Q 39: Poster: Quantum Optics and Photonics II

Time: Tuesday 16:15–18:15 Location: Zelt Ost

Q 39.1 Tue 16:15 Zelt Ost

Rydberg quantum optics in ultracold gases — •Nina Stiesdal, Christoph Braun, Philipp Lunt, Simon Ball, Christoph Tresp, and Sebastian Hofferberth — Department of Physics, Chemistry and Pharmacy, SDU, Campusvej 55, 5230 Odense M, Denmark

Mapping the strong interaction between Rydberg excitations in ultracold atomic ensembles onto single photons enables the realization of optical nonlinearities which can modify light on the level of individual photons. This approach forms the basis of a growing Rydberg quantum optics toolbox, which already contains photonic logic building-blocks such as single-photon sources, switches, transistors, and conditional pi-phase shifts [1].

Following our relocation from Universität Stuttgart to University of Southern Denmark, Odense, we present the new iteration of our experimental apparatus. We also present the recent demonstration of strong coherent interaction between a few-photon probe field and an effective two-level Rydberg 'superatom' [2]. We further introduce our steps towards the formation of two such superatoms.

We discuss how the interference between the possible storage paths in Rydberg atoms and molecules affects the efficiency of storing and retrieving photons [3], and present our investigation of photon subtraction by many-body decoherence [4].

[1] O. Firstenberg et. al., J. Phys. B 49, 152003 (2016)
[2] A. Paris-Mandoki et. al., Phys. Rev. X 7, 41010 (2017)
[3] I. Mirgorodskiy et. al., Phys. Rev. A 69, 011402 (2017)
[4] C. R. Murray et. al., arXiv:1710.10047v1 (2017)

Q 39.2 Tue 16:15 Zelt Ost

Quantum imaging with incoherently scattered light from a free-electron laser — •Raimund Schneider — Universität Erlangen-Nürnberg — Erlangen Graduate School in Advanced Optical Technologies

We report on a new method to reconstruct an unknown geometry of light sources using higher order spatial intensity correlations. Our imaging protocol allows the extraction of structural information from the light scattered by a source distribution even though the sources emit completely incoherently. The imaging method is of particular interest in the X-ray regime where coherence is easily lost, e.g., due to imperfect beam optics or incoherent scattering processes. We present experimental results of imaging a hexagonal source arrangement mimicking a benzene molecule. In the experiment the atoms are simulated by holes in a SiN membrane illuminated with the incoherent light scattered from a diffusor which itself is irradiated by the beam of the FLASH free electron laser at DESY, Hamburg.

Q 39.3 Tue 16:15 Zelt Ost

Time multiplexed photonic quantum walks with 4D coins — •Lennart Lorz[1], Sonja Barkhofen[1], Evan Meyer-Scott[1], Thomas Nitsche[1], Václav Potocek[2], Igor Jex[2], and Christine Silberhorn[1] — [1]Applied Physics, University of Paderborn, Warburger Strasse 100, 33098 Paderborn, Germany — [2]Department of Physics, Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University in Prague, Brehová 7, 115 19 Praha, Czech Republic

Discrete time quantum walks, realized in time multiplexed architecture, are an established tool to experimentally study quantum transport phenomena. We implemented a photonic quantum walk on a looped Michelson interferometer in contrast to the standard Mach-Zehnder setup to investigate the benefits of a new interferometric geometry. By exploiting the two different traveling directions in the loop in addition to the two possible polarizations of the walker we establish a four dimensional coin space for one spatial dimension. A new key feature is the possibility to implement a quantum walk on a circle allowing for the experimental simulation of dynamics with periodic boundary conditions. We will present our new setup, its theoretical modeling, experimental results and future applications.

Q 39.4 Tue 16:15 Zelt Ost

Controlled optical transport of cold atoms into a hollow-core fiber — •Ronja Wirtz, Maria Langbecker, Mohammad Noaman, Wei Li, Parvez Islam, and Patrick Windpassinger — Institut für Physik, Johannes Gutenberg-Universität Mainz, Staudingerweg 7, 55128 Mainz, Germany

Cold atoms inside hollow-core fibers are a promising candidate for a well defined atom-light interface. To obtain high control over the system, the characterization of the interactions between atoms and the fiber wall is required. Here, one essential part is an efficient and well controlled transport of the atoms inside the fiber. By this, both spatial and temporal distribution of the atoms can be manipulated.

