Q 49: Poster – Photonics, Lasers, and Applications

Time: Wednesday 17:00–19:00 Location: Tent

Q 49.1 Wed 17:00 Tent

Application of a fs-laser-written Mach-Zehnder interferometer for characterisation of hydrogels — •Johannes Schnegas[1], Karo Becker[2], Alexander Szameit[2], and Udo Kragl[1,3] — [1]Universität Rostock, Institut für Chemie, Albert-Einstein-Str. 3a, 18059 Rostock, Deutschland — [2]Universität Rostock, Institut für Physik, Albert-Einstein-Straße 23-24, 18059 Rostock, Deutschland — [3]Universität Rostock, Department LL&M, Albert-Einstein-Straße 25, 18059 Rostock, Deutschland

Integrated optics offers a significant advantage in the design of miniaturised optical sensors for applications such as chemical sensing. An example of these devices is the integrated optical interferometer, such as the Mach-Zehnder interferometer (MZI). Many examples are provided in the literature, such as protein characterisation, methane detection, and concentration measurement. In this work, an fs-laser-written MZI fabricated in fused silica is presented, which is composed of two waveguides combined by evanescent field couplers. One part of each interferometer arm runs close below the glass surface. A sensor area was created by exposing one of these via mechanical polishing, while the other interferometer arm serves as a reference. A liquid sample applied to the sensor area results in a shifted phase to which the interferometer responds with a change in the output intensity. The integrated optical MZI will be used to characterise hydrogels, which are 3D polymer networks that can take up a large amount of water and have a large field of applications. The effect of water the uptake on the refractive index was investigated in this study.

Q 49.2 Wed 17:00 Tent

Towards enhanced homodyne detection with a squeezed local oscillator — •Aishi Barua[1,2], Lorenzo M. Procopio[1,2], Laura Ares[1,2], Jan Sperling[1,2], and Tim J. Bartley[1,2] — [1]Institute for Photonic Quantum Systems (PhoQS), Paderborn University, Warburger Str. 100, Paderborn, Germany — [2]Department of Physics, Paderborn University, Warburger Str. 100, Paderborn, Germany

Homodyne detection, a well-known technique in the field of quantum optics, serves as a powerful measurement method for continuous-variable quantum states, by typically utilizing a strong coherent local oscillator to establish a stable phase reference. By squeezing either the local oscillator or the probe signal field, quantum noise can be reduced below the standard quantum limit, thereby enhancing the sensitivity of homodyne detection We present a novel approach aimed to enhance homodyne detection by implementing bright squeezed light as the local oscillator, a concept that remains unexplored. For measurement we aim to use photon-number-resolving detectors instead of linear photodiodes for intensity correlations at the single-photon level. We discuss our progress, future goals and feasibility of this approach.

Q 49.3 Wed 17:00 Tent

Noise cancelling in solid-state lasers — •Thomas Konrad[1], Tobias Steinle[1], Roman Bek[2], Michael Scharwaechter[2], Matthias Seibold[2], Andy Steinmann[1], and Harald Giessen[1] — [1]4th Physics Institute and Research Center SCoPE, University of Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart — [2]Twenty-One Semiconductors GmbH, Allmandring 3, 70569 Stuttgart

Fast and precise measurements are key for many challenging laser applications, such as biological and biomedical imaging. The precision is limited by the noise of the systems we use. Once the measurement precision reaches the laser noise level, the measurement time must be increased quadratically for further improvement. Especially with biological samples, a significant longer measurement time can alter the specimen and/or results. Therefore, exploiting the optimum noise characteristic of the driving source is superior to increasing measurement time.

In this work, we investigate noise reduction of a solid-state laser in the spectroscopically relevant 1 kHz - 10 MHz frequency range. Our approach is to reduce the noise in the oscillator itself instead of using a subsequent noise eater. It is the laser resonator that couples the lasers characteristic properties such as output power, optical spectrum, pulse duration, and therefore, consistent noise reduction of all properties must take place within the resonator itself. To reduce the noise, we use a second high-speed gain medium in the cavity whose pump is controlled by a PID feedback loop.

Q 49.4 Wed 17:00 Tent

Optical design and tolerance analysis of additively manufactured optical interfaces for spin qubits — •Lucas Kirchbach and Andreas Stute — Technische Hochschule Nürnberg Georg Simon Ohm

Readout efficiency is crucial in all optical quantum technologies that employ single qubits or single quantum emitters. One of those systems is the nitrogen vacancy (NV-Center) in diamond, where total internal reflection at the diamond surface severely limits the photon yield. Recent efforts for enhancing the collection efficiency of single NV-Centers include shaping the diamond surface to a hemisphere or printing solid-immersion lenses (SIL) on top of it. In order to further improve the photon collection efficiency, we intend to additively manufacture polymer lenses on top of the crystal via multi-photon lithography. This works presents multiple optical designs based on 3D-printed polymer lenses and discusses their performance, robustness and scalability via simulation of their optical, thermal and mechanical properties. We also present a method to determe lens geometries based on a differential equation approach.

Q 49.5 Wed 17:00 Tent

Towards photonic interference with VV centres on industrial-compatible SIC-OI chips — •NienHsuan Lee[1,2], Sushree Swateeprajnya Behera[1,2], Jonas Schmid[1,2], Leonard Zimmermann[1,2], Jonah Heiler[1,2], Flavie D. Marquis[1,2], Stephan Kucera[1], and Florian Kaiser[1,2] — [1]MRT Department, Luxembourg Institute of Science and Technology, Belval, Luxembourg — [2]Department of Physics and Materials Science, University of Luxembourg, Belval, Luxembourg

Colour centres in solid-state materials are promising for quantum communication, offering robust optical and spin properties. However, scaling up the experiment from single colour centres to plethora of colour centres on chips remains a significant challenge. Here, we present an approach to fabricating photonic quantum chips with divacancy (VV) centres in silicon carbide (SiC). By utilizing SiC-on-insulator (SiC-OI) substrates, we could establish a robust and industry-compatible design for scalable quantum technologies. Our method integrates VV centres into photonic structures, enabling efficient spin-photon interactions and chip-scale integration. With these chips, our ambition is to perform photonic interference experiments to entangle neighbouring VV centres on a chip.

Q 49.6 Wed 17:00 Tent

Metasurfaces Meet Multicore Fibers: A Platform for Generating Complex States of Light. — •Rahaf Ismail and Markus A. Schmidt — Leibniz Institute of Photonic Technology, Jena, Germany

This research combines nano-printed metasurfaces with multicore fibers to generate orbital angular momentum (OAM) beams. Using 3D nano-printing, microprisms were fabricated and tested on planar substrates, SMF-28 single-core fibers, and multicore fibers. Experimental results showed precise deflection angles, with deviations within 1.5 degrees. Current work focuses on validating uniform deflection from multicore fibers, paving the way for efficient light manipulation and OAM beam generation.

