Q 55: Poster VI

Time: Thursday 17:00–19:00 Location: Tent B

Q 55.1 Thu 17:00 Tent B

Enhanced laser systems for photoassociation spectroscopy and cold Hg atoms — •Rudolf Homm and Thomas Walther — Technische Universität Darmstadt, Institut für Angewandte Physik, Laser und Quantenoptik, Schlossgartenstraße 7, 64289 Darmstadt

Cold Hg atoms in a magneto-optical trap offer opportunities for various experiments. The two stable fermionic isotopes are of interest for a new time standard based on an optical lattice clock employing the $^1S_0$ - $^3P_0$ transition at 265.6 nm. All stable isotopes can be used to form ultracold Hg dimers by photoassociation combined with vibrational cooling by applying a specific excitation scheme.

Our experimental setup consists of two UV laser systems and a magneto-optical trap for Hg atoms with a 2D-MOT for preselection of the desired isotopes. Both laser systems consist of a MOFA setup followed by two successive frequency doubling stages.

The cooling laser aims for stabilization at a fixed frequency and high output power. Therefore, we use Doppler-free saturation spectroscopy and a frequency doubling stage with an elliptical focus in the crystal. We can now produce more than 1 W at 253.7 nm without any sign of degradation in the BBO crystal.

We improved the output power of the spectroscopy laser to over 200 mW at 254.1 nm and are installing a feed-forward setup for the frequency doubling cavities to match the tuning range of the ECDL.

We will report on the status of the experiments.

Q 55.2 Thu 17:00 Tent B

Machine Learning techniques in Quantum Gas Transport Experiments — •Gabriel Müller[1], Victor J. Martínez-Lahuerta[1], Philipp-Immanuel Schneider[2,3], Ivan Sekulic[2,3], and Naceur Gaaloul[1] — [1]Leibniz University Hannover, Germany — [2]JCMwave GmbH, Berlin, Germany — [3]Zuse Institute Berlin, Germany

Precision atom interferometry (AI) requires an accurate quantum state engineering of the atomic ensembles at the input port. With Bose-Einstein Condensates (BECs), quick and robust transports have been experimentally realised using shortcut to adiabaticity (STA) protocols [N. Gaaloul et al., *Nature communications* 13(1), 7889 (2022)]. These STA protocols, however, as well as alternative approaches featuring Optimal Control Theory (OCT) [S. Amri et al. *Scientific Reports* 9(1), 5346 (2019)], are either limited by approximations to avoid expensive computations or by a limited number of control parameters.

To address these limitations, we propose a novel approach that utilises Bayesian optimisation with Gaussian processes as machine learning surrogates. We evaluate its level of control in comparison to STA and OCT methods and later extend the application to reduce the amount of approximations and open up more degrees of freedom.

Once these methods are verified, one could consider dual-species transport and improve its robustness by taking into account experimental imperfections on ground and in microgravity.

Acknowledgements: Funded by the German Space Agency (DLR) with funds under Grant No. 50WM2253A/B (AI-quadrat).

Q 55.3 Thu 17:00 Tent B

Preparation and Adaptation for the Integration of the BECCAL Laser System — •Marc Kitzmann[1], Matthias Schoch[1], Christoph Weise[1], Hamish Beck[1], Hrudya Thaivalappil Sunilkumar[1], Bastian Leykauf[1], Evgeny Kovalchuk[1], Jakob Pohl[1], Achim Peters[1], and the BECCAL Collaboration[1,2,3,4,5,6,7,8,9,10] — [1]HUB, Berlin — [2]FBH, Berlin — [3]JGU, Berlin — [4]LUH, Hannover — [5]DLR-SI, Hannover — [6]DLR-QT, Ulm — [7]UULM, Ulm — [8]ZARM, Bremen — [9]DLR, Bremen — [10]DLR-SC, Braunschweig

The Bose-Einstein Condensate and Cold Atom Laboratory (BECCAL) is a cold atom experiment designed for operation onboard the ISS. This multi-user facility will enable the exploration of fundamental physics with Rb and K BECs and ultra-cold atoms in microgravity, facilitating prolonged time- and ultra-low energy scales.

