HL 82: Focus Session: Semiconductor-based Quantum Communication II

(Continuation of Part I)

Time: Thursday 15:00–16:30 Location: ER 164

Invited Talk HL 82.1 Thu 15:00 ER 164
Quantum dot - nanocavity QED for quantum information processing — •Jelena Vuckovic — Ginzton Laboratory, Stanford University, Stanford, CA 94305-4088

Single quantum dots (QDs) in photonic crystal nanocavities are interesting both as a testbed for fundamental cavity quantum electrodynamics (QED) experiments, as well as a platform for quantum and classical information processing. In addition to providing a scalable, on-chip, platform, these systems also enable large dipole-field interaction strengths, as a result of the localization of the field to very small optical volumes. Such a platform could be employed to demonstrate a number of devices, including nonclassical light sources, electro-optic modulators and switches operating at the single photon level, and quantum gates. QD-cavity QED systems also exhibit interesting phonon-assisted off-resonant interaction between the QD and the cavity which can be employed for spectral filtering, as well as for coherent optical spectroscopy and quantum dot state readout, thereby overcoming issues coming from quantum dot inhomogeneous broadening. In order to make the platform compatible with fiber-optic telecommunication wavelengths, the intrinsic optical nonlinearity of the semiconductor employed to make a nanocavity can be employed for frequency conversion.

Topical Talk HL 82.2 Thu 15:30 ER 164
The Single-Quantum-Dot Laser — •Christopher Gies[1], Matthias Florian[1], Paul Gartner[1,2], and Frank Jahnke[1] — [1]Institut für Theoretische Physik, Universität Bremen — [2]National Institute of Materials Physics, Bucharest-Magurele, Romania

A single quantum-dot emitter coupled to a single microcavity mode represents a model system for fundamental quantum optical effects and various applications. We study the emission properties of this system for different excitation regimes from a single-photon source to lasing on the basis of a semiconductor model. As a function of the excitation conditions we investigate the onset of stimulated emission, the possibility to realize stimulated emission in the strong-coupling regime, as well as the excitation-dependent changes of the photon statistics and the emission spectrum. The role of possible excited charged and multi-exciton states and the different sources of dephasing for various quantum-dot transitions are discussed.

Topical Talk HL 82.3 Thu 16:00 ER 164
Coherence and photon statistics of the Mollow triplet sideband emission of a quantum dot — •Sven M. Ulrich, Ata Ulhaq, Stefanie Weiler, and Peter Michler — Institut für Halbleiteroptik und Funktionelle Grenzflächen (IHFG), Universität Stuttgart

Analysis and minimization of dephasing processes in quantum light emitters is a central research issue for future quantum information processing schemes. Single quantum dot (QD) resonance fluorescence has proven to be nearly Fourier transform-limited for excitation powers below emitter saturation [1]. Here we present detailed investigations of QD resonance emission above saturation, where the 'dressed' character confirms by the so-called Mollow triplet. Single InGaAs/GaAs QDs in planar waveguide structures and high-quality pillar cavities have been studied. By high-resolution photoluminescence, we trace Mollow triplet spectra under variable excitation powers and detuning conditions. Photon correlation measurements demonstrate both 'single' and 'cascaded' emission from the Mollow triplet sidebands. By laser detuning the very bright emission can be frequency-tuned over 15 times its linewidth. Furthermore, the effect of dephasing in terms of systematic spectral broadening of the triplet sidebands and oscillation damping in g(1) coherence are observed as a strong fingerprint of excitation-induced dephasing [2]. Our results are consistent with predictions of a recently presented model on phonon-dressed QD Mollow triplet emission in the cavity QED regime [3]. [1] S. Ates et al., Phys. Rev. Lett. 103, 167402 (2009). [2] S.M. Ulrich et al., Phys. Rev. Lett. 106, 247402 (2011). [3] C. Roy and S. Hughes, Phys. Rev. Lett. 106, 247403 (2011).