Q 49.7 Wed 17:00 Tent

Optimized Fabry-Perot Resonators for strong coupling between excitons in Ruddlesden-Popper Perovskite to cavity photons — •Prabhdeep Singh[1], Maximilian Black[1], Sara Darbari[2], and Nahid Talebi[1] — [1]Institute of Experimental and Applied Physics, Kiel University, Kiel 24098, Germany — [2]Nano-Sensors and Detectors Lab., Faculty of Electrical and Computer Engineering, Tarbiat Modares University, Tehran

Ruddlesden-Popper Perovskites (RPPs), due to their quasi-two dimensional layered structure and quantum confinement effects host excitons with typically high binding energies. In this study we model a Fabry-Perot resonator designed to study the coupling between excitons and cavity photons. The cavity features a multilayer structure of gold (and silicon nitride as reflective layers, enclosing a central chamber comprising an air gap and RPP as the active medium. Utilizing the transfer matrix method, we calculate reflection, transmission, and absorption spectra as functions of incident angle and photon energies. The results demonstrate strong coupling between the Fabry-Perot cavity resonances and the RPP excitons around the energy of 2.34 eV. Integrated reflection coefficient across incident angles (0-40°) used to simulate the microscope objectives, capture the angular dependence effects and features the energy split associated with the strong-coupling effect. The study demonstrates the importance of the resonator design for studying exciton-photon hybridization and its application in optoelectronic devices.

Q 49.8 Wed 17:00 Tent

The photoluminescence of transparent glass-ceramics based on ZnO nanocrystals Co-doped with Lanthanide elements Eu3+, Yb3+ ions. — •Moursi Abu Bieh[1] and Grigory Arzumanyan[2] — [1]Photo Chemistry Department, Egyptian National Research Center, El-Behoos Street, Giza, Cairo, Egypt — [2]Dubna, Russia

Transparent glasses of the K2O.ZnO.Al2O3.SiO2 Chemical Formula which is Co-doped with Eu2O3 and Yb2O3 were prepared by the melt-quenching technique. transparent zincite ZnO glass ceramics were obtained by secondary heat treatment methods at 860°C.At 860°C, traces of Eu Oxyapatite will appear in addition to ZnO nanocrystals. The average crystal size obtained from the X-ray diffraction data was found to range between 14 and 35 nm. The absorption spectra of the initial glasses are composed of an absorption edge and absorption bands due to the electronic transitions of Eu ions. With heat-treatment, the absorption edge pronouncedly shifts to the visible spectral range. The luminescence properties of glass and glass-ceramics were studied by measuring their excitation and emission spectra at 300, 78, and 4.2 K. Changes in the luminescence properties of the Eu-related excitation and emission bands were observed after heat-treatments at 680°C and 860°C. ZnO nanocrystals showed both broad luminescence (400-850 nm) and free-exciton emission near 3.3 eV at room temperature. upconversion luminescence spectrum of initial glass was obtained under excitation of the 976 nm laser source.

Q 49.9 Wed 17:00 Tent

Exciton-Plasmon Coupling at the Borophene/ZnO Interfaces Unraveled by Cathodoluminescence Spectroscopy — •Bharti Garg[1], Masoud Taleb[1], Yaser Abdi[2], and Nahid Talebi[1] — [1]Institute for Experimental and Applied Physics, Kiel University, Kiel, Germany — [2]Department of Physics, University of Tehran, Tehran, Iran

Borophene, a two-dimensional atomic sheet of boron, exhibits unique anisotropic in-plane polaritons in the visible spectral range [1] . In this work, we leverage advanced deep-subwavelength cathodoluminescence spectroscopy to investigate the coupling of the plasmons of borophene with the excitons of ZnO nanorods at the borophene/ZnO interface. Our results show that the near-band-edge emission (exciton transition) in ZnO nanorods is enhanced at the borophene/ZnO interface attributed to a coupling between ZnO excitons and borophene plasmons. Additionally, an emission around 800 nm is observed in the cathodoluminescence spectrum, corresponding to the plasmon-polariton peak of borophene, with a modified and reduced bandwidth and stronger luminescence peak, that is due to the coherent interactions between excitons and plasmon polaritons. Interestingly, high-resolution cathodoluminescence hyperspectral imaging from different interfaces of borophene/ZnO shows that the cathodoluminescence of the borophene/ZnO interface strongly depends on the crystallographic direction of the borophene attached to ZnO nanorods due to the anisotropic electrical and optical behavior of borophene. [1]arXiv preprint arXiv:2404.13609v

Q 49.10 Wed 17:00 Tent

Transport, alignment and focusing of a VUV laser beam for nuclear laser excitation of a single ^{229}Th ion — •Tamila Teschler[1], Georg Holthoff[1], Daniel Moritz[1], Kevin Scharl[1], Markus Wiesinger[1], Stephan Wissenberg[1,2], and Peter G. Thirolf[1] — [1]Ludwig-Maximilians-Universität München (LMU) — [2]Fraunhofer Institute for Laser Technology (ILT)

Direct frequency-comb spectroscopy represents a promising way for narrowband nuclear laser excitation. The combination of a VUV frequency comb being developed at Fraunhofer ILT and the cryogenic Paul trap operated at LMU Munich as part of an ERC Synergy project, aims to enable the excitation of the isomeric first excited state in ^{229}Th using laser radiation with $\lambda \approx 148$ nm. This advancement is an important step towards the realization of a nuclear clock based on the unique properties of ^{229}Th, which could provide extraordinary precision for timekeeping and potentially offers insights into new physics beyond the Standard Model. In this device, the single-ion nuclear clock relies on the irradiation of a single, laser-cooled $^{229m}Th^{3+}$ ion with a narrowband frequency comb. The goal is to achieve a VUV focus with a diameter of about 3 μm, to provide sufficient laser radiation intensity for driving nuclear Rabi oscillations. To achieve this, selecting the proper optical components is essential to minimize optical aberrations and power losses. Transport, alignment and focusing of a VUV laser beam from the generation site to the trapped ions will be presented. Funding: ERC Synergy project Thorium Nuclear Clock, Grant Agreement No. 856415.

Q 49.11 Wed 17:00 Tent

Towards Accurate Group Index Measurement in Lithium Niobate Waveguide Resonator — •Stefan Kazmaier and Kaisa Laiho — German Aerospace Center (DLR e.V.), Institute of Quantum Technologies, Wilhelm-Runge-Str. 10, 89081 Ulm, Germany

Lithium niobate (LN) is one of the most used materials in nonlinear quantum optics for the generation of quantum light. The spectral properties of the generated states are influenced by the group indices of the interacting modes, since they ultimately dictate the so-called joined spectral amplitude. However, the group index is often only simulated instead of measured accurately, which may lead to wrong conclusions. Therefore, we show a linear optical measurement of the group index and the optical losses in a peridodically-poled LN waveguide (WG). For that purpose, we measure the transmission spectrum of a LN WG resonator, allowing us to determine the birefringence of the group index for varying wavelengths and temperatures [1]. Altogether, our results help in interpreting the spectral properties of quantum states more accurately.

