TRR 142
Tailored Nonlinear Photonics

TRR Guest Scientist Lecture / Seminar

Date/Time: 09.04.2018 / 13:00 Uhr
Location: Paderborn, A1.322

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Coherent Spectroscopy of a Semiconductor Microcavity

Abstract:

Semi conductor microcavities are of interest for their strong enhancement of optical emission and as platforms for exploring novel quantum phases. A planar semiconductor micocavity is comprise of a quantum well, with its quantum-confined exciton resonance (X), and a wedged λ-cavity that allows for the cavity mode (γ) to be detuned with respect to the exciton resonance. Normal-mode splitting leads to generation of exciton-polariton branches, with their signature anti-crossing behaviour, associated with fast energy transferred back and forth between the exciton and photon that lifts the degeneracy. In our experiments, we use three 100-fs pulse in a box geometry for four-wave mixing measurements, with phase control and heterodyne detection, to perform two-dimensional coherent spectroscopy (2DCS).[1] Rephrasing spectra reveal quantum interference between the upper and lower polariton branches. 2DCS are recorded over a 12-nm detuning range.[2] Close to zero detuning the two diagonal features are nearly identical (especially in terms of line width characteristics), when away from zero detuning the two exciton modes are either more photonic or excitonic, in agreement with Hopfield coefficients. When the cavity mode is lower in energy than the exciton, a biexciton (XX) feature is clearly distinguishable. At small positive detuning the lower polariton branch is tuned through the energy of the biexciton binding, leading to a repulsive and attractive potential analogous to a Feshbach resonance in ultracold atomic physics. This response shows up most clearly in the off-diagonal (interaction) features. This study sets the stage for investigating novel quantum phases using this sophisticated 2DCS technique.

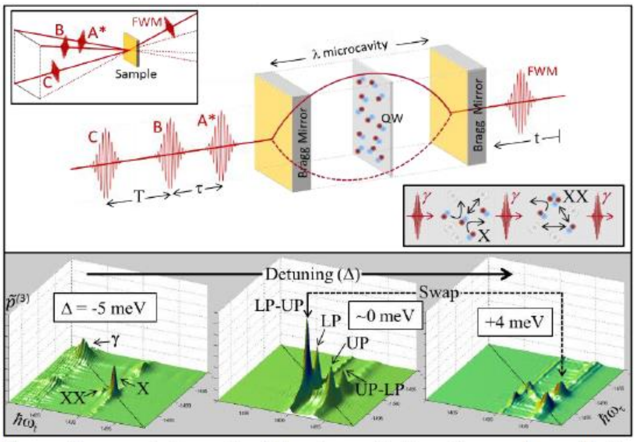

Figure Top panel shows the interaction with three laser pulses with the microcavity to generate a four-wave mixing signal. Bottom panel shows the resulting two-dimensional coherent spectra of the exciton (X), cavity (γ) and biexciton (XX) resonances transitioning into lower- (LP) and upper-polariton (UP) modes with cavity detuning (Δ).

References

1. Bristow, A. D. et al. A versatile ultrastable platform for optical multidimensional Fourier-transform spectroscopy. Rev Sci Instrum 80, 073108–8 (2009).
2. Wilmer, B. L., Passmann, F., Gehl, M., Khitrova, G. & Bristow, A. D. Multidimensional coherent spectroscopy of a semiconductor microcavity. Phys. Rev. B 91, 201304(R) (2015).

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