BECCAL must be operable without intervention for three years on the ISS. To reach that goal and match the stringent SWaP limitations, we have to fulfill strict product assurance requirements for the complex laser system. This not only involves higher cleanliness and ESD standards but also demands a meticulous integration process. To navigate this, the use of prototypes becomes imperative. In this context, the first essential integration tests, along with the adaptations made, based on the experience gained, will be presented.

This work is supported by the DLR with funds provided by the BMWK under grant number 50WP2102.

Q 55.4 Thu 17:00 Tent B

Optical zerodur bench system for the BECCAL ISS quantum gas experiment — •Faruk Alexander Sellami[1], André Wenzlawski[1], Esther del Pino Rosendo[1], Jean Pierre Maburger[1], Ortwin Hellmig[2], Klaus Sengstock[2], Patrick Windpassinger[1], and THE BECCAL TEAM[1,2,3,4,5,6,7,8,9,10,11] — [1]Institut für Physik, JGU Mainz — [2]ILP, Universität Hamburg — [3]Institut für Physik, HUB — [4]FBH, Berlin — [5]IQ & IMS, LUH, Hannover — [6]ZARM, Bremen — [7]Institut für Quantenoptik, Universität Ulm — [8]DLR-SC, Braunschweig — [9]DLR-SI, Hannover — [10]DLR-QT, Ulm — [11]OHB-SE, Bremen

The NASA-DLR collaboration BECCAL will be a multi-user-multi-purpose facility for the study of Bose Einstein Condensates in the microgravity environment of the International Space station. Its laser system provides light distribution and frequency stabilization and must be robust and compact to withstand the rocket launch and temperature fluctuations during the runtime on the ISS. To this end a toolkit based on the glass ceramic Zerodur is developed, that has already successfully been used on numerous space missions like FOKUS, KALEXUS or MAIUS. This poster discusses the optical modules developed and tested for BECCAL. Our work is supported by the German Space Agency DLR with funds provided by the Federal Ministry for Economic Affairs and Energy (BMWK) under grant number 50 WP1433, 50 WP 1703 and 50 WP 2103.

Q 55.5 Thu 17:00 Tent B

Purcell modified Doppler cooling of quantum emitters inside optical cavities — •Julian Lyne[1,2], Nico Bassler[1,2], Seong eun Park[3], Guido Pupillo[4], and Claudiu Genes[2,1] — [1]Department of Physics, Friedrich-Alexander-Universität Erlangen-Nürnberg, Staudtstraße 7, D-91058 Erlangen, Germany — [2]Max Planck Institute for the Science of Light, D-91058 Erlangen, Germany — [3]Daegu Gyeongbuk Institute of Science and Technology,333 Techno jungang-daero, Hyeonpung-eup, Dalseong-gun, Daegu, South Korea — [4]Centre Européen de Sciences Quantiques (CESQ), Institut de Science et d' Ingénierie Supramoléculaires (ISIS) (UMR7006) and Atomic Quantum Computing as a Service (aQCess), University of Strasbourg and CNRS, Strasbourg 67000, France

Standard cavity cooling of atoms or dielectric particles is based on the action of dispersive optical forces in high-finesse cavities. We investigate here a complementary regime characterized by large cavity losses, resembling the standard Doppler cooling technique. For a single two-level emitter a modification of the cooling rate is obtained from the Purcell enhancement of spontaneous emission in the large cooperativity limit. This mechanism is aimed at cooling of quantum emitters without closed transitions, which is the case for molecular systems, where the Purcell effect can mitigate the loss of population from the cooling cycle. We extend our analytical formulation to the many particle case governed by weak individual coupling but exhibiting collective strong Purcell enhancement to a cavity mode.

Q 55.6 Thu 17:00 Tent B

Laser system Designs in BECCAL for Cold Atom Experiments on ISS — •Hrudya Thaivalappil Sunilkumar[1], Jakob Pohl[1,2], Matthias Schoch[1], Christoph Weise[1], Hamish Beck[1], Marc Kitzmann[1], Bastian Leykauf[1], Evgeny Kovalchuk[1], Achim Peters[1,2], and The BECCAL Collaboration[1,2,3,4,5,6,7,8,9,10] — [1]HUB, Berlin — [2]FBH, Berlin — [3]JGU, Mainz — [4]LUH, Hannover — [5]DLR-SI, Hannover — [6]DLR-QT, Ulm — [7]UULM, Ulm — [8]ZARM, Bremen — [9]DLR, Bremen — [10]DLR, Braunschweig

Bose-Einstein Condensate and Cold Atom Laboratory (BECCAL) is a multi-user facility designed for operation on the ISS. This DLR and NASA collaboration enables the exploration of fundamental physics with Rb and K BECs and ultra-cold atoms in microgravity, facilitating prolonged timescales and ultra-low energy scales.