[1] Hofstetter and Thornton Opt. Lett. 22 1831-1833 (1997)

Q 49.12 Wed 17:00 Tent

Tunable Pulsed UV-Laser System for Laser Cooling of Highly Charged Bunched Ion Beams Employing Walk-Off Compensation — •Tamina Grunwitz[1], Benedikt Langfeld[1,2], and Thomas Walther[1,2] — [1]TU Darmstadt — [2]HFHF Campus Darm stadt, Department for Atomic and Plasma Physics

Laser cooling of bunched ion beams is a promising technique for narrowing the relative momentum distribution of highly charged ions in accelerators. To achieve efficient laser cooling at the new SIS100 of the GSI FAIR facility, in addition to a continuous laser, two pulsed lasers are planned to be used which, due to their spectral bandwidth, can cool a large part of the ion ensemble. For a flexible application all laser systems should be continuoulsy tunable in their wavelength in the UV region. In this contribution, we present our tunable pulsed laser system in the UV range of 257 nm. In order to achieve a high tunability of the whole system, the wavelength in the IR can be continouly tuned over a range of 3 nm around a centre wavelength of 1030 nm. With the use of two SHG stages, the IR light can be converted into the UV regime. Automated phasematching (critical) of the used BBO crystal allows continuous tuning of the UV wavelength. To compensate the beam offset due to wavelength change, a walk-off compensated setup of two BBO crystals is used, which provides a better stability of the UV beam position during tuning. In this work, we will present our most recent results regarding the automatic tuning of the wavelength in the UV with this setup, as well as the beam movement with change in wavelength

Q 49.13 Wed 17:00 Tent

Towards coherent dipole-dipole coupling: cryogenic single molecule spectroscopy of DBATT dimers — •Tim Hebenstreit[1,2], Siwei Luo[1,2], Michael Becker[1], Alexey Shkarin[1], Aleksandr Oshchepkov[3], Konstantin Amsharov[3], Jan Renger[1], Tobias Utikal[1], Vahid Sandoghdar[1,2], and Stephan Götzinger[1,2] — [1]Max Planck Institute for the Science of Light, Erlangen, Germany — [2]Department of Physics, Friedrich Alexander University Erlangen-Nuremberg, Erlangen, Germany — [3]Department of Chemistry, Martin-Luther-University Halle-Wittenberg, Halle, Germany

Coherently coupled molecules are an interesting resource for quantum optics and quantum information processing, providing access to sub- and superradiant states. Such pairs of molecules have previously been found by tedious search routines, since molecules are randomly doped into the host matrix at low concentrations. To address this issue, our approach is to use a newly developed chemical synthesis method that can connect two emitters with a linker that is less than 2 nm in length. Here, we present cryogenic single molecule spectroscopy studies on 2,3,8,9- dibenzanthanthrene (DBATT) dimers. By embedding these dimers in shock-frozen tetradecane matrices, we demonstrate lifetime-limited linewidths of DBATT dimers that also exhibit similar fluorescence spectra as isolated DBATT molecules. Our results are a first step towards a routine investigation of cooperative phenomena using molecular dimers.

Q 49.14 Wed 17:00 Tent

Label-free single nanoparticle sensing with a high-finesse microcavity — •Shalom Palkhivala, Larissa Kohler, and David Hunger — Physikalisches Institut, Karlsruhe Institute of Technology, Karlsruhe, Germany

Since many biochemical processes occur in aqueous environments, the sensing and characterisation of single, unlabelled particles in water is of interest in fields of science such as biophysics and chemistry.

We demonstrate an open-access optofluidic platform for the label-free sensing of nanoparticles in aqueous suspension, using a fibre-based Fabry-Perot microcavity with high finesse (5×10^4 in water) [1]. By monitoring interactions between diffusing nanosystems and the optical cavity field, the dynamics of the nanosystems can be investigated. The analysis of diffusion dynamics allows us to measure the hydrodynamic size of single particles with diameters of down to a few nanometers.

Furthermore, the rotational dynamics of anisotropic particles are investigated by interrogating orthogonal polarization modes of the cavity. Thus, the rotation of single nanorods could be tracked with high temporal resolution (~ 10 ns), which is orders of magnitude faster than most other current techniques.

As an application of our sensor to the field of biosensing, we demonstrate the measurement of proteins, and detect single DNA "origami" structures.

[1] Kohler, L. et al. Nat Commun 12, 6385 (2021).

Q 49.15 Wed 17:00 Tent

Quantum photonics using color centers in a diamond membrane coupled to a photonic structure — •Surena Fatemi[1], Jan Fait[1], Roy Konnoth Ancel[2], Aurelie Broussier[2], Philipp Fuchs[1], Christophe Couteau[2], and Christoph Becher[1] — [1]Fachrichtung Physik, Universität des Saarlandes, Campus E2.6, 66123, Saarbrücken, Germany — [2]Light, nanomaterials, nanotechnologies (L2n), Université de Technologie de Troyes, 10004 Troyes, France

In recent years, color centers in wide band-gap materials have garnered significant attention for their exceptional properties in quantum technologies. Among these, group-IV color centers in diamonds are particularly promising due to their long spin coherence times and excellent optical characteristics, such as narrow emission lines, high spectral stability, and bright single-photon emission.

A major challenge in realizing quantum devices based on color centers is the inefficient out-coupling of photon emission from the diamond, leading to low extraction rates. To address this, we study group-IV color centers in diamond membranes coupled to TiO2-based photonic waveguides. Using Finite-Element-Method simulations and Monte-Carlo optimization, we optimize membrane geometry, coupling interfaces, and waveguide structures to enhance photon out-coupling and achieve high photon rates. The optimized structures will then be fabricated and experimentally characterized, enabling the practical implementation of efficient quantum devices.

Q 49.16 Wed 17:00 Tent

Floquet Topological Engineering in Graphene: Towards Ultrafast Device Control — •Selina Nöcker[1], Daniel Lesko[1], Weizhe Li[1], and Peter Hommelhoff[1,2] — [1]Department Physik, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), 91058 Erlangen — [2]Department Physik, Ludwig-Maximilians-Universität München (LMU), 80799 München

Topological insulators offer exciting prospects for both fundamental research and technological applications. Irradiation with strong laser light allows dressing any material into a non-equilibrium state known as a Floquet topological insulator. Graphene is a highly symmetric 2D material with exceptional properties and provides an ideal platform to explore laser-engineered topological phenomena. Upon irradiation with a circularly polarized pulse, we induce a topological phase transition to an inversion symmetric and time reversal symmetry-broken Chern insulator. With a phase-locked optical second harmonic field, we probe the sub-cycle properties measuring phase-dependent photocurrents. For this, we use strong few-cycle pulses generated from normal-dispersion highly nonlinear fibers. We employ precise control over their carrier-envelope-phase and two-color phase delay, enabling attosecond control of the Floquet topological state. The dressed graphene exhibits intriguing optical responses, including photocurrent circular dichroism and an all-optical anomalous Hall current. Our work highlights the potential of using short laser pulses to manipulate electronic states within matter, paving the way for ultrafast device engineering in graphene and other 2D materials.

