bosonic effects. Recent experiments have shown picosecond-scale oscillations in circular polarization degree of emission from microcavities under resonant [1] or non-resonant polarized pumping [2]. Recently we have published a theoretical work [3] presenting the spin-density matrix technique which allowed one to describe polariton spin relaxation under non-resonant excitation taking into account polariton coupling with acoustic phonons.

In the present work we present a new, more general formalism accounting for polariton-polariton scattering as well and allowing to describe also the "optical parametric oscillator" regime [1] where resonant polariton-polariton scattering dominates over other relaxation mechanisms. Our approach is based on the Lindblad-type equation [4] which is obtained from the standard density matrix Liouville equation by iterating it once and applying Born-Markov approximation and can be presented in the following form

$$\dot{\rho}(t) = -\frac{1}{\hbar^2}\int_{-\infty}^{t}\left[\hat{H}(t),\left[\hat{H}(\tau),\rho(t)\right]\right]d\tau.$$

Here $\hat{H}(t)$ is the Hamiltonian in the interaction representation. Starting from this equation one can derive set of kinetic equations for the occupation numbers and pseudospin components of the exciton polaritons.

Derived equations allow us to describe the spin-dynamics of exciton-polaritons in semiconductor microcavities in the strong coupling regime.

We describe both the "polariton laser" regime (non-resonant excitation) and "optical parametric oscillator" regime (resonant excitation at the magic angle). We obtain a good agreement with experimental data on dynamics of polarization of light emitted by microcavities.

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