In our experimental setup, laser cooled Rubidium atoms are transported into a hollow-core fiber using an optical conveyor belt. This poster explains the details of optimizing our transport procedure both for moving the atoms outside and inside the fiber. We are applying different types of acceleration ramps to vary the transport process. Additionally power ramps of the trapping beams are implemented to reduce heating of the atoms caused by the two counterpropagating dipole trap beams. This technique is an important ingredient to investigate properties of Rydberg atoms inside hollow-core fibers [1].

[1] M. Langbecker, M. Noaman, N. Kjaergaard, F. Benabid, and P. Windpassinger, Phys. Rev A 96, 041402(R) (2017).

Q 39.5 Tue 16:15 Zelt Ost

Microtrap for hybrid Rb-Yb$^+$ systems — •Abasalt Bahrami[1], Matthias Müller[1], Jannis Joger[2], Rene Gerritsma[2], and Ferdinand Schmidt-Kaler[1] — [1]QUANTUM, Institut für Physik, Universität Mainz, Staudingerweg 7, 55128 Mainz — [2]Institute of Physics, Universiteit van Amsterdam

Trapped ions represent a highly controllable quantum system with strong long-range repulsive Coulomb interactions [1]. Laser cooled ions are spatially localised, they can be individually detected and allow for investigating local properties of a cold atomic sample [2]. In order to combine laser cooled ions and atoms in a single experimental setup, we have designed and fabricated a hybrid atom-ion trap based on modern chip trap technology [3]. Here, we report trapping of Yb$^+$ in this device. We plan loading ^{87}Rb atoms into mirror-MOT [4], eventually a magnetic chip trap. We report applications for studies of cold chemistry, cold collisions, and polaron physics.

[1] W. Paul, Rev. Mod. Phys. 62, 531 (1990). [2] A. Härter, J. Hecker Denschlag, Cont. Phys., 55, 33 (2014). [3] J. Joger, Master thesis, University of Mainz (2013). [4] J. Reichel, W. Hänsel, T. W. Hänsch, Phys. Rev. Lett. 83, 3398 (1999).

Q 39.6 Tue 16:15 Zelt Ost

Manipulation by four-photon Hong-Ou-Mandel interference — •Alessandro Ferreri, Vahid Ansari, Polina Sharapova, Christine Silberhorn, and Torsten Meier — Department of Physics and CeOPP, University of Paderborn, Warburger Strasse 100, D- 33098 Paderborn, Germany

Multiphoton quantum interference recently is in focus of research because of its possibility to extended the basis of encoding information and to improve the precision of phase measurement. Moreover multiphoton quantum interference plays significant role in quantum information science and allows investigating mesoscopic effects. In this work we focused on the Hong-Ou-Mandel (HOM) interference by involving four photons generated in KTP. Photons are created by using a type-II Parametric Down Conversion (PDC) source. By manipulation of Joint Spectral Amplitude (JSA) it is possible to change significantly the HOM-dip profile. Here we consider different shapes of JSA by increasing the laser pulse duration; different values of BS parameter (50/50 and unbalanced); different laser profile, by considering a Gaussian profile or first order Hermite-Gaussian pump laser. Our system was studied both theoretically and experimentally. We show that HOM interference profile depends on the number of Schmidt modes of PDC light and can be manipulated by laser pulse duration. We observed that by increasing the number of modes a raising of HOM dip/peak in the coincidence probability. By using BS parameters it is possible to manipulate the visibility of HOM interference. Theoretical simulations are in good agreement with the experimental results.

Q 39.7 Tue 16:15 Zelt Ost

Single Silicon-Vacancy centre with improved spectral stability in nanodiamonds — •Ou Wang[1], Lachlan Rogers[2], Andrea Filipovski[1], Valery Davydov[4], Viatcheslav Agafonov[3], Fedor Jelezko[1], and Alexander Kubanek[1] — [1]Institut für Quantenoptik, Ulm Universität, Ulm, Deutschland — [2]Department of Physics and Astronomy, Macquarie University, Sydney, Australia — [3]Institute for High Pressure Physics, Russian Academy of Science, Moscow, Russia — [4]Greman, Universit F. Rabelais, Tours, France

With appealing properties, weak side band and mostly polarized fluorescence, silicon vacancy centers (SiVs) in diamonds have became a promising system for the realization of bright, narrow bandwidth, single-photon sources. In bulk diamond at cryogenic temperatures the SiV ZPL has been observed with a linewidth limited only by fluorescence lifetime, and the transitions were spectrally stable over hours.Unfortunately the spin coherence time was found to be severely limited by phonon processes in the ground state, which may be quenched in small nanodiamonds (NDs).