Q 49.17 Wed 17:00 Tent

Probing quantum non-reversability in photonic waveguide systems — •Bashar Karaja, Nico Fink, Viviane Bauer, James Anglin, and Christina Jörg — Physics Department and Research Center OPTIMAS, RPTU Kaiserslautern-Landau

We investigate the onset of irreversibility in a quantum system emulating a Bose-Hubbard model with interactions [1], implemented within a photonic waveguide platform. Our goal is to uncover the origins of irreversibility at the quantum level. To address this, we prepare the system in an initial state and subject it to an adiabatic time evolution that is precisely reversed at the midpoint. Irreversibility is quantified by the system's inability to return to its initial state, despite the exact time-reversal of the system's Hamiltonian. Given that numerous studies have demonstrated the feasibility of replicating quantum-optical effects in photonic waveguide systems [2], we apply this model to a setup of two coupled Kerr-nonlinear waveguides. By gradually increasing the on-site potential difference -controlled through the waveguide radius - and reversing this process midway, we analyze the waveguide output under varying input conditions of intensity and phase distribution. Additionally, we aim to investigate the role of time-varying intensity profiles (e.g., pulses) in shaping the irreversibility threshold of the system.

[1] Bürkle, R., Vardi, A., Cohen, D. et al., Sci Rep 9, 14169 (2019).
[2] Longhi, S., Laser & Photon. Rev. 3:243-261 (2009).

Q 49.18 Wed 17:00 Tent

Nonlinear Spectroscopy of CdTeSe/ZnS Quantum Dots in a Single-Photon Fluorescence-Microscopy Setup — •Raphael Wichary and Tobias Brixner — Institut für Physikalische und Theoretische Chemie, Universität Würzburg, Am Hubland, 97074 Würzburg, Germany

We present measurements on commercial CdTeSe/ZnS core–shell quantum dots in a single-photon fluorescence microscope. Different methods of sample preparation, as well as the influence of oxygen and the excitation power on the stability of the sample in two-dimensional electronic spectroscopy experiments are explored. Comparisons are made between the behavior of clusters of multiple quantum dots and single quantum dots.

Different techniques are tried out to eliminate higher-order contamination of nonlinear signals.

Q 49.19 Wed 17:00 Tent

Using Rh6G as sensitizer in commercial photoresins for two-step-absorption lithography — •Sabrina Hammel[1], Georg von Freymann[1,2], and Christina Jörg[1] — [1]Physics Department and Research Center OPTIMAS RPTU Kaiserslautern-Landau, Kaiserslautern, Deutschland — [2]Fraunhofer Institute for Industrial Mathematics ITWM, Kaiserslautern, Germany

A widely used technique for creating arbitrary 3D structures at the micron scale is Direct Laser Writing (DLW), which uses the nonlinear process of Two-Photon Absorption (2PA). In 2PA, the simultaneous absorption of two photons excites a photoinitiator molecule, triggering a polymerization reaction. A recently shown technique, Two-Step-Absorption (TSA) [1], achieves similar resolution to 2PA, but needs only a simple cw-laser diode instead of a pulsed fs-laser. In TSA, the virtual state in 2PA is replaced by a real electronic state with a relatively long lifetime. So far, TSA lithography typically requires special photoresins consisting of appropriately chosen photoinitiators, scavengers and monomers. To also make commercial photoresins usable for TSA, we examine the use of a photosensitizer [2], Rhodamine 6G (Rh6G). Rh6G undergoes the TSA process, subsequently transferring energy to the photoinitiator in the commercial resin. By incorporating photosensitizers, we aim to make TSA more versatile, using existing commercial materials with minimal modification.

[1] V. Hahn, T. Messer, N.M. Bojanowski et al., Nat. Photon. 15, 932-938 (2021).
[2] D.T. Meiers et al., Adv. Eng. Mater. 25:2370037 (2023).

Q 49.20 Wed 17:00 Tent

Observation of the Spin Hall Effect of Light in Confocal Microscopy — •Anton Lögl[1], Wenze Lan[1], Meryem Benelajla[2], Clemens Schäfermeier[2], Khaled Karrai[2], and Bernhard Urbaszek[1] — [1]Institute for Condensed Matter Physics, Technische Universität Darmstadt, 64289 Darmstadt, Germany — [2]attocube systems AG, Eglfinger Weg 2, 85540 Haar, Germany

In the quantum picture of light the two spin states of photons correspond to right- and left-handed cicrular polarizations σ^+ and σ^-. Depending on the chirality of its circular polarization, the trajectory of a circularly polarized beam will shift above or below the plane of incidence when reflected off a surface. This Imbert-Fedorov shift is due to spin-orbit coupling of light upon each reflection and is typically several orders of magnitude smaller than the photon wavelength. For this reason, it has up to now required complex detection schemes and hence limiting detailed experimental investigations and practical applications. Here, we present a novel method to directly observe the spin-orbit coupling of light in confocal microscopy.

Q 49.21 Wed 17:00 Tent

Tunable Focusing Metalens on a Fiber with Two Cores — •Jun Sun[1], Malte Plidschun[1], Jisoo Kim[1], Torsten Wieduwilt[1], and Markus A. Schmidt[1,2,3] — [1]Leibniz Institute of Photonic Technology, Albert-Einstein-Str. 9, 07745 Jena, Germany — [2]Otto Schott Institute of Material Research, Friedrich Schiller University Jena, Fraunhoferstrasse 6, 07743 Jena, Germany — [3]Abbe Center of Photonics and Faculty of Physics, Friedrich-Schiller-University Jena, Max-Wien-Platz 1, 07743 Jena, Germany

We propose a novel approach for fast, power-controlled spatial focus shape modulation through an all-fiber-integrated system utilizing a 3D nanoprinted intensity-sensitive hologram. This hologram enables dynamic control of focus geometric ellipticity by modulating the power distribution between the modes of a dual-core fiber. The resulting power-dependent interference pattern alters the hologram's intensity distribution, achieving precise focus shape control. Our study encompasses computational design, advanced 3D nanoprinting, and fiber fabrication, demonstrating the feasibility of this monolithic solution. Experiments and simulations validate its high-speed modulation capability, with promising applications in optical manipulation, laser micromachining, telecommunications, etc.

Q 49.22 Wed 17:00 Tent

Cryogenic spectroscopy of single molecules in the blue wavelength region — •Tianyu Fang, Ricardo Alvarez, Babak Behjati, Max Masuhr, Bo Deng, Delia Siedenberg, Kathrin Schumacher, and Daqing Wang — Institut für Angewandte Physik, Universität Bonn, Bonn, Germany

Various polycyclic aromatic hydrocarbon (PAH) molecules have been studied for quantum optical investigations in the green to near-infrared wavelength range. Detecting narrow-linewidth molecular transitions in the blue wavelength region can open new possibilities for single PAH molecules in quantum optics. Here, we report on fluorescence spectroscopy of perylene molecules in various host-guest systems at cryogenic temperatures. The emission properties of perylene in crystal matrices of anthracene, dibenzothiophene and biphenyl are measured and evaluated. In addition, we report on the detection of single perylene molecules adsorbed on hexagonal boron nitride (hBN) and benchmark their emission linewidth and photostability.

Q 49.23 Wed 17:00 Tent

Limits for coherent optical control of quantum emitters in hexagonal Boron Nitride — •Alexander Pachl[1], Michael K. Koch[1,2], Vibhav Bharadwaj[1,3], and Alexander Kubanek[1,2] — [1]Institut for Quantum Optics, University Ulm, 89081 Ulm, Germany — [2]Center for Integrated Quantum Science and Technology (IQst), Ulm University, 89081 Ulm, Germany — [3]Department of Physics, Indian Institute of Technology Guwahati, 781039 Guwahati, Assam, India

Single Photon emitters hosted in hexagonal Boron Nitride (hBN) are promising candidates for integration into upcoming quantum optical technologies. Some of these emitters show a very interesting and promising optical property of Fourier transform limited linewidth up to room temperature [1,2]. This can be explained by out-of-plane distorted defects, which show a weak coupling to low energy in-plane phonon modes [3]. This enables coherent optical driving and the observation of optical Rabi oscillations up to elevated temperatures as demonstrated in our most recent work [4].

