Optical Limiting in Coherently Driven Exciton-Polaritons

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Optical limiting is a process in which the transmission of a material decreases with incident light intensity. In order to observe the limitation process, a material with nonlinear effects is required.

Optical cavities in strong light-matter coupling regime have demonstrated high nonlinear effects. The strong coupling between exciton in a quantum well and photon in a cavity results in the formation of exciton-polariton modes. The nonlinear effects in this system results from Kerr nonlinearities due to polariton-polariton interactions. When the cavity is coherently driven by a laser, a bistable hysteresis loop in input-output characteristics has been observed [1, 2].

In this work we show a unique type of inverted bistability together with the optical limiting effects in exciton-polariton microcavities. We excite the cavity with laser energy (ω_L) below the lower polariton energy mode (E_{LP}), where the laser detuning satisfies condition E_{LP} - ω_L < $\sqrt{3}\ \gamma_P$, where γ_P is the polariton linewidth. In such a regime a linear increase in transmitted light is observed and the system is in the strong coupling regime. At certain incident light intensity a transition from the strong to weak regime is observed accompanied with a sharp decrease of transmitted light intensity. This behavior is assisted by a formation of a hysteresis loop. The direction of those hystereses is inverted in respect to those resulting from the Kerr nonlinearities. Our results prove that microcavity optical limiter can be used for optical switches, optical information transfer or in memory systems.

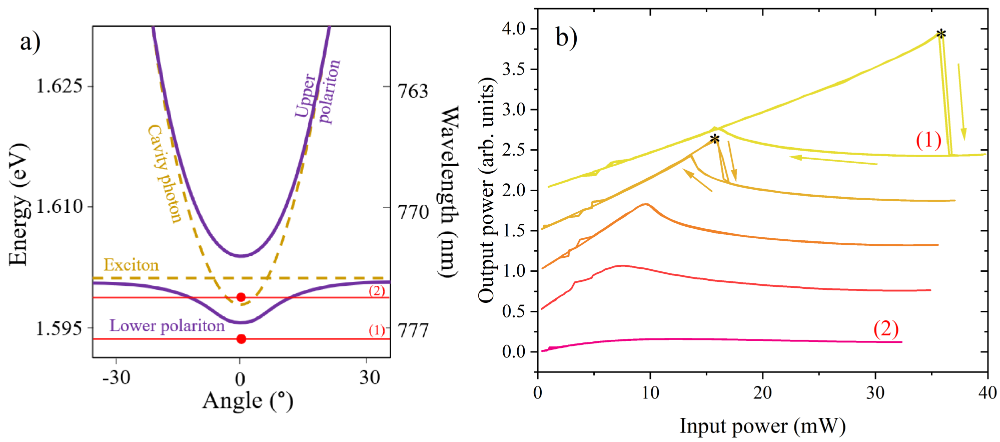

Figure: a) Scheme of the dispersion relation with the laser energies marked for hysteresis where the limitation process is observed (point 1) and for linear response of the system (point 2), panel b) shows the experimental results for the formation of inverted hysteresis.

[1] H. M. Gibbs, *NY Academic*, Optical Bistability: Controlling Light with Light (1985).

[2] A. Baas et al., *Physical Review A* **69**, 023809 (2004).