PHD GRANT

Differential ultrafast mode switching in micropillar cavities

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LABORATORIES : INAC, NEEL

The injection of free carriers can change the resonance frequency of a semiconductor optical microcavity reversibly within few ps. While cavity switching dynamics is commonly probed using pump-probe spectroscopy, we have introduced a novel approach using quantum dots as a broadband internal light source. The analysis of the cavity emission using a spectrometer and a streak camera (Fig.) probes the switching dynamics of all cavity modes in a single experiment. We have also studied the effect of a strongly inhomogeneous distribution of the injected electron/hole pairs. We observe drastically different switching amplitudes and dynamics for different cavity modes, that we quantitatively model through the different overlaps between free carriers and field intensity distributions.

Non-uniform free carrier switching appears as a powerful tool to tailor the modal structure of a cavity and the switching dynamics of each mode. This is an interesting novel feature in view of applications of cavity switching in quantum optics. For instance, it provides an additional degree of freedom for controlling in time the interaction between quantum dots and a microcavity mode, and it is currently used in our lab to generate ultrashort non-coherent pulses of spontaneous emission.

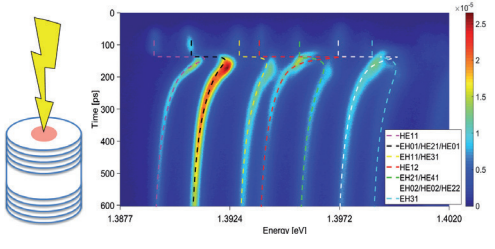

Fig: Streak camera image showing the temporal evolution of various cavity modes frequencies, after the localized injection of free carriers around the axis of a GaAs-AlAs micropillar at 130 ps. The result of numerical simulations is shown by dashed lines

OUTCOMES

[1] Cavity switching: A novel resource for solid-state quantum optics, Proceedings of ICTON 2017, IEEE Book series DOI10.1109/ICTON.2017.8025177

Invited oral presentations : ICNN, Yokohama (2016); SPIE10111 Photonics West, San Francisco (2017); ICTON, Girona, Spain (2017).

Collaboration: W. L. Vos, University of Twente, Netherlands.

Leverage: Novel collaboration with PUC Rio (Brazil) on frequency translation experiments in switched optical microcavities (joint PhD thesis G. Monteiro Torelly).