[1] A. Dietrich et al., Physical Review B, Vol. 98 (2018)
[2] A. Dietrich et al., Physical Review B, Vol. 101 (2020)
[3] M. Hoese et al., Science Advances, Vol. 6 (2020)
[4] M. Koch et al., Communications Materials, Vol. 5 (2024)

Q 49.24 Wed 17:00 Tent

Tunable cw UV Laser for Cooling of Relativistic Bunched Ion Beams — •Florian Stein, Jens Gumm, Denise Schwarz, and Thomas Walther — TU Darmstadt

Experiments with highly charged ions at relativistic energies are of great interest for many atomic and nuclear physics experiments at accelerator facilities. To decrease the longitudinal momentum spread and emittance, laser cooling has proven to be a powerful tool. In this work we present a cw UV laser system operating at 257.25nm for ion beam cooling at ESR in Darmstadt. The laser system can be scanned mode-hop free, via two SHG stages, over 20GHz with a 50 Hz scan rate. In our latest measurements we achieve a power of 2.45W in the UV regime employing a novel elliptical focussing cavity to reduce the degradation effect in BBO. The laser system will be used to minimize the final ion beam momentum spread and, therefore, the ion bunch length.

Q 49.25 Wed 17:00 Tent

Frequency Response of Surface Bragg Gratings for Monolithic Extended Cavity Diode Lasers — •Sten Wenzel, Olaf Brox, Jörg Fricke, Igor Nechepurenko, and Andreas Wicht — Ferdinand-Braun-Institut (FBH), Gustav-Kirchhoff-Straße 4, 12489 Berlin

Monolithic extended cavity diode lasers (mECDL) are a compact, robust and efficient light source with ultra-low frequency noise well suited for optical quantum technologies such as optical atomic clocks and quantum sensors based on atom interferometry. The extended propagation section results in a narrow longitudinal mode spacing of the cavity. Hence, the frequency selective element utilized to establish single mode operation, in this case a distributed Bragg reflector (DBR), must provide a spectrally narrow resonance with a width of the order of a few tens of GHz. We achieve this by a DBR with a small coupling coefficient and increased length of 2 mm. Since the spectral characteristics of a DBR scale with its length, uncertainties in the grating design, which arise from potential shortcomings in the modeling or technological implementation, may lead to significant deviations between the expected (simulated) and real performance. We therefore developed and implemented a method for the characterization of the spectral reflectance and transmission of such gratings in ridge-waveguides by laser spectroscopy. In this work, we present our findings and compare our measurement results with the theoretical prediction.

Q 49.26 Wed 17:00 Tent

SiV centers in nanodiamonds for quantum networks — •Kathrin Schwer[1], Marco Klotz[1], Andreas Tangemann[1], David Opferkuch[1], Viatcheslav Agafonov[2], and Alexander Kubanek[1] — [1]Institut für Quantenoptik Universitat Ulm — [2]Universite Francois Rabelais de Tours

Combining conventional photonic systems with the good optical and spin properties of group IV defects in diamond puts a platform for quantum technologies into reach. Here, we present measurements of characteristic properties of SiV centers in nanodiamond in comparison with bulk diamond. This reveals key benefits of a nanostructured defect host for future integration into photonic-enhancing structures, e.g. cavities.

Q 49.27 Wed 17:00 Tent

Fiber-Interfaced Hollow-Core Light Cage: A Novel Lab-on-Fiber Platform — •Wenqin Huang[1], Diana Pereira[1,2], Jun Sun[1], Matthias Zeisberger[1], and Markus A. Schmidt[1,3,4] — [1]Leibniz Institute of Photonic Technology, Albert-Einstein-Str. 9, 07745 Jena, Germany — [2]i3N & Physics Department, University of Aveiro, Campus de Santiago, 3810-193 Aveiro, Portugal — [3]Abbe Center of Photonics and Faculty of Physics, Friedrich Schiller University Jena, Max-Wien-Platz 1, 07743 Jena, Germany — [4]Otto Schott Institute of Material Research, Friedrich Schiller University Jena, Fraunhoferstr. 6, 07743 Jena, Germany

We present an innovative platform for fiber-integrated photonic devices by incorporating hollow-core light cages (LCs) onto fibers using 3D nanoprinting. Two LC geometries, featuring record-high aspect ratio polymer strands, were fabricated directly onto step-index fibers, providing unique lateral access to the core and showcasing excellent optical properties. The anti-resonance effect within these structures enables precise spectral transmission and efficient light confinement, validated through strong experimental agreement with theoretical models. This work highlights the small-core geometry, which achieves high fringe contrast and exceptional reproducibility. The fiber-interfaced LCs introduce a platform with potential in diffusion-based sensing, environmental analysis, nanoscience, and quantum technologies. The mechanical stability, achieved through customized support structures, ensures durability without compromising performance, enabling practical use in demanding environments.

Q 49.28 Wed 17:00 Tent

Quantum lattice solitons in a two-dimensional Harper-Hofstadter model — •Hugo Gerlitz, Julius Bohm, and Michael Fleischhauer — Department of Physics and Research Center OPTIMAS, University of Kaiserslautern-Landau, 67663 Kaiserslautern

Since the discovery of the integer quantum Hall effect, topological 2D lattice models have attracted significant interest in many-body physics. These models can be simulated using ultra-cold atoms in optical lattices [1]. Recent experiments were able to investigate lattice solitons in waveguides with nonlinear Kerr media [2].

In one-dimensional systems a quantum mechanical description of solitons in topological lattice models is typically done by exact diagonalization and tensor network approaches. These approaches are strongly limited by the system size and thus less efficient in higher dimensions. The examination of a reduced Hilbert-space to describe the 1D solitons was succesful in reproducing well known quantities like effective Chern numbers and Wilson loops. Motivated by this we here present the reduced quantum mechanical description of an interacting two-dimensional Harper-Hofstadter model and investigate the emerging soliton properties.