A ground-based replicate of the apparatus must also be built to support the operation of the flying experiment. The size, weight, and power constraints of such a Ground-based Test Bed (GTB) are relaxed, and so the laser system may be made from Commercial Off-The-Shelf (COTS) components. The design of this GTB laser system will be presented alongside the design of the flight hardware for a direct comparison.

Funding by DLR / BMWK grant numbers 50 WP 2102, 2103, 2104.

Q 55.7 Thu 17:00 Tent B

Two-dimensional grating magneto-optical trap — •Joseph Muchovo[1], Hendrik Heine[1], Aaditya Mishra[1], Julian Lemburg[1], Kai-Christian Bruna[1], Waldemar Herr[1,2], Christian Schubert[1,2], and Ernst M. Rasel[1] — [1]Leibniz Universität Hannover, Institut für Quantenoptik — [2]Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Institut für Satellitengeodäsie und Intertialsensorik (SI)

Ultracold atoms provide exciting opportunities for matterwave interferometry and tests of fundamental physics. When used as separate source chambers, Two-dimensional (2D) magneto-optical traps MOTs are advantageous in pre-cooling and faster loading of atoms to three-dimensional grating MOTs. To realise field applications of quantum sensors utilising cold atoms, there is need for simpler, more efficient and more compact sources.

In this poster, we will present the design, simulation and implementation of a 2D grating MOT requiring only a single input cooling beam. This will lead to a robust, compact and efficient source of ultracold atoms that can be used in field and space applications.

This work is supported by the German Space Agency (DLR) with funds provided by the Federal Ministry for Economic Affairs and Climate protection (BMWK) due to the enactment of the German Bundestag under grant number DLR 50RK1978 (QCHIP) and by the German Science Foundation (DFG) under Germany's Excellence Strategy - EXC-2123 QuantumFrontiers - 390837967.

Q 55.8 Thu 17:00 Tent B

Chip-Scale Quantum Gravimeter — •Julian Lemburg[1], Hendrik Heine[1], Joseph Muchovo[1], Aaditya Mishra[1], Kai-Christian Bruns[1], Ernst M. Rasel[1], Waldemar Herr[1,2], and Christian Schubert[1,2] — [1]Leibniz Universität Hannover, Institut für Quantenoptik — [2]Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institut für Satellitengeodäsie und Inertialsensorik (SI)

Atom interferometry with Bose-Einstein condensates enables very precise measurements of gravity with residual uncertainties on the order of nm/s^2. A low size, weight, and power consumption are essential for potential applications like ground or space-borne geodesy. This challenge can be tackled by using atom chips as they offer the desired magnetic fields at low power. Additionally, the atom chip can be equipped with a grating to facilitate the creation of a magneto-optical trap with a single beam or with a mirror for Raman interferometry.

In this poster, we will present a concept for a novel atom chip that combines the features of the grating and the mirror, that allows us to reduce the sensor head to shoe-box size. With this novel atom chip and an additional relaunch scheme an innovative single-beam quantum gravimeter is envisaged. Through the miniaturization and reduction of complexity of the sensor head, the transportability and usability of the quantum gravimeter are enhanced and ease in-field operations.

This work is funded by the German Research Foundation (DFG) in the CRC 1464 "TerraQ" (Project A03) and under Germany's Excellence Strategy (EXC 2123) "QuantumFrontiers".