However, intermittencies in luminescence, as well as significant spectral diffusion were found when investigating SiV in NDs. With surface treatment, we have improved the optical stability of SiV in NDs and gained access to single SiVs in NDs. The spectroscopical measurements on SiV ZPL fine structures showed a wide distribution of tranversial strain in NDs, with which we took a glimpse into the SiV strain model. The possibility of finding bulk-like low strained SiV offered new paths of acquiring indistiguishable photon emissions by SiV in NDs.

Q 39.8 Tue 16:15 Zelt Ost

Surface-Electrode Trap to Control Levitating Nano-diamonds — •Deviprasath Palani, Oleg Orlov, Tobias Schaetz, and Ulrich Warring — Albert-Ludwigs-Universität Freiburg, Physikalisches Institut, Hermann-Herder-Strasse 3, 79104 Freiburg, Germany

Physical properties of crystal defects, e.g., nitrogen-vacancy (NV) centers, in synthetic diamonds are intensively studied, as they rise the promise for several applications within the fields of physics, nanotechnology, and life science [1]. As the quantum nature (coherence) of NV centers is well protected by the surrounding diamond lattice, it can be harnessed even under ambient conditions. To use these defects as nanoscale sensors, they are packed into diamond crystallites of a few tens of nanometers in diameter comprised of about 10^9 carbon atoms. But to harness their full potential, suitable techniques are required to control their spatial position and orientation, as well as, to efficiently manipulate their quantum state. In our presentation, we introduce details of a compact and robust experimental setup that builds on a so-called surface-electrode trap [2], originally developed for trapping individual atoms [2]. Our setup integrates components necessary to control all degrees of freedom(as mentioned above) in a commercially fabricated printed circuit board. We present preliminary benchmark results and discuss application prospects. [1] Schirhagl, R. et al., Annual Review of Physical Chemistry. 2014 Apr;65(1):83*105. [2] Seidelin, S. et al., Phys. Rev. Lett. 96, 253003 (2006).

Q 39.9 Tue 16:15 Zelt Ost

Iterative Time Ordering for Optimal Control of Open Quantum Systems — •Lutz Marder and Christiane P. Koch — Institut für Physik, Universität Kassel, Heinrich-Plett-Str. 40, 34132 Kassel (Germany)

An explicit time-dependence of the Hamiltonian, for example due to an external driving field, introduces an additional challenge for dynamical simulations. The most commonly used propagation approaches usually rely on dividing the overall propagation time into small steps, in which the time-dependence of the Hamiltonian is approximately constant and the time evolution operator becomes a matrix exponential. This inevitably introduces inaccuracies due to neglection of time ordering. In contrast, the iterative time ordering (ITO) approach allows to fully account for any explicit time-dependence of the Hamiltonian. It was originally constructed for numerically exact propagation in Hilbert space for state vectors. Here, we generalize it to density matrices and use the driven quantum harmonic oscillator for benchmarking. Furthermore we discuss the combination of this algorithm with quantum optimal control theory and apply it to a strongly driven superconducting circuit.

Q 39.10 Tue 16:15 Zelt Ost

Enhancing superradiance at a distance through motional states — •Martin Korzeczek and Daniel Braun — University Tübingen - Institute for theoretical Physics, Tübingen

Superradiance from atomic clouds is usually only observed if the atomic distances are much smaller or comparable to the wavelength of the atomic transition. Here, we investigate to what extent superradiance can be modified by engineering the motion of the atoms. For negligibly close atoms, the motion can only decrease the superradiance. We show that for atoms that are far away from each other (distances much larger than the wavelength) superradiance can be retained to a certain degree by carefully designing the motional states. We determine the upper bounds of the enhancement compared to the motionless states and give examples for motional states that enable such a relative enhancement for atoms at distances comparable to the wavelength of the emitted light.