[1]: I. Bloch, Rev. Mod. Phys. 80, 885 (2008)
[2]: Jürgensen et. al., Nature 596, 63-67 (2021)

Q 49.29 Wed 17:00 Tent

Chiral Landau Levels and Fermi-Arcs of Weyl Points under Pseudomagnetic Fields — Sachin Vaidya[1], •Alaa Bazayeed[2], Mikael Rechtsman[3], Adolfo Grushin[4], Marin Soljačić[1], and Christina Jörg[2] — [1]Department of Physics, Massachusetts Institute of Technology, Cambridge, USA — [2]Physics Department and Research Center OPTIMAS, RPTU Kaiserslautern-Landau, Germany — [3]Department of Physics, The Pennsylvania State University, USA — [4]Univ. Grenoble Alpes, CNRS, Grenoble INP, Institut Néel, France

Weyl materials are 3D topological systems characterized by Weyl points - singularities in momentum space where two energy bands touch. These Weyl points act as monopoles of Berry curvature, giving rise to surface states known as Fermi arcs, which connect projections of opposite-chirality Weyl points. Under the application of a magnetic field, the energy bands become quantized into discrete levels known as Landau levels (LL). Due to the chirality and topology of the Weyl points, the linearly dispersing zeroth LL are also chiral. In this work, we investigate the influence of pseudo-magnetic fields (e.g., those arising from strain) on Weyl systems. These fields couple to the Weyl points in a chirality-dependent manner, such that the dispersion of all zeroth LLs share the same chirality. In this case, we find that the Fermi arcs disperse in the opposite direction and provide the opposite chirality required to satisfy the fermion doubling theorem. This system thus separates the two chiralities between the surface and the bulk. We explore this behavior in a photonic model system consisting of stacks of silicon and SiO_2 layers with controlled thickness variations.

Q 49.30 Wed 17:00 Tent

Thin disk single frequency Ruby laser for metrology — •Sönke Metelmann[1], Luca Diedrich[1], Thomas Müller-Wirts[2], Carsten Reinhardt[1], Walter Luhs[3], and Bernd Wellegehausen[4] — [1]University of Applied Sciences Bremen — [2]TEM-Messtechnik — [3]Photonics Engineering Office — [4]Institut für Quantenoptik - Leibniz University Hannover

In recent contributions [1-2], 405 nm diode laser pumped cw single frequency operation of a ruby laser have been presented in linear and ring laser configurations, showing the potential for metrology applications. In this contribution, we report on laser performance, using different commercially available few- to single-mode laser diodes, which can be driven with optical output powers up to 1.5 W. The Ruby laser performance, e.g. slope efficiency, thermal and spectral properties and linewidth measurements will be presented. With a thin disk ruby crystal of only 0.5 mm, an ultra-compact single frequency laser has been realized, delivering up to 15 mW at a diode pump power of 500 mW. Features of this laser system and investigations on frequency stability and linewidth, using interferometric and beat frequency techniques will be presented and discussed.

[1] W. Luhs and B. Wellegehausen, "Diode pumped cw ruby laser," OSA Continuum 2, 184-191 (2019)
[2] W. Luhs and B. Wellegehausen, "Diode pumped compact single frequency cw ruby laser", J. Phys. Communications 7 (2023) 055007

Q 49.31 Wed 17:00 Tent

Studying the transport of optical modes carrying OAM in coupled waveguides — •Max Weber[1], Julian Schulz[1], Christina Jörg[1], and Georg von Freymann[1,2] — [1]Physics Department and Research Center OPTIMAS, RPTU Kaiserslautern-Landau, 67663 Kaiserslautern, Germany — [2]Fraunhofer Institute for Industrial Mathematics ITWM, 67663 Kaiserslautern, Germany

In solid state physics, electrons are described by Bloch states, which contain a spin and an orbital angular momentum (OAM) degree of freedom. Due to the spin-orbit coupling, the Spin Hall Effect (SHE) is based on the more fundamental Orbital Hall Effect (OHE). The SHE is well known and widely studied. The importance of the OAM for transport processes has been neglected. To study this effect, the explicit example of a polarized tin-tellurium layer is used. To examine the transport phenomena that depend on the orbital degree of freedom, a model system of waveguides is created. By analogy of the Schrödinger equation and the Helmholtz equation, the coupling of the electrons in the atoms can be related to the coupling of the light in the waveguides. We use optical waveguide modes with OAM to examine how transport phenomena depend on the orbital degree of freedom. To show that the OAM is coupled to the momentum of the excited wave packet, the lattice is excited with a wave packet with positive and negative OAM. We observe a change in the group velocity of the wave packet when the sign of the input OAM is switched. Thus, the momentum and the OAM are coupled.

Q 49.32 Wed 17:00 Tent

Deterministic positioning of nanocrystals in polymer waveguides with direct-laser-writing — •Thomas Utz[1], Artur Widera[1], and Georg von Freymann[1,2] — [1]Physics Department RPTU Kaiserslautern-Landau, Kaiserslautern, Germany — [2]Fraunhofer Institute for Industrial Mathematics ITWM, Kaiserslautern, Germany

In order to observe collective emission, it is necessary to localise the emitters in each direction to a length that is smaller than their emission wavelength. In the present study, nitrogen vacancy (NV) centers in nanodiamonds were used as emitters. The NV centers provide a well-controlled system for studying the collective emission. It is essential to achieve precise positioning of the two nanodiamonds in order to create optimal conditions for observing collective emission. We present a method for the fabrication of nanodiamond-doped waveguides that fulfil the conditions required for collective emission. The waveguides are fabricated in a heterostructure approach using the direct-laser-writing (DLW) process. In the initial phase of the process, the waveguide structures are written into a photopolymer without nanodiamonds, leaving small gaps in the waveguide to position the nanodiamonds in the next step. After development, a polymer containing nanodiamonds is used. The material is exposed only at the position of the gap to close the gap and incorporate the nanodiamonds. The volume fraction of nanodiamonds is selected in order to achieve an average of one nanodiamond per gap. After development, waveguides are fabricated with nanodiamonds in the desired position.

Q 49.33 Wed 17:00 Tent

Status of Laser Cooling at the FAIR SIS100 — •Denise Schwarz[1], Jens Gumm[1], Benedikt Langfeld[1], Tamina Grunwitz[1], Danyal Winters[2], Sebastian Klammes[2], and Thomas Walther[1,3] — [1]TU Darmstadt — [2]GSI Darmstadt — [3]HFHF Darmstadt

Bunched relativistic ion beams with a narrow momentum distribution are essential for precision experiments at modern accelerator facilities. Laser cooling presents a promising approach to further reduce the relative momentum distribution of such ion beams.

Previous experiments at the Experimental Storage Ring (ESR) at GSI have demonstrated the effectiveness of both continuous-wave (cw) and pulsed UV laser in minimizing the relative momentum distribution of bunched relativistic ion beams. To enhance cooling performance, a novel approach of integrating three laser systems - one cw and two pulsed lasers - has been proposed for application at the FAIR SIS100 accelerator. Successful implementation of this strategy requires the optimization of spatial, temporal, and energy overlap between the three laser beams and the ion beam.

This work explores the principles of laser cooling with a multi-laser configuration, with a particular emphasis on achieving precise spatial overlap between the laser and ion beams. Additionally, the critical role of active laser beam stabilization in ensuring consistent overlap is addressed.

Q 49.34 Wed 17:00 Tent

Examination of structures in transparent materials using scanning acoustic microscopy (SAM) — •Cornelia Bauer[1], Max Steudel[1], Max-Jonathan Kleefoot[2], Sebastian Funken[2], and Anne Harth[1] — [1]Center of Optical Technologies, Aalen University, Aalen — [2]Laserapplicationcenter, Aalen University, Aalen

Scanning acoustic microscopy is a non-destructive measuring technique to examine biological samples and non-transparent brittle materials. It enables the detection of internal structures and defects without causing damage. An transducer emits ultrasonic waves, which are reflected at acoustic impedance changes. The reflected signal is detected after a specific time delay by the transducer, thereby providing information regarding impedance alterations [1]. In this study, the goal is to investigate micro-scale volume modification in transparent materials using SAM. Inital results include successful measurements of laser modification in bulk fused silica glasses, demonstrating the potential of this approach for high-resolution material analysis [2]. [1] Hyunung Yu. Applied microscopy, 50(1):25, 2020. [2] Max Steudel and et al. Optics express, 32(11):19221*19229, 2024.