Q 55.9 Thu 17:00 Tent B

Assessing interactions of Rb vapor with mirror coatings — •Constantin Avvacumov, Alexander Herbst, Klaus Zipfel, Ali Lezeik, Dorothee Tell, Jonas Klussmeyer, and Dennis Schlippert — Leibniz Universität Hannover, Institut für Quantenoptik

Atom interferometers are effective tools for fundamental research and geodesy applications, e.g. for gravimetry. Fundamentally, quantum projection noise motivates the development of high-flux sources of cold atoms. A typical first cooling stage is a two-dimensional magneto-optical trap (2D-MOT). In recent years, attempts to improve on 2D-MOTs' SWaP (size, weight, and power) budget raised questions regarding the compatibility of high-quality optical coatings exposed to alkali vapor, e.g. rubidium or potassium.

In this work, we systematically analyse the interaction of Rb vapor with highly reflective coating materials (gold, silver, aluminium, dielectric coatings). Our mirror testing setup enables simultaneous exposure of multiple mirror samples to a high flux of Rb atoms and measurement of their reflectivity degradation as a function of time and alcali partial pressure. The results will yield better understanding of the reactivity of alkali vapor with various materials and will thus be useful for future compact quantum optical experiments.

Q 55.10 Thu 17:00 Tent B

Comparison of Laser system Designs in BECCAL for Cold Atom Experiments on ISS — •Hrudya Thaivalappil Sunilkumar[1], Hamish Beck[1], Marc Kitzmann[1], Matthias Schoch[1], Christoph Weise[1], Bastian Leykauf[1], Evgeny Kovalchuk[1], Jakob Pohl[1], Achim Peters[1], and The BECCAL Collaboration[1,2,3,4,5,6,7,8,9,10] — [1]HUB, Berlin — [2]FBH, Berlin — [3]JGU, Mainz — [4]LUH, Hannover — [5]DLR-SI, Hannover — [6]DLR-QT, Ulm — [7]UULM, Ulm — [8]ZARM, Bremen — [9]DLR, Bremen — [10]DLR- SC, Braunschweig

Bose-Einstein Condensate and Cold Atom Laboratory (BECCAL) is a multi-user facility designed for operation on the ISS. This DLR and NASA collaboration enables the exploration of fundamental physics with Rb and K BECs and ultra-cold atoms in microgravity, facilitating prolonged timescales and ultra-low energy scales.

A ground-based replicate of the apparatus must also be built to support the operation of the experiment. The size, weight, and power constraints of such a Ground-based Test Bed (GTB) are relaxed, and so the laser system may be made from Commercial Off-The-Shelf (COTS) components. The design of this GTB laser system will be presented alongside the design of the flight hardware for a direct comparison.

This work is supported by the DLR with funds provided by the BMWK under grant number 50WP2102.

Q 55.11 Thu 17:00 Tent B

Driving Raman transitions using a nano-structured atom chip — •Kai-Christian Bruns[1], Julian Lemburg[1], Hendrik Heine[1], Joseph Muchovo[1], Aaditya Mishra[1], Waldemar Herr[2], Christian Schubert[2], and Ernst M. Rasel[1] — [1]Leibniz Universität Hannover, Institut für Quantenoptik — [2]Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institut für Satellitengeodäsie und Inertialsensorik (SI)

In the field of quantum sensing, atom interferometers are a crucial tool for high-resolution measurements. Unfortunately, current systems remain bulky and power consuming making them unreliable for field applications. Grating atom chips simplify quantum sensors by enabling the trapping of atoms in a MOT with a single incident beam.

In this poster, we show measurements of Raman transitions on an atom chip with a grating with a single incident modulated laser beam as well as simulations, which support the results. Using the diffracted beams from the grating in combination with the incoming beam, we can drive Raman transitions along different axes allowing for the construction of a compact multi-axis atom interferometer.

This work is supported by the German Space Agency (DLR) with funds provided by the Federal Ministry for Economic Affairs and Climate protection (BMWK) due to the enactment of the German Bundestag under grant number DLR 50WM1947 (KACTUS II), by the German Research Foundation (DFG) in the CRC 1464 'TerraQ' (Project A03) and from 'QVLS-Q1' through the VW foundation and the ministry for science and culture of Lower Saxony.