Q 39.11 Tue 16:15 Zelt Ost

Nanoscale Manipulation of Nanodiamonds — •Konstantin Fehler[1,2], Lukas Hartung[2], Andrea Filipovski[2], Yan Liu[2], Ou Wang[2], Alexander Kubanek[1,2], and Fedor Jelezko[1,2] — [1]Center for Integrated Quantum Science and Technology (IQst), Ulm University, Albert-Einstein-Allee 11, D-89081 Ulm, Germany — [2]Institute for Qunatum Optics, Ulm University, D-89081 Ulm

Nanoscale manipulation of nanodiamonds opens new perspectives for building hybrid quantum systems. One and two dimensional spatial positioning, dipole alignment, decomposition of nanodiamond clusters and pick and drop of nanodiamonds are among the main challenges. The recently shown bulk like properties of SiV in nanodiamonds [1], like almost fourier limited linewidths and low strain, together with the creation of single quantum emitters per nanodiamond enable to build future hybrid quantum systems.

[1] Jantzen U et al., 2016 New J. Phys. 18 073036

Q 39.12 Tue 16:15 Zelt Ost

Gearing nanodiamonds towards quantum optical applications — •Lukas Hartung[1], Konstantin Fehler[1,2], Stefan Häussler[1,2], Ou Wang[1], Andrea B. Filipovski[1], Fedor Jelezko[1,2], and Alexander Kubanek[1,2] — [1]Institute for Quantum Optics, Ulm University, D-89081 — [2]Center for Integrated Quantum Science and Technology (IQst), Ulm University, D-89081 Ulm

Recent experiments have demonstrated SiV^- centers in low-strain nanodiamonds with narrow optical transitions, almost fourier-limited lines and a good polarization contrast [2]. Together with a narrow inhomogeneous distribution of optical tranistions SiV^- nanodiamonds offer potential for the creation of indistinguishable photons from distinct emitters. Furthermore, SiV^- nanodiamonds open up new perspectives for prolonged spin coherence times T_1 [1,2]. These properties make SiV nanodiamonds a promising candidate for quantum optical applications consisting of many connected quantum systems, like quantum repeaters.

[1] Uwe Jantzen et al. 2016 New J. Phys. 18 073036
[2] Lachlan J. Rogers et al. (in preparation)

Q 39.13 Tue 16:15 Zelt Ost

SiRypY: Strongly interacting Rydberg polaritons in Ytterbium — •Simon Ball, Nina Stiesdal, Christoph Braun, Christoph Tresp, Philip Lunt, and Sebastian Hofferberth — Department of Physics, Chemistry and Pharmacy, SDU, Campusvej, 55230 Odense M, Denmark

We study non-linear quantum optics by reversibly mapping the strong inter-atomic interactions between Rydberg excitations onto single optical photons [1]. A key figure of merit for such experiments is the optical depth per Rydberg blockade volume optimised by achieving high atomic densities. However, at high atomic densities, Rydberg-ground-state collisions become a limiting factor with the commonly used alkali elements [2].

Here we discuss the development of a new experiment designed to study the interactions between a large number of Rydberg polaritons simultaneously propagating through a medium with extremely high atomic density [3]. It is proposed to overcome the atomic density limitations through the use of Ytterbium, an alkaline-earth-like element without a p-wave resonance between the Rydberg electron and surrounding ground state atoms [4].

[1] Firstenberg et al, J. Phys. B 49, 152003 (2016)
[2] Balewski et al, Nature 502, 664 (2013)
[3] Jachymski et al, Phys. Rev. Lett. 117, 053601 (2016)
[4] Camargo et al, Phys. Rev. A 93, 022702 (2016)

Q 39.14 Tue 16:15 Zelt Ost

Towards practical integrated Quantum Pulse Gate devices — •Jano Gil López, Matteo Santandrea, Nicola Montaut, John Donohue, Vahid Ansari, Markus Allgaier, Harald Herrmann, Raimund Ricken, and Christine Silberhorn — Universit\"{a}t Paderborn, Integrierte Quantenoptik, Warburger Str. 100, D-33098

Nonlinear wave-mixing allows for frequency conversion, bandwidth manipulation and temporal-mode selective operations such as Quantum Pulse Gates (QPGs). Such processes have many applications in photonic networks, both classical and quantum. These processes can be engineered in integrated optical devices in nonlinear materials to increase the efficiency, ease the alignment and reduce the footprint.

The conditions needed for single-mode waveguiding vary drastically between different wavelengths. To support all the fields interacting simultaneously in wave-mixing processes, significant engineering is required. Waveguide inhomogeneities and fabrication defects, which degrade the process fidelity, must also be surpassed. To overcome these issues and increase the efficiencies we investigate the use of on-chip tapers, bendings and dichroic couplers in Lithium Niobate waveguides. The goal is to produce efficient integrated wave-mixing devices (with a focus on QPGs), reducing the footprint and the need for bulk optics while allowing for complex interactions and processes.

