HL 2: Semiconductor Optics (joint session HL/TUT)

The field of semiconductors optics explores the interaction of semiconductors and their nanostructures with light. This includes on the one hand the optical control of semiconductors via light fields. On the other hand, semiconductors can act as light sources like lasers or single and entangled photon sources. In particular the latter plays a decisive role for applications in photonic quantum technology and often a quantum description of the semiconductor and the light field is required to describe the underlying physics. In the tutorial "Semiconductor Optics" various aspects of light-matter interaction in nanostructures will be discussed from both the experimental and theoretical point of view.

Organizers: Doris Reiter (U Münster) and Stephan Reitzenstein (TU Berlin)

Time: Sunday 16:00–18:25 Location: H 1058

Tutorial HL 2.1 Sun 16:00 H 1058
Quantum dots for photonic quantum technologies — •Peter Michler — Institut für Halbleiteroptik und Funktionelle Grenzflächen, University of Stuttgart, Allmandring 3, 70569 Stuttgart, Germany

This tutorial aims to provide a general introduction to the physics of quantum dots and an overview of recent exciting developments in the field of semiconductor quantum optics with quantum dots (QDs). Semiconductor QDs have been identified as promising hardware for implementing the basic building blocks of novel quantum technologies, such as quantum computing, quantum communication, quantum metrology and quantum sensing. This is because individual charge carriers in QDs can be generated, manipulated, and coherently controlled. Moreover, miniaturized and integrated solutions with existing semiconductor technology are foreseeable. The topics addressed in this tutorial are two-photon interference with remote QDs, quantum dots in photonic integrated circuits, quantum sensing with QD photons, and hybrid atom-quantum dot systems.

5 min. break

Tutorial HL 2.2 Sun 16:50 H 1058
Non-classical light emission and superradiant emitter coupling in semiconductor nanolasers — •Frank Jahnke — Institute for Theoretical Physics, University of Bremen, 28334 Bremen, Germany

Quantum effects of the light-matter interaction in nanolasers can lead to highly unusual effects not known in conventional lasers, such as a strongly reduced laser threshold and non-classical light emission. The emission properties can be characterized using the second-order photon correlation function $g^{(2)}$. Lasers usually exhibit a change from $g^{(2)} = 2$ for thermal light to $g^{(2)} = 1$ for coherent emission. For a nanolaser with a small number of atom-like quantum-dot emitters in an optical cavity we demonstrate that radiative coupling of the emitters via the cavity field can establish a superradiant state of the active material, which reveals itself via a giant photon bunching with $g^{(2)} >> 2$ in the emitted radiation. Furthermore, superradiant pulse emission and excitation trapping are demonstrated for quantum-dot based nanolasers.

[1] J. Wiersig, C. Gies, F. Jahnke, M. Aßmann, T. Berstermann, M. Bayer, C. Kistner, S. Reitzenstein, C. Schneider, S. Höfling, A. Forchel, C. Kruse, J. Kalden, and D. Hommel, Nature 460, 245 (2009).

[2] F. Jahnke, C. Gies, M. Aßmann, M. Bayer, H.A.M. Leymann, A. Foerster, J. Wiersig, C. Schneider, M. Kamp, and S. Höfling, Nature Communications 7, 11540 (2016).

5 min. break

Tutorial HL 2.3 Sun 17:40 H 1058
Semiconductor spin-photon interfaces for quantum repeaters and cluster state generation — •Ruth Oulton — QET Labs, School of Physics and Department of Electrical and Electronic Engineering, University of Bristol, Tyndall Avenue, Bristol, BS8 1FD, UK

In this tutorial I will describe how one may use the spin of carriers in semiconductor quantum dots to store quantum information, and transfer or entangle that information with the polarization state of a photon. With efficient photonic structure surrounding the quantum dot, one may efficiently entangle a photon input into the structure with the QD a spin-photon interface. This is the basic building block of many functionalities, including a means to achieve a quantum repeater in quantum communication networks, and to generate entire strings of photons, all of which are entangled with each other after interacting with a mediating spin.