Multimode physics in confined microcavity polariton systems

Claudéric Ouellet-Plamondon

Institute of Physics, École Polytechnique Fédérale de Lausanne (EPFL), CH-1015 Lausanne, Switzerland

Microcavity polaritons, quasiparticles that arise from the strong coupling of a quantum well exciton to a microcavity photon, is a fascinating platform for studying light-matter interaction. These quasiparticles inherit the properties of both constituents: a small effective mass due to the photon part and nonlinear interactions due to the exciton part. In particular, polariton-polariton interaction greatly modifies the optical response of the system, leading to effects like optical bistability and spin multistability [1]. Although planar microcavity is a single mode coupling system, there are many situations where multimode coupling occurs. For instance, a multiplicity of polariton modes can be obtained in microcavities where the photon field is confined.

In this talk, I will present recent results obtained with resonantly driven laterally confined microcavity polaritons, in cases where the multimode aspect of the systems cannot be avoided. First, I will demonstrate a different type of optical multistability where all the steady states of the multihysteresis curve have a distinct spatial profile [2]. This effect occurs when a series of confined polariton modes are resonantly excited and the excitation power is cycled. Through this experiment, I will show that this effect is a consequence of polariton-polariton cross interaction: orthogonal polariton modes interact with one another at large densities.

In the second part of the talk, I will focus on the effect of dephasing on confined polaritons [3]. I will show that the polariton hysteresis loop collapses in a similar way when increasing the temperature or under non-resonant excitation power. This effect is explained by the population of an incoherent reservoir that induces dephasing and repulsive interaction. For both part of the talk, the experimental results are analyzed using a multimode generalization of the polariton mean field equations.

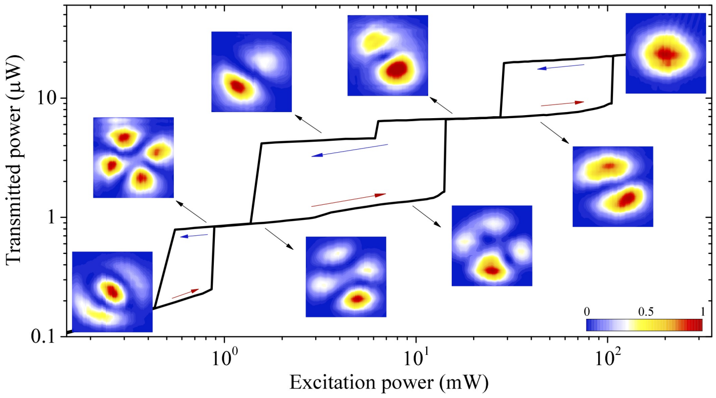

FIG. 1. Spatial multistability measured on a 9 μm mesa. The black curve shows the multi-hysteresis cycle when we integrate spatially the transmitted signal. Each colormap represents the spatial profile measured at the energy of the transmitted laser for the specific power indicated by the black arrows.

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[1] T. Paraiso *et al.*, *Nat. mater.* **9**, 655 (2010). H. Abbaspour *et al.*, *Phys. Rev. B* **92**, 162303 (2015).
[2] C. Ouellet-Plamondon *et al.*, *Phys. Rev. B* **93**, 085313 (2016).
[3] C. Ouellet-Plamondon *et al.*, *Accepted for publication in Phys. Rev. B.*