Q 23: Photonik 1

Time: Tuesday 10:30–12:45 Location: V38.01

Q 23.1 Tue 10:30 V38.01

Low temperature studies of charge dynamics of nitrogen-vacancy center — •Petr Siyushev[1], Adam Gali[2], Fedor Jelezko[3], and Jörg Wrachtrup[1] — [1]3. Physikalisches Institut and Research Center SCOPE, University of Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart, Germany — [2]Research Institute for Solid State Physics and Optics, Hungarian Academy of Sciences, 1525 Budapest, Hungary — [3]Institut für Quantenoptik, Universität Ulm, Ulm D-89073, Germany

Nitrogen-vacancy center duo to its exceptional properties is a promising candidate for quantum information processing, quantum metrology, nanoscale magnetometery and electric field sensing. Nevertheless, all applications mentioned above relate to one particular charge state, namely negative, whereas NV center can occur in at least two: negative and neutral. Therefore, it is highly desirable to understand charge switching mechanism of the defect. We show direct evidence of the photoionization process of a single NV^- center under resonant excitation via photoluminescence excitation spectrum detection of its neutral counterpart. It is found that excitation of NV^0 at its zero-phonon line leads to recovering of the negative charge state. This type of conversion allows significantly improve spectral stability of NV^- center. Moreover, charge state can be deterministically prepared. New model of charge switching, not involving any additional impurities close to NV defect, is tentatively proposed.

Q 23.2 Tue 10:45 V38.01

Coupling of colour centres to photonic crystal cavities in diamond — •Laura Kipfstuhl[1], Janine Riedrich-Möller[1], Christian Hepp[1], Elke Neu[1], Martin Fischer[2], Stefan Gsell[2], Matthias Schreck[2], and Christoph Becher[1] — [1]1Universität des Saarlandes, Fachrichtung 7.2, 66123 Saarbrücken — [2]Universität Augsburg, Experimentalphysik IV, 86159 Augsburg

Colour centres in diamond are a very attractive system for realisation of basic building blocks for quantum information processing. Many of the proposed schemes, e.g. cavity enhanced single photon sources, cavity based spin measurements or optical qubits in quantum networks, require coupling of color centres to a cavity mode of high quality factor and small mode volume. Photonic crystal cavities directly fabricated in single crystal diamond allow for such coupling with high efficiency and low losses.

Here we present the fabrication of 1D and 2D photonic crystal cavities in single crystal diamond grown on iridium. Free-standing diamond membranes are produced with dry-etching techniques and patterned by focussed ion beam milling. We realise 1D nanobeam cavities in freestanding waveguides as well as 2D cavities. The experimentally obtained Q-factors are up to 700 with modal volumes on the order of one cubic wavelength. The resonance wavelength of both cavity types can be shifted up to 15 nm in a controlled post-processing procedure. Using this procedure, we tune a cavity mode of a 2D cavity into resonance with the zero phonon line of an ensemble of intrinsic SiV centres and observe a Purcell enhancement of the spontaneous emission.

Q 23.3 Tue 11:00 V38.01

Spectroscopy of caesium atoms using optical microfibres — •Jan Hartung, Konstantin Karapetyan, Ulrich Wiedemann, Wolfgang Alt, and Dieter Meschede — Institut für Angewandte Physik, Universität Bonn

We present our results of using optical microfibres for evanescent field spectroscopic measurements of a heated atomic caesium vapour. For this purpose we place a tapered optical fibre in a vacuum chamber where the evanescent field of the fibre waist interacts with the hot caesium vapour. In linear absorption spectroscopy, Doppler-broadened absorption of up to 90% has been observed at 80°C.

With counterpropagating pump and probe light in the microfibre we want to realise Doppler-free saturation spectroscopy. The small extension of the evanescent field (abt. 300nm) makes this experiment sensitive to effects of short transit times, reduced optical pumping, and surface effects such as Van-der-Waals shifts.