Q 55.12 Thu 17:00 Tent B

The MAIUS-2 laser system — •Pawel Arciszewski[1], Klaus Döringshoff[1], Achim Peters[1], and The MAIUS Team[1,2,3,4,5] — [1]Institut für Physik, Humboldt-Universität zu Berlin — [2]Ferdinand-Braun-Institut, Berlin — [3]ZARM, Zentrum für Angewandte Raumfahrttechnologie und Mikrogravitation, Bremen — [4]Institut für Physik, JGU Mainz — [5]IQO, Leibniz Universität Hannover

The first production of a Bose-Einstein condensate in space carried out in the MAIUS-1 sounding rocket mission in January 2017 paved the way for more advanced experiments with ultra-cold matter in space. The goal of the MAIUS-2 mission is the creation of mixtures of ultracold rubidium and potassium atoms onboard a sounding rocket.

To this end, an advanced laser system was developed, that can provide the light required for simultaneous laser cooling of rubidium and potassium as well as imaging of the Bose-Einstein condensates. The system was realized and qualified to meet the demands of a sounding rocket mission.

We report on the performance of the system, its assembly process, the used technologies as well as tests carried out to assure that the laser system can face the needs of the mission.

This work is supported by the German Space Agency (DLR) with funds provided by the Federal Ministry of Economics and Technology (BMWi) under grant number 50 WP 1432.

Q 55.13 Thu 17:00 Tent B

PRIMUS - all-optical source of ultracold rubidium atoms for microgravity — •Marian Woltmann[1], Jan Eric Stiehler[1], Marius Prinz[1], Sven Herrmann[1], and The PRIMUS-Team[1,2] — [1]Center of Applied Space Technology and Microgravity (ZARM), University of Bremen, Germany — [2]Institute of Quantum Optics, LU Hannover, Germany

Atom interferometers based on ultracold atoms have proven to be effective tools in measuring weakest forces. As their sensitivity scales with the squared interrogation time, the application of matter wave interferometers in microgravity offers the potential of highly increased sensitivities. While many cold-atom based microgravity-experiments use magnetic chip traps, the PRIMUS-project develops an all-optical trap as an alternative source of ultracold rubidium atoms in a drop tower experiment. Solely using optical potentials offers unique advantages, e.g. improved trap symmetry, trapping of all magnetic sub-levels and the accessibility of Feshbach resonances. We demonstrated rapid Bose-Einstein condensation of ^{87}Rb in less than two seconds on ground while now focusing on the optimization for an efficient preparation in microgravity. The PRIMUS-project is supported by the German Space Agency DLR with funds provided by the Federal Ministry for Economic Affairs and Climate Action under grant number DLR 50 WM 2042.

Q 55.14 Thu 17:00 Tent B

Experimental realization of a two-dimensional sodium potassium mixture — •Brian Bostwick, Anton Eberhardt, Malaika Göritz, Lilo Höcker, Jan Kilinc, Helmut Strobel, and Markus K. Oberthaler — Kirchhoff Institut für Physik, Heidelberg, Deutschland

Multiple-species Bose-Einstein condensates provide versatile platforms for many-body quantum dynamics. Mixtures of sodium and potassium are particularly attractive due to the substantial interspecies and intraspecies Feshbach resonances, providing a broad range of tunability via magnetic fields. Experiments in reduced dimensions enable probing the excitations on the atomic cloud with high spatial resolution. We show the latest developments of our experimental setup for the production and imaging of a dual-species Bose-Einstein condensate in 2D.

Q 55.15 Thu 17:00 Tent B

An ion-trap chip with integrated elements for a scalable quantum processor — •Benjamin Bürger, Ivan Boldin, Christof Wunderlich, Saptarshi Biswas, and Daniel Busch — University of Siegen, Germany

Scaling up a trapped ion-based quantum information processing to hundreds of qubits could be achieved by arranging several trapping zones on an ion-trap-chip. The zones can be entangled by means of shuttling ions between the zones [1]. Here, we use hyperfine levels as qubits of 171Yb+ ions trapped in a planar microstructured trap with MAgnetic Gradient Induced Coupling (MAGIC) between them [2]. We report on the design and characterization of this novel trap chip that includes an integrated microwave electrode for efficient single-qubit manipulations, permanent magnets for creating a field gradient of 100 T/m required for multi-qubit gates via MAGIC, and an ion transport zone for testing the qubit coherence properties when shuttling the ion in and out of the interaction zone. The trap chip is designed to serve as a basis for a up-scalable device.

