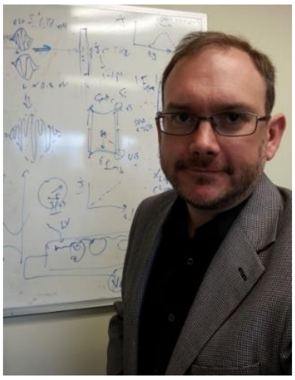
TRR 142
Tailored Nonlinear Photonics

TRR Guest Scientist Lecture / Seminar

Date/Time: 25.06.2015 / 2pm
Location: TU-Do, P1-02-111



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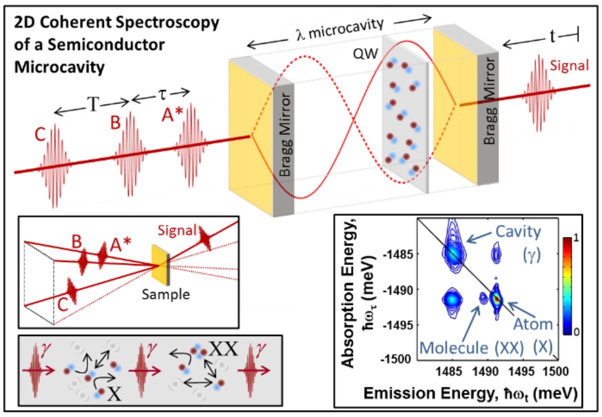
Two-Dimensional Coherent Spectroscopy of a Semiconductor Microcavity

Abstract:
Semiconductor microcavities are of interest for their strong enhancement of optical emission and as platforms for exploring novel quantum phases. Our planar semiconductor micocavity system 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



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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

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).

Alan D. Bristow received a Ph.D. in Physics from the University of Sheffield in 2004. He was a Postdoctoral Fellow at the University of Toronto from 2003-2006 and a Research Associate at JILA (a division of National Institute of Standards and Technology on the campus of the University of Colorado - Boulder) from 2006 to 2010. He was an Adjunct Instructor at Colorado School of Mines in 2009 and has been an Assistant Professor at West Virginia University since 2010. Dr. Bristow leads the Ultrafast Nanophotonics Group at WVU, studying light-matter interaction in nanoscale materials. Dr. Bristow is a member of the American Physical Society and the Optical Society of America.

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