Q 26: Quantum Optics IV

Time: Tuesday 14:30–16:00 Location: P 5

Q 26.1 Tue 14:30 P 5

Spectral intensity correlations of broadband amplified spontaneous emission from superluminescent diodes — •Patrick Janassek, Sébastien Blumenstein, and Wolfgang Elsässer — Institute of Applied Physics, Technische Universität Darmstadt, Germany

The intensity correlations of broadband light play an important role in understanding the physics of the emission processes. Photons emitted by thermal light sources show the well-known bunching effect which leads to a second-order coherence degree of $g^{(2)}(0) = 2$. However, the measurement of high-order coherence functions of broadband light sources such as superluminescent diodes (SLD) is particular challenging due to the very short correlation timescales. By exploiting two-photon-absorption (TPA) interferometry[1] the intensity correlations of the amplified spontaneous emission (ASE) from SLDs with THz-wide optical spectra can be measured. Here, we present experiments on varying spectral intensity correlations of SLD light. Within a TPA Mach-Zehnder interferometer configuration, intensity cross-correlation functions between different spectral components $g^{(2)}(\tau, \lambda)$ are determined. We observe a continuous reduction of the second-order coherence degree with increasing spectral separation of selected spectral windows measured by introducing variable bandpass filters in both arms of the interferometer. These observations suggest the existence of frequency correlations of bunched photons from ASE of SLDs.

[1] F. Boitier, A. Godard, E. Rosencher, and C. Fabre, Nat. Phys. 5, 267 (2009)

Q 26.2 Tue 14:45 P 5

Spectrally filtered photon pairs cannot be both pure and efficient — •Evan Meyer-Scott, Nicola Montaut, Linda Sansoni, Harald Herrmann, Tim J. Bartley, and Christine Silberhorn — Universität Paderborn, Integrierte Quantenoptik, Warburger Str. 100, D-33098 Paderborn

Photon pairs from spontaneous parametric down conversion or four-wave mixing are widely employed in quantum cryptography, quantum computing, and fundamental physical tests. For photons from separate sources to interfere, for example for entanglement swapping, linear optical quantum computing, or quantum walks, the photons must be spectrally pure. This requires that the frequency of each photon in the pair be uncorrelated with the other's, which can be achieved by narrowband filtering each photon. Here we show that this filtering comes at a direct cost of heralding efficiency, the efficiency to detect one photon of the pair given a detection of the other. We find this effect is fundamental rather than technical, and independent of filter shape and filter, pump, and phasematching bandwidth, but can be eliminated by source engineering to bring the phasematching angle to a certain range. We support our analytical and numerical results with an experiment that directly shows the tradeoff between purity and heralding efficiency.

Q 26.3 Tue 15:00 P 5

Synchronization of Active Atomic Clocks via Quantum and Classical Channels — •Alexander Roth and Klemens Hammerer — Leibniz University Hannover

Superradiant lasers based on atomic ensembles exhibiting ultra-narrow optical transitions can emit light of unprecedented spectral purity and may serve as active atomic clocks. We consider two frequency-detuned active atomic clocks, which are coupled in a cascaded setup, i.e. as master & slave lasers, and study the synchronization of the slave to the master clock. In a setup where both atomic ensembles are coupled to a common cavity mode such synchronization phenomena have been predicted by Xu et al. [Phys. Rev. Lett. 113, 154101 (2014)] and experimentally observed by Weiner et al. [arXiv:1503.06464 (2015)]. Here we demonstrate that synchronization still occurs in cascaded setups but exhibits distinctly different phase diagrams. We study the characteristics of synchronization in comparison to the case of coupling through a common cavity. We also consider synchronization through a classical channel where light of the master laser is measured phase sensitively and the slave laser is injection locked by feedback and compare to the results achievable by coupling through quantum channels.

Q 26.4 Tue 15:15 P 5

Probing Nanofriction and Aubry-type signatures in a finite self-assembled system — •Jan Kiethe[1], Ramil Nigmatullin[2], Dimitri Kalincev[1], Thorben Schmirander[1], and Tanja Mehlstäubler[1] — [1]PTB, Braunschweig, Deutschland — [2]University of Sydney, Sydney, Australia

Ion traps are a versatile tool for a broad range of applications, such as quantum information and precision measurements. They offer a well-controlled experimental environment in which ions can be stored and manipulated. If the ions are cooled to energies lower than the potential energy of the Coulomb system, they form crystals, which can be used as quantum simulators and emulators for non-equilibrium statistical physics. A great advantage of trapped ion crystals is the in situ access to the dynamics of the particles, which are often not accessible in the emulated system. We mimic the boundary of two atomically flat solids with a self-assembled ion Coulomb crystal in the zigzag phase and study nanofriction between these back-acting ion chains. With the help of phonon mode spectroscopy and high resolution imaging we show that a structural defect causes a sticking-to-sliding transition with Aubry-type signatures. We observe the soft vibrational mode in the motional spectrum and symmetry-breaking in the crystal configuration. The corresponding order parameter and the soft mode frequency exhibit critical scaling near the transition. This model system can be used to investigate the tribological behaviour of self-organized structures in the classical and in the quantum regime.

Q 26.5 Tue 15:30 P 5

Photoluminescence excitation spectroscopy of SiV$^-$ and GeV$^-$ color center in diamond — •Stefan Häussler[1], Andreas Dietrich[1], Gergo Thiering[2], Junichi Isoya[3], Takayuki Iwasaki[4], Adam Gali[2], Fedor Jelezko[1], and Alexander Kubanek[1] — [1]Institute for Quantum Optics, Ulm University, D-89081 Ulm, Germany — [2]Wigner Research Centre for Physics, Budapest, Hungary — [3]Research Center for Knowledge Communities, Tsukuba, Japan — [4]Tokyo Institute of Technology, Tokyo, Japan

Color centers in diamond and in particular the NV center have been proved to be good candidates for the realization of protocols for quantum information and quantum sensing. Recently the negatively charged silicon-vacancy (SiV$^-$) and germanium-vacancy (GeV$^-$) defects have drawn attention due to their exceptional optical properties. For SiV$^-$ a comparably large DW factor, a very small inhomogeneous line broadening and a large spectral stability has been demonstrated, facilitating efficient generation of indistinguishable photons. Understanding the electronic level structure is of fundamental interest for future quantum optics experiments based on the two color centers.

We present photoluminescence (PL) and excitation (PLE) measurements for both, an ensemble of negatively charged SiV and GeV centers at room temperature using a costum build confocal microscope. We measured PLE spectra over a broad wavelength range from 460 to 650 nm and performed saturation spectroscopy with high power density laser to investigate the electronic level structure of the two color centers comparing our results with in-depth theoretical simulations.

Q 26.6 Tue 15:45 P 5

Closed-loop optimization of single spin control in room-temperature solids — •Florian Frank[1], Thomas Unden[1], Ressa S. Said[2], Jonathan Zoller[2], Simone Montangero[2], Tomasso Calarco[2], Boris Naydenov[1], and Fedor Jelezko[1] — [1]Institute for Quantum Optics, Ulm University, D-89081 Ulm, Germany — [2]Center for Integrated Quantum Science and Technology, Institute for Complex Quantum Systems, Ulm University, D-89081 Ulm, Germany

We show a closed-loop correction of electron spin dynamics associated with a single colour center in diamond at room-temperature.

Target spin state and process are examined by standard tomographic measurements and their performances against systematic errors are iteratively rectified by an optimal pulse engineering algorithm manifesting full potential for applications in quantum technologies.