References:

[1] D. Kielpinski, C. Monroe and D. J. Wineland, Nature 2002 Vol. 417 Pages 709-711

[2] Piltz et al 2016

Q 55.16 Thu 17:00 Tent B

Towards Sympathetic Cooling of Ytterbium Ions Using Sub-Doppler Cooled Barium Ions in a Novel Planar Micro-Structured Segmented Linear Paul Trap — •Pedram Yaghoubi, Florian Köppen, Ernst Alfred Hackler, Dorna Niroomand, Michael Johanning, and Christof Wunderlich — Department of Physics, School of Science and Technology, University of Siegen, 57068 Siegen, Germany

Sympathetic cooling of trapped ions in an inhomogeneous magnetic field is important for various applications in quantum information processing, quantum simulation, and precision measurements. We work towards sub-Doppler cooling of Barium ions and their use for sympathetically cooling Ytterbium ions [1]. We use a novel planar microstructured segmented linear Paul trap to trap Yb+ and Ba+ ions simultaneously. Two schemes for Electromagnetically Induced Transparency (EIT) cooling tailored to the use in inhomogeneous magnetic fields are investigated, the first one takes advantage of Zeeman sublevels of the S1/2-P1/2 transition, and the second includes sublevels of the D3/2 state in 138Ba+. We showcase the outcomes of numerical simulations for various cooling methods, indicating that ions can achieve mean phonon numbers of 0.9 at rates of a few kHz in the axial mode at 150 kHz secular trap frequency. Furthermore, details of the experimental setup and first measurement results are presented. Specifically, we investigate tailored EIT cooling schemes in the absence and presence of magnetic field gradients. References [1] K. Sosnova, et al., Physical Review A 103, 012610 (2021)

Q 55.17 Thu 17:00 Tent B

Elements for quantum computing with trapped ions using cryogenic electronics — •Rodolfo Munoz-Rodriguez, Dorna Niroomand, Ivan Boldin, Daniel Busch, Patrick Huber, Markus Nünnerich, and Christof Wunderlich — Department of Physics, School of Science and Technology, University of Siegen, 57068 Siegen, Germany

Coherently controlling internal and motional degrees freedom of trapped ions is a prerequisite for using them for quantum information processing. Scaling up ion traps such that control of a large number of ions becomes possible requires typically excellent vacuum (XHV) and low heating rates of the ions motion, both are achieved in a cryogenic environment. At the same time, electronics generating electro-magnetic fields for ion control should be placed on or near micro-structured traps.

We set up an apparatus for investigating cryogenic (4 K) planar ion traps with electrodes controlled by cryogenic digital-to-analog-converters (DACs). Our trap chip architecture includes elements for creating a static magnetic field gradient which allows the use of radio frequency fields for coherent control. The integrated DACs allow for flexibly shaping the trapping potential for the targeted control and optimization of the interaction between ions for specific gate operations, and transport ions between different trapping zones. The first trap generation will consist of a single layer metallization layer, a single processing zone, 26 DC electrodes and a combination of integrated and external DACs.

Q 55.18 Thu 17:00 Tent B

Double imaging and stray light suppression for a multi species Paul trap for quantum computing — •Ernst Alfred Hackler, Pedram Yaghoubi, Florian Köppen, Hendrik Siebeneich, and Christof Wunderlich — Department of Physics, School of Science and Technology, University of Siegen, 57068 Siegen, Germany

Multi-species ion crystals are useful, for example, for quantum information processing with trapped ions or for quantum logic spectroscopy. Here, we report on the development and performance of an imaging system for mixed ion crystals of Barium and Ytterbium ions. Since the wavelengths of the resonance fluorescence of these two ion species are far apart (369 nm and 493 nm, respectively), dispersion in a refractive imaging system has to be considered. To image both species simultaneously, a double imaging system was designed and built, taking into account dispersion and chromatic aberrations. At the same time, this set-up efficiently suppresses stray light. In this poster, I present the simulation and measurement results that were used to quantify the performance of this set up.