Q 39.15 Tue 16:15 Zelt Ost

Temporal-mode selective purification and manipulation of multimode quantum light — Vahid Ansari[1], •John Matthew Donohue[1], Markus Allgaier[1], Linda Sansoni[1], Benjamin Brecht[1,2], Jonathan Roslund[3], Nicolas Treps[3], Georg Harder[1], and Christine Silberhorn[1] — [1]Universität Paderborn, Integrierte Quantenoptik, Warburger Str. 100, D-33098 Paderborn — [2]Clarendon Laboratory, University of Oxford, Oxford OX1 3PU, United Kingdom — [3]Laboratoire Kastler Brossel, UPMC-Sorbonne Universités, 75252 Paris, France

In order to fully exploit the time-frequency degree of freedom for photonic quantum information science, it is necessary to develop and demonstrate techniques which can manipulate the temporal structure of multimode quantum light without introducing excess noise. In this work, we experimentally demonstrate such a technique using shaped ultrafast pulses and dispersion-engineered frequency conversion as a quantum pulse gate. We controllably select broadband field-orthogonal (i.e. intensity overlapping) modes out of a multimode downconverted photon state, converting the specified mode from the infrared to the visible regime while leaving the unselected modes unaffected. Through photon-number correlation measurements, we show that such a technique selects a single mode with high purity (above 95%) and low noise (SNRs above 70). We also show through the photon-number correlations that our device can be used to both purify and redistribute the coefficients of a multimode photon state.

Q 39.16 Tue 16:15 Zelt Ost

Towards a near-unity-β laser — •Luis Morales-Inostroza[1], Xiao-Liu Chu[1], Stephan Götzinger[1,2], and Vahid Sandoghdar[1,2] — [1]Max Planck Institute for the Science of Light, 91058 Erlangen, Germany — [2]Department of Physics, Friedrich Alexander University, 91058 Erlangen, Germany

Fluidic dye lasers were first developed in 1966 and are still useful optical devices due in part to their wide bandwidth which makes large wavelength tunability and short pulse generation possible. More recently, miniaturization of fluidic dye lasers has emerged as a powerful option for integration of coherent light sources on a lab-on-a-chip device. Despite efforts by several groups, realization of room-temperature chip-based dye lasers with low threshold still remains a challenge. In this work, we introduce a new approach based on flowing a highly concentrated dye solution through a planar optical antenna. With our current design, we will be able to collect 99% of the spontaneously emitted photons [1,2] into the lasing mode of a cavity formed by an external mirror and the antenna. Based on our high collection efficiency, we expect to achieve a high coupling efficiency ($\beta = 1$) and low laser threshold.

Q 39.17 Tue 16:15 Zelt Ost

double transverse wavevector correlations in photon pairs generated by spdc pumped by bessel-gauss beams — verónica vicuña hernández[1], •josé tomás santiago[2], yasser jerónimo moreno[3], roberto ramírez alarcón[4], héctor cruz ramirez[1], alfred barry u'ren[1], and rocio jáuregui renaud[3] — [1]Instituto de Ciencias Nucleares, Universidad Nacional Autónoma de México, Apartado Postal 70-543, 04510 Ciudad de México, México — [2]Max-Planck-Institute for the Science of Light, Staudtstraße 2, 91058 Erlangen, Germany — [3]Instituto de Física, Universidad Nacional Autónoma de México, Apartado Postal 20-364, 01000 Ciudad de México, México — [4]Centro de Investigaciones en Optica, Loma del Bosque 115, Colonia Lomas del Campestre, 37150 León Guanajuato, México

In this work we present an experimental study of type I, frequency degenerate spontaneous parametric down conversion (SPDC) pumped by Bessel Gauss beams. Generating these beams either in the paraxial or nonparaxial regime, we studied their effects on the angular spectrum (AS), on the conditional angular spectrum (CAS) of signal-mode single photons as heralded by the detection of an idler photon, and on the transverse wavevector correlations (TWC). Our measurements show that while the pump is made nonparaxial, the AS acquires a non-concentric double-cone structure, and the CAS shape becomes dependent on the azimuthal location of the heralding detector, while the signal-idler wavevector correlation splits into doublet stripes, contrasting with the case of single-stripe when the pump is Gaussian.