Q 49.35 Wed 17:00 Tent

An Interface Concept for Ion Quantum Computer: Fiber-Based Cavities for Enhanced Optical Connection — •Luca Graf[1], Lasse Irrgang[1], Tuncay Ulas[1], and Ralf Riedinger[1,2] — [1]Zentrum für Optische Quantentechnologien, Universität Hamburg, 22761 Hamburg — [2]The Hamburg Centre for Ultrafast Imaging, 22761 Hamburg

The development of quantum computers promises to solve computational complex problems in the future that cannot be solved with classical computers. Just as in conventional computing clusters, quantum computers must also be networked in a scalable way. We present an innovative concept for an interface that has been specially developed for ion traps. This approach uses special coated fiber-based cavities to establish an efficient optical connection between ion traps. Furthermore, this approach can be used to couple optical qubits, such as entangled photons, with ions in the trap.

Q 49.36 Wed 17:00 Tent

Implementation of a laser system for alkali vapor MEMS cell activation — •Janice Wollenberg[1], Julien Kluge[1,2], Daniel Emanuel Kohl[1], Andreas Thies[2], Klaus Döringshoff[1,2], and Markus Krutzik[1,2] — [1]Institut für Physik - Humboldt-Universität zu Berlin — [2]Ferdinand-Braun-Institut(FBH), Leibniz-Institut für Höchstfrequenztechnik

We present a laser system designed for the activation and characterization of rubidium vapor MEMS cells. Utilizing these mm-scale cells is a cruicial step towards chip-scale optical frequency references based on two-photon spectroscopy of rubidium at 778 nm. Our approach involves employing a high-power laser at 1064 nm to activate a rubidium dispenser pill, which is contained in one of the MEMS cells chambers. After activation, the pill releases elementary rubidium and micro-channels guide the rubidium vapor into a second chamber for spectroscopy. We use Doppler-free saturation spectroscopy of the D2 transition at 780 nm to characterize the cells. The outcomes of this work are expected to help produce rubidium cells for optical clocks. This involves further refinement and testing cell geometries, channel configurations, and relevant cell parameters, as well as the implementation of automated setup processes. This work is supported by the German Space Agency (DLR) with funds provided by the Federal Ministry for Economic Affairs and Climate Action (BMWK) due to an enactment of the German Bundestag under grant numbers 50RK1971, 50WM2164, 50WM2169.

Q 49.37 Wed 17:00 Tent

Collective Driving of Many-Photon Quantum States — •Gabriela Carla Silva Militani[1], Moritz Kaiser[1], René Schwarz[1], Ria Krämer[2], Stefan Nolte[2], Philip Poole[3], Dan Dalacu[3], Gregor Weihs[1], and Vikas Remesh[1] — [1]Institute for Experimental Physics, University of Innsbruck, Technikerstrasse 25d, 6020 Innsbruck, Austria — [2]Institute of Applied Physics, Abbe Center of Photonics, Friedrich Schiller University Jena, 07745 Jena, Germany — [3]National Research Council Canada, Ottawa, ON K1A 0R6, Canada

This work aims to present the simultaneous excitation of two uncoupled InP/InAsP quantum dots embedded in a nanowire. Our excitation method is the two-photon excitation adiabatic rapid passage, by which both dots are excited to their biexciton state and subsequently emit polarization-entangled photon pairs in a cascade. In this scheme, a pulsed laser tuned to the two-photon resonance is chirped using a custom-designed chirped fiber Bragg grating (CFBG). The resulting spectral phase variation induces an adiabatic population transfer in the dot. Because of this, the biexciton state population does not exhibit Rabi rotations under a pulse area scan. In other words, our excitation method is robust and insensitive to laser power and frequency fluctuations. Taking advantage of this, we simultaneously excite both dots and demonstrate the generation of two pairs of entangled photon states. Our work paves the way for the scalable generation of multiphoton entangled states for advanced quantum technology applications.

Q 49.38 Wed 17:00 Tent

Violating the thermodynamic uncertainty relation in the three-level laser — •Sander Stammbach — Universität Basel, Basel, Schweiz

Heat engines are devices that convert thermal energy into useful work under continuous, cyclic operation. The prime example of a quantum heat engine is the three-level laser (or maser) [1]: an incoherent pump process plays the role of a heat reservoir, providing thermal energy to create a population inversion. At the same time, the lasing transition leads to useful work output in the form of stimulated emission into a coherent driving field that is usually treated as a time-dependent coherent amplitude. Here, we consider a model in which the three-level system is placed in a single-mode cavity that is externally driven by coherent light. Making use of the framework of full counting statistics [2], we investigate the fluctuating energy currents of the system as a function of the drive. We also evaluate the thermodynamic uncertainty relation (TUR) [3] and identify the quantum regimes of operation in which its classical bound can be violated. In previous studies without cavity, these regimes could result in an enhanced output power, i.e., a quantum advantage. Our findings suggest that this is no longer the case in a cavity.

Q 49.39 Wed 17:00 Tent

Coherent Control in Size Selected Semiconductor Quantum Dot Thin Films — •Victor Kärcher[1], Tobias Reiker[1], Pedro F. M. G. da Costa[2], Andrea S. S. de Camargo[3], and Helmut Zacharias[1] — [1]48149, Münster, Uni Münster — [2]São Carlos Institute of Physics, University of São Paulo, São Carlos - SP 13566-590, Brazil, — [3]Federal Institute for Materials Research and Testing (BAM), 12489 Berlin

We introduce a novel technique for coherent control that employs resonant internally generated fields in CdTe quantum dot (QD) thin films at the L-point. The bulk band gap of CdTe at the L-point amounts to 3.6 eV, with the transition marked by strong Coulomb coupling. Third harmonic generation is used to control quantum interference of three-photon resonant paths between the valence and conduction bands. Different thicknesses of the CdTe QDs are used to manipulate the phase relationship between the external fundamental and the internally generated third harmonic, resulting in either suppression or strong enhancement of the resonant third harmonic, while the non-resonant components remain nearly constant. This development could pave the way for new quantum interference based applications in ultrafast switching of nanophotonic devices.

Q 49.40 Wed 17:00 Tent

Towards three-dimensional confinement of the electron beam inside dielectric laser accelerators — •Manuel Konrad[1], Stefanie Kraus[1], Leon Brückner[1], Julian Litzel[1], Zhexin Zhao[1], Tomas Chlouba[1,2], Roy Shiloh[1,3], and Peter Hommelhoff[1,4] — [1]Department Physik, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), 91058 Erlangen — [2]Center for Nanophotonics, AMOLF, 1098 XG Amsterdam — [3]Institute of Applied Physics, Hebrew University of Jerusalem (HUJI), Jerusalem, Israel

— [4]Department Physik, Ludwig-Maximilians-Universität München (LMU), 80799 München

While classical particle accelerators typically utilize metal cavities driven by radio-frequency fields to create the accelerating fields, dielectric laser accelerators (DLA) adapt the same concepts to dielectric structures driven by high repetition rate laser pulses. Alternating phase focusing (APF) is employed so that the electron beam stays confined inside the acceleration channel [1]. After we successfully applied this concept to gain phase space control over the electron in one longitudinal and one transversal direction [2], we have recently shown coherent acceleration of electrons. By keeping the beam confined in a 500 um long structure, we were able to accelerate the electrons from 28.4 to 40.7 keV in a scanning electron microscope [3]. We will show how the APF scheme can be expanded to full 3D confinement and discuss how it is affected by illuminating the structure from the top.