Q 55.19 Thu 17:00 Tent B

Towards a Quantum Gas Microscope for fermionic NaK molecules — •Leonard Bleiziffer, Shrestha Biswas, Sebastian Eppelt, Xingyan Chen, Christine Frank, Timon Hilker, Immanuel Bloch, and Xinyu Luo — Max Planck Institute for Quantum Optics, Garching, Germany

This poster presents the development of a quantum gas microscope tailored for fermionic sodium-potassium (NaK) molecules in an optical lattice. Our approach involves disassembling the molecules and then applying Raman Sideband cooling to the potassium atoms. This technique will enable the imaging of potassium atoms through the utilization of thousands of scattered photons, ensuring their retention within the lattice despite the heating due to photon recoil. We address the challenges associated with implementing Raman sideband cooling in such a setup, particularly the required Raman-and repumper-beams apparent from the hyperfine fermionic potassium level structure. Also, we describe the plan for a modification of the optical lattice into a deep, bow-tie configuration to reach the Lamb-Dicke regime necessary for Raman Sideband cooling. As a demonstrative example, we want to explore the long-range XY model, which is particularly noteworthy as it can only be simulated in the context of the long-range interactions characteristic of polar molecules, a feat not achievable with standard atomic quantum simulators. We currently work on a tensor-network simulation of the long-range XY model showcasing the dynamics of the global spin-polarization that we later want to compare to the quantum simulation utilizing the new Quantum gas microscope.

Q 55.20 Thu 17:00 Tent B

Non-abelian invariants in periodically-driven quantum rotors — •Volker Karle, Areg Ghazaryan, and Mikhail Lemeshko — Institute of Science and Technology Austria, Am Campus 1, 3400 Klosterneuburg

This poster explores the role of topological invariants in the non-equilibrium dynamics of periodically-driven quantum rotors, inspired by experiments on closed-shell diatomic molecules driven by periodic, far-off-resonant laser pulses. This approach uncovers a complex phase space with both localized and delocalized Floquet states. We demonstrate that the localized states are topological in nature, originating from Dirac cones protected by reflection and time-reversal symmetry. These states can be modified through laser strength adjustments, making them observable in current experiments through molecular alignment and observation of rotational level populations. Notably, in scenarios involving higher-order quantum resonances leading to multiple Floquet bands, the topological charges become non-Abelian. This results in the remarkable finding that the exchange of Dirac cones across different bands is non-commutative, enabling non-Abelian braiding, paving the way for the study of controllable multi-band topological physics in gas-phase experiments with small molecules, as well as for classifying dynamical molecular states by their topological invariants.

Q 55.21 Thu 17:00 Tent B

Signatures of many-body localization in a two-dimensional lattice of ultracold polar molecules with disordered filling — •Timothy J. Harris[1,2,3], Andrew J. Groszek[1], Arghavan Safavi-Naini[4,5], and Matthew J. Davis[1] — [1]ARC Centre of Excellence for Engineered Quantum Systems, School of Mathematics and Physics, University of Queensland, Brisbane, QLD 4670, Australia — [2]Department of Physics and Arnold Sommerfeld Center for Theoretical Physics, Ludwig-Maximilians-Universität München, 80333 München, Germany — [3]Munich Center for Quantum Science and Technology, 80799 München, Germany — [4]Institute for Theoretical Physics, Institute of Physics, University of Amsterdam, Science Park 904, 1098 XH Amsterdam, the Netherlands — [5]QuSoft, Science Park 123, 1098 XG Amsterdam, the Netherlands

We present our work exploring many-body localization (MBL) in systems of ultracold polar molecules confined to a two-dimensional (2D) optical lattice with disordered filling. We perform large-scale exact diagonalization simulations to characterize the dynamics and eigenstate properties of the system. We observe several key signatures of MBL as the relative strength of the spin-density interactions is increased, including retention of initial state memory in the system's long-time dynamics, logarithmic growth of bipartite entanglement entropy and a transition to Poissonian level-spacing statistics. Our predictions may be realised in state-of-the-art quantum gas microscope experiments with alkali-metal dimers, and open exciting new avenues to explore non-equilibrium many-body physics with ultracold polar molecules.