Q 23.4 Tue 11:15 V38.01

Universal Dynamics of Kerr-Frequency Comb Formation in Microresonators — •Tobias Herr[1], Klaus Hartinger[1,2], Johann Riemensberger[1], Christine Wang[2,3], Emanuel Gavartin[1], Ronald Holzwarth[2,3], Michael Gorodetsky[4], and Tobias Kippenberg[1,3] — [1]École Polytechnique Fédérale de Lausanne (EPFL), 1015 Lausanne, Switzerland — [2]Menlo Systems GmbH, Am Klopferspitz 19a, 82152 Martinsried, Germany — [3]Max-Planck-Institut für Quantenoptik, 85748 Garching, Germany — [4]Faculty of Physics, Moscow State University, Moscow 119991, Russia

Optical frequency combs allow for precise measurement of optical frequencies and are used in a growing number of applications beyond spectroscopy and frequency metrology. A new class of frequency comb sources is based on parametric frequency conversion in optical microresonators via the Kerr nonlinearity. A severe limitation in experiments working towards applicable systems is phase noise, observed in the form of linewidth broadening and multiple radio frequency beat notes. These phenomena are not explained by current theory of Kerr-comb formation, yet this understanding is crucial to maturing Kerr-comb technology. In this work we employ both crystalline MgF_2 and planar Si_3N_4 microresonators to experimentally investigate the origin of broad and multiple RF beatnotes. We reveal a universal platform independent behavior in Kerr-comb generators, based on the interplay of four-wave mixing and dispersion. Finally, we provide a quantitative condition for low phase noise performance.

Q 23.5 Tue 11:30 V38.01

Fiber Bragg grating resonator with integrated optical nanofiber for cavity quantum electrodynamics experiments — •Christian Wuttke[1], Martin Becker[2], Sven Brückner[2], Manfred Rothhardt[2], and Arno Rauschenbeutel[1] — [1]VCQ TU Wien – Atominstitut, Stadionallee 2, A-1020 Wien — [2]Institut of Photonic Technologies, Albert-Einstein-Str. 9, D-07745 Jena

Subwavelength diameter optical fibers have proven to be a powerful tool for the efficient coupling of light and matter due to the strong lateral confinement of the light field. The coupling can be further enhanced with a resonator that also confines the light along the fiber. Such a resonator is highly attractive because the strong coupling regime of light and matter can be reached even with a moderate finesse of about 30. In this case, fiber Bragg gratings (FBGs) are a advantageous candidate as mirrors: They are fiber-integrated and can be tailored for a range of wavelengths and reflectivities. We present a realization of such a nanofiber resonator for a design wavelength of 852 nm based on two FBG mirrors which enclose a tapered optical fiber with a subwavelength-diameter waist. The resonator has a monolithic design and is intrinsically mode-matched to the fiber mode while being simultaneously tunable over many free spectral ranges.

We gratefully acknowledge financial support by the Volkswagen Foundation and the ESF.

Q 23.6 Tue 11:45 V38.01

Fiber based optical microcavities for spectroscopy of nanoscale systems — •David Hunger[1,2], Hanno Kaupp[1,2], Matthias Mader[1,2], Christian Deutsch[1,2], Louis Costa[1,2], Jakob Reichel[3], and Theodor W. Hänsch[1,2] — [1]Ludwig-Maximilians-Universität München, Deutschland — [2]Max-Planck Institut für Quantenoptik, Garching, Deutschland — [3]Laboratoire Kastler Brossel, E.N.S, Paris, Frankreich

We introduce fiber-based Fabry-Perot optical microcavities [1] as a versatile tool to study the optical properties of individual nanoscale solid state systems. This type of cavity benefits from full tunability, free space access to cavity modes, a mode volume on the order of a few tens of wavelengths cubed, and optical quality factors exceeding 10^6. In our experiments we want to use these exceptional properties to study nanoscale systems with high sensitivity and to realize strong light-matter interactions.