[1] Niedermayer et al., PRL 121, 214801 (2018) [2] Shiloh et al., Nature 597, 498 (2021) [3] Chlouba et al., Nature, 622, 476 (2023)

Q 49.41 Wed 17:00 Tent

Coherent Optical Control of Semiconductor Quantum Dots — •Charlie Evagora[1], Rene Schwarz[1], Saimon da Silva[2], Armando Rastelli[2], Doris Reiter[3], Vikas Remesh[1], and Gregor Weihs[1] — [1]Institute for Experimental Physics, University of Innsbruck, Technikerstrasse 25d, 6020 Innsbruck, Austria — [2]Institute of Semiconductor Physics, Johannes Kepler University Linz, Altenbergerstr. 69, A-4040 Linz, Austria — [3]Condensed Matter Theory, Department of Physics, TU Dortmund, 44221 Dortmund, Germany

The development of quantum technologies is heavily dependent on reliable sources of single photons with near perfect indistinguishability. In recent years, semiconductor quantum dots (QD) have become a viable platform with high brightness, tunability, and deterministic mode of operation.

The most prominent scheme for QD excitation is the Rabi scheme, using an on-resonance pulse to invert the emitter population. Despite guaranteeing near perfect photon properties, it is counterproductive in terms of brightness, necessitating extra filtering procedures.

Given this context, an alternative scheme that has gained particular interest is the Swing-UP of quantum EmitteR (SUPER) scheme, which uses 2 red-detuned pulses to drive population inversion. This scheme was realised by our group for a GaAs/AlGaAs system, which has subsequently been implemented by numerous other groups for a variety of platforms. Here we report detailed investigation on the detuning dependence of photon indistinguishability and photon number purity under SUPER excitation.

Q 49.42 Wed 17:00 Tent

Integrated Photonic Quantum Walks for Universal Computation — •Lasse Wendland[1], Florian Huber[2,3,4], Benedikt Braumandl[2,3,4], and Jasmin Meinecke[1,2] — [1]Institut für Festkörperphysik, Technische Universität Berlin, Berlin, 10623, Germany — [2]Max-Planck-Institut für Quantenoptik, Garching, Germany — [3]Department für Physik, Ludwig-Maximilians-Universität, München, Germany — [4]Munich Center for Quantum Science and Technology (MCQST), München, Germany

As the quantum mechanical analog of a classical random walk, quantum walks offer a powerful framework for advancing various modern quantum technologies. Furthermore, quantum walks can be viewed as a model of computation. In 2009, Andrew M. Childs demonstrated that any quantum circuit can be efficiently simulated by a simple quantum walk on a sparse graph. Although the graph associated with a quantum walk computation is exponentially large in the number of qubits and therefore cannot be efficiently implemented using spatially separated vertices, this model can still serve as a useful testbed for studying quantum walk computations. In our research, we leverage the inherent stability, compactness, and versatility of photonic waveguide arrays as a platform for exploring these computations.

Q 49.43 Wed 17:00 Tent

Investigation of the valence electronic structure and dynamics of nanostructured materials via high-order harmonic generation — Agata Azzolin[2,5], •Noah Tettenborn[1,5], Sani Harouna-Mayer[3], Oliviero Cannelli[2,5], Yogesh Mahor[3], Francesco Caddeo[3], Andrea Trabattoni[2,4,5], Terry Mullins[2,5], Vincent Wanie[2,5], Dorota Koziej[3], and Francesca Calegari[1,2,5] — [1]University of Hamburg — [2]Desy, Hamburg — [3]Institute for Nanostructure and Solid State Physics, University of Hamburg — [4]Leibniz University Hannover — [5]Center for Free-Electron Laser Science, Hamburg

In previous works, HHG has been shown to be a suitable tool for characterizing valence potentials in bulk systems [1]. Here, we aim to establish this technique as a complementary, all-optical, in-situ tool to characterize nanoengineered transition metal oxides, mapping their response across different ordering scales.

Preliminary experimental data exploring excitations at different wavelengths, intensities, and polarizations will be presented for different ordered systems. The results are supported by simulations done in the framework of TDDFT for different crystal structures, incident intensities, wavelengths, and polarizations. These are used to predict the reconstructive capabilities at different configurations.

[1] Lakhotia et al., Nature, 2020, https://doi.org/10.1038/s41586-020-2429-z

Q 49.44 Wed 17:00 Tent

Engineering mirrors on the nanoscale: Cavity fiber mirrors by Qlibri — •Franziska Haslinger, Michael Förg, Manuel Nutz, Jonathan Noé, and Thomas Hümmer — Qlibri GmbH, Munich, Germany

Tunable optical-fiber-based micro-cavities offer a variety of applications such as sensing (Jiang, 2001), manipulation of solid-state systems (Dufferwiel, 2015), quantum information processing (Grinkemeyer, 2024), and absorption microscopy (Hümmer, 2016). The key component of such a system is an optical fiber with a precise spherically shaped depression in its end facet. This has previously not been manufacturable with reproducible results on a large scale.

Here, we present a fabrication method for high quality fibers to use in an open micro-cavity system utilizing laser induced thermal ablation and dielectric coating. With hundreds of shots, only ablating a few nanometers per shot, the resulting symmetry and fiber geometry are reproducible and reliable. Precise tuning of properties such as the mode volume, mode-matching and very short and very long operable cavity lengths is thus possible.

Tailoring their geometrical and optical properties allows to adapt to a variety of experimental needs. In selected experiments we demonstrate the performance of these fibers in state-of-the-art micro-cavity applications.

Q 49.45 Wed 17:00 Tent

Quantum Sensing with Nanodiamonds — •Zeeshan Nawaz Khan[1], Wanrong Li[1], Mike Johannes[1], Oliver Benson[1], and Masazumi Fujiwara[2] — [1]Insitute for Physics, HU Berlin, Germany — [2]Okayama University, Okayama, Japan

Nitrogen Vacancy (NV) NV centers in diamond, due to their compact size and operation at room temperature, are strong candidates for quantum sensing applications, i.e., magnetic field or temperature sensing. In our lab, we are developing a scanning confocal microscope setup which is optimized for diamond magnetometry in living cells at room temperature. Based on our previous work with C. Elegans [1], we will now focus on plant cells in collaboration with the *Integrative Center - Life in Space at Time*, IZ-LIST, at Humboldt-University. We present first results with our setup on the temperature dependence of optically detected magnetic resonance (ODMR). Practical issues such as sensitivity and fluorescence background in plant cells will be discussed. Future studies aim at the investigation of heat management in biological systems on the cellular level.