Q 39.18 Tue 16:15 Zelt Ost

Quantum Optics in Mercury-filled Hollow-core Photonic Crystal Fibers — •Ömer Bayraktar[1,2], Florian Sedlmeir[1,2], Ulrich Vogl[1,2], Nicolas Y. Joly[1,2], Gerd Leuchs[1,2,3], and Christoph Marquardt[1,2] — [1]Max-Planck-Institut für die Physik des Lichts, Erlangen, Deutschland — [2]Department Physik, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Erlangen, Deutschland — [3]Department of Physics and Max Planck Centre for Extreme and Quantum Photonics, University of Ottawa, Ottawa (ON), Canada

Light-matter interactions in gas-filled fibers facilitate the observation of large non-linear optical effects at very low optical powers, ultimately at the single-photon level.

Here, we introduce a warm vapor of Mercury into a Kagomé-style hollow-core photonic crystal fiber (HC-PCF). Due to Mercury's low reactivity, no special treatment of the fiber and no additional light fields are required to prohibit atoms sticking to the fiber walls, as it is the case for similar experiments with Alkali vapors. In earlier investigations it was shown that large optical depths can be reached in this configuration [1]. Investigating coherent light-matter interactions in this setup, we study the efficient generation of non-classical light by exploiting the self-induced transparency for optical pulses [2,3,4].

[1] U. Vogl *et al.*, Optics Express **22**, 29375 (2014).
[2] K. Watanabe *et al.*, Physical Review Letters **62**, 2257 (1989).
[3] W. Zhong *et al.*, CLEOE-IQEC 2007, 4386698.
[4] U. Vogl *et al.*, Frontiers in Optics/Laser Science 2016, FW5F.4.

Q 39.19 Tue 16:15 Zelt Ost

Coherent combination of blue-green laser diodes for direct pumped Ti:Sapphire laser power scaling — •Mario Niebuhr, Axel Heuer, and Markus Gühr — Institute for Physics and Astronomy, Uni Potsdam, Germany

Direct diode pumped solid state lasers have been an important step towards smaller, more efficient and cheaper laser sources. Ti:Sapphire systems, one of the most important sources in the ultra-short community, unfortunately need a blue-green pump not easily accessible to laser diodes (LDs). While first concepts with blue LDs have been around for some time [1], even more recent experiments with multiple, more suitable green LDs [2] show only moderate output powers.

One reason would be that single emitter LDs are limited to either high output powers and a bad beam profile or vice versa due to geometrically constraints of their structure. This problem can be resolved by coupling multiple low power LDs with a *passive coherent* scheme. It would yield good beam profiles similar to a single emitter but with scalable output power compared to an incoherent approach such as in [2]. We will show first results of coherent coupling of two green LDs with 1 W of output power each using diffractive Dammann grating structures [3] written e.g. in volume Bragg gratings. In these first experiments, the grating structures will be emulated with a spatial light modulator for flexibility.

[1] Roth et al., Optics Letters, 34, 21 (2009)
[2] Gürel et al., Optics Express, 23, 23 (2015)
[3] Dammann et al., Optics Communications, 3, 5 (1971)

Q 39.20 Tue 16:15 Zelt Ost

Improved thermo-optic dispersion formulas from SPDC and nonlinear spectral magnification — •Aron Vanselow and Sven Ramelow — Institut für Physik, Humboldt-Universität zu Berlin, Berlin, Germany

The accurate knowledge of the dispersion properties of nonlinear crystals is vital for many applications in classical and quantum nonlinear optics. Here, we experimentally demonstrate a new method using spontaneous parametric down-conversion (SPDC) to accurately measure thermo-optic dispersion formulas for nonlinear crystals to extend and improve on existing relations.

Our method generates photon pairs via SPDC at birefringently phase-matched signal and idler wavelengths using 3 different pump lasers. Recording the temperature-dependent signal photon spectra using a grating spectrometer then allows for fitting the temperature-dependent dispersion relations for the signal and remarkably also for the undetected idler wavelengths. Specifically, we investigate the ordinary refractive indices n_o of undoped and 5.0 mol% MgO doped congruent lithium niobate (LN) as well as the principal refractive index of the y-axis, n_y, of flux-grown potassium titanyl phosphate (KTP).

The potential error sources of our method are analysed in detail and we demonstrate that even standard spectrometers with uncooled detectors are sufficient, making our new method robust and cost-effective. Finally, we show how our setup and the new dispersion formulas can be useful for nonlinear spectral magnification, which allows for a significant increase in resolution measuring the pump laser spectrum.