We show first experimental results on absorption spectroscopy of individual gold nanoparticles and report first steps towards the observation of cavity enhanced emission of NV color centers in diamond.

[1] Hunger, Reichel *et al.*, NJP **12**, 065038 (2010)

Q 23.7 Tue 12:00 V38.01

Silicon electro-optic modulators based on one-dimensional photonic crystals — •Aws Al-Saadi, Bülent Franke, Sebastian Kupijai, Ulrike Woggon, Hans Eichler, and Stefan Meister —

Technische Universität Berlin, Institut für Optik und Atomare Physik, Berlin, Germany

Electro-optic modulators based on a 1-D photonic crystal microresonators are fabricated in sub-micrometer silicon-on-insulator (SOI) rib waveguides. Modulation results from change of the carrier density inside the resonator cavity due to applied an electric field produced by a p-i-n diode formed inside the resonator cavity. Carrier density variations result in refractive index changes which lead to shift of the transmission peak of the resonator. The intensity of the transmitted light can therefore be modulated. We study the influence of the intrinsic width of the modulator p-i-n diode on the modulation depth, speed, absorption losses as well as power consumption. Theoretical and experimental results will be presented.

Q 23.8 Tue 12:15 V38.01

A pick-and-place technique for the assembly of integrated quantum optical hybrid devices — •Andreas W. Schell, Günter Kewes, Janik Wolters, Tim Schröder, Thomas Aichele, and Oliver Benson — Nanooptik, Humboldt-Universität zu Berlin, Deutschland

Combining pre-selected nanoparticles with nano-or microstructures produced in a top down process is an important but challenging step in the production of hybrid devices for nano-optics. Here, a pick-and-place technique for the controlled bottom up assembly of integrated quantum optical devices based on atomic force microscopy combined with optical confocal microscopy is introduced [1]. This technique allows for the placement of nanoparticles on nearly arbitrarily shaped samples. By coupling nitrogen vacancy defect centers in diamond nanocrystals, which are capable of emitting single photons, to photonic and plasmonic structures like photonic crystals, photonic crystal fibers or nanoantennas using this pick-and-place technique, hybrid quantum optical elemements are produced.

[1] A.W. Schell et al., Rev. Sci. Instrum. 82, 073709 (2011).

Q 23.9 Tue 12:30 V38.01

Interference, Couping and Switching of Higher Order Modes in Asymmetric Dimers — •Martina Abb[1], Yudong Wang[2], Kees C. H. de Groot[2], Javier Aizpurua[3], and Otto Lambert Muskens[1] — [1]SEPnet and the Department of Physics and Astronomy, University of Southampton, United Kingdom — [2]School of Electronics and Computer Science, University of Southampton, United Kingdom — [3]DIPC and CSIC-UPV/EHU, Donostia-San Sebastian, Spain

Plasmonic nanoantennas are receiving enormous interest for their capacity of controlling light on the nanoscale [1]. Like many other nanostructures, they sustain both radiative (bright) and nonradiative (dark) modes. Here, we present a comprehensive study of coupling and interference of higher order modes, both radiative and nonradiative in asymmetric dimers for the first time.

Based on a full electromagnetic calculation including retardation, we explore the coupling behaviour of dark and bright modes in coupled nanorods depending on gap size and mode position. We also show experimental proof of the interaction between the first three modes in lithographically designed asymmetric nanoantenna dimers. Furthermore, we present the corresponding nonlinear response of our coupled asymmetric nanorod system when placed on a photoexcitable semiconductor (see [2] for earlier work).

[1] P. Mühlschlegel, H.-J. Eisler, O. J. F. B. Martin, B. Hecht and D. W. Pohl, Science **308**, 1607 (2005).

[2] M. Abb, P. Albella, J. Aizpurua and O. L. Muskens, Nano Lett. **11**, 2457 (2011).