Q 39.21 Tue 16:15 Zelt Ost

Polymer waveguide fabrication with high aspect ratio by direct laser writing — •Julian Schulz[1], Christina Jörg[1], and Georg von Freymann[1,2] — [1]Physics Department and Research Center OPTIMAS, University of Kaiserslautern, Germany — [2]Fraunhofer Institute for Industrial Mathematics ITWM, Kaiserslautern, Germany

Due to the robustness of topologically protected states, topology is of great interest in physics since the discovery of the quantum hall effect. To simulate, e.g., topological effects one can use structures of evanescently coupled waveguides. This is due to the fact, that the time evolution of a quantum mechanical wave function in a 2D-solid corresponds to the light intensity along the propagation direction of these waveguides.

To produce these structures, we use direct laser writing (DLW) which allows to fabricate three-dimensional objects made of polymer with a resolution of less than 1 μm. First, the inverse of these waveguide arrays is written by DLW and then infiltrated with SU8. This way, waveguides with axes curved along 3D trajectories are fabricated [1].

Up to now, these waveguide axes are always oriented normal to the substrate, i.e. along the z-direction. Therefore the lower z-resolution, due to the elongation of the writing voxel in z, is no problem. However, the maximal height of these structures is thus limited by instability. To overcome this limitation, we develop a technique to fabricate waveguides with axis parallel to the substrate. This would result in a much longer evolution of light and thus more observable physics.

[1] Jörg, et al., New J. Phys. 19, 083003 (2017).

Q 39.22 Tue 16:15 Zelt Ost

Angular dependent polarization properties of graphene on nanostructured silicon carbide — •Tim Käseberg[1,2], Johannes Dickmann[1], Mattias Kruskopf[3], Thomas Siefke[4], and Stefanie Kroker[1,2] — [1]Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig, Germany — [2]Technische Universität Braunschweig, LENA Laboratory for Emerging Nanometrology, Pockelsstraße 14, 38106 Braunschweig, Germany — [3]National Institute of Standards and Metrology, 100 Bureau Drive, Stop 1070, 20899-1070, Gaithersburg, MD, United States — [4]Friedrich-Schiller-Universität Jena, Institute of Applied Physics, Albert-Einstein-Straße 15, 07745 Jena, Germany

Two-dimensional materials such as graphene have attracted recent interest in many optical and electronical applications. Particularly for nano-optical metasurfaces the use of graphene promises compact tunable devices with broad spectral bandwidth. For example, the high absorption of graphene layers can be used to realize nano-optical polarizers. In this contribution, we investigate the angular dependent polarization properties of graphene as a coating on nano-structured silicon carbide (SiC) samples. To this end, we set up a Mueller matrix polarimeter for wavelengths from 400 to 1650 nm. Further, we developed an effective medium approach to model the experimental results.

Q 39.23 Tue 16:15 Zelt Ost

Direct Laser Written Polymer Waveguides for Optical Chips — •Alexander Landowski[1,2], Stefan Guckenbiehl[1], Marius Schönberg[1], Jonas Gutsche[1], Georg v. Freymann[1,3], and Artur Widera[1,2] — [1]Department of Physics and State Research Center OPTIMAS, University of Kaiserslautern, Erwin-Schroedinger-Str. 46, 67663 Kaiserslautern, Germany — [2]Graduate School Materials Science in Mainz, Erwin-Schroedinger-Str. 46, 67663 Kaiserslautern, Germany — [3]Fraunhofer Institute for Industrial Mathematics ITWM, Fraunhofer-Platz 1, 67663 Kaiserslautern

Control over the degrees of freedom of photons in microscopic photonic structures, such as polarization, spatial mode, or orbital angular momentum, is essential for applications, e.g., quantum optical experiments on a chip.

We have recently shown direct laser written polymer waveguides fabricated from a low-fluorescent negative tone photoresist via two-photon lithography [1]. Here, we present an optimization of the waveguide's shape, minimizing losses of the propagating light. Further, we report on the current status of structures enabling manipulation of the guided light's polarization in our waveguides.

Our work opens the door to control over photonic degrees of freedom in micro-optical networks for quantum optical experiments and coupling to individual nanoemitters on photonic chips.

References: [1] A. Landowski et al., APL Photonics 2, 106102 (2017)