Q 55.22 Thu 17:00 Tent B

Evaluation of the potential of PL5-7 centers in 4H-SiC for spin-based quantum sensing — •Raphael Wörnle[1], Jonathan Körber[1], Timo Steidl[1], Georgy Astakhov[2], Florian Kaiser[1,3], and Jörg Wrachtrup[1] — [1]3rd Institute of Physics, IQST and Research Centre SCoPE, University of Stuttgart, ZAQ, Stuttgart, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Institute of Ion Beam Physics and Materials Research, Dresden, Germany — [3]MRT Department, Luxembourg Institute of Science and Technology, Belvaux, Luxembourg

4H-silicon carbide (SiC) has emerged as a promising platform to host point defects with possible applications in quantum technologies, such as distributed quantum computing or sensing. However, the typically detected spin signal contrast of color centers in SiC and the count rates are quite low.

Recently, divacancies located near stacking faults in 4H-SiC (PL5- 7 centers) have drawn considerable attention. They impress with a high readout contrast and a high photon count rate, making them competitive with the NV center in diamond. However, as the defects are relatively new, their theoretical properties are unexplored and their creation is not yet deterministically possible.

Here, we present the generation of PL5-7 centers through ion irradiation and characterize their spin properties via optically detected magnetic resonance (ODMR) and pulsed measurements at room temperature. Further, we show the coupling between a nuclear spin and single defect spins.

Q 55.23 Thu 17:00 Tent B

Computer Simulation Framework for coherent two-dimensional electronic Spectroscopy — •Joel Ströhmann and Mario Agio — Laboratory of Nano Optics, Universität Siegen, Siegen, Germany

2D spectroscopy represents the electric field intensity as a correlation map of two independent variables, e.g. the excitation and emission frequency of a quantum system. This allows the deconvolution of different spectral features along the second axis, in particular the presence of coherent couplings in off-diagonal peaks between the coupled states. My masters project was to summarize the mathematical formulation of the optical response function for an arbitrary pulse trail based on perturbation theory and develop a software framework for the automated computation of the optical response. The system's properties and the pulse shape are provided as external parameters to the software and the numerical simulation is carried out either with full integration over the pulse envelope or in the semi-impulsive limit. In particular, the computation of the optical response of an arbitrary number of two-level systems with arbitrary, lossless pair-wise couplings can be computed automatically including dephasing and population relaxation for each two-level system.

Q 55.24 Thu 17:00 Tent B

Quantum photonics using color centers in a diamond membrane coupled to a photonic structure — •Surena Fatemi[1,2], Aurélie Broussier[2], Roy Konnoth Ancel[2], Jan Fait[3], Christophe Couteau[2], and Christoph Becher[1] — [1]Fachrichtung Physik, Universität des Saarlandes, Campus E2.6, 66123, Saarbrücken, Germany — [2]Light, nanomaterials, nanotechnologies (L2n), EMR CNRS 7004, Université de Technologie de Troyes (UTT) 12 rue Marie Curie, CS 42060, 10004 Troyes cedex, France. — [3]FZU - Institute of Physics of the Czech Academy of Sciences, Prague

In recent years, color centers of wide band-gap materials have drawn a lot of attention due to their superior properties for quantum technologies. One of the most interesting color center systems are the group-IV color centers in diamond due to their long spin coherence times and excellent optical properties such as narrow optical emission lines, high spectral stability, and bright single-photon emission. However, one of the main obstacles for realization of a quantum device exploiting color centers is the lack of efficient out-coupling of photon emission from the diamond itself which leads to low photon rates. We consider a group-IV color center in a diamond membrane evanescently coupled to photonic waveguides such as Silicon-on-Insulator and Ion-Exchanged glass waveguides. We present design studies and simulations including the membrane geometry, coupling interface, and waveguide structures using Finite-Element-Method simulations and Monte-Carlo optimization to improve the out-coupling of the emission in order to achieve high photon rates.

Q 55.25 Thu 17:00 Tent B

A triggered narrow-band photon number adjustable emitter using organic molecule — •Yijun Wang, Subhabrata Ghosh, Maximilian Luka, and Ilja Gerhardt — Institut für Festkörperphysik, Leibniz Universität Hannover, Appelstraße 2, D-30167 Hannover, Germany

We utilize single molecule microscopy under cryogenic conditions as single photon emitters. Our near-sodium-resonance photon emitters' robustness allows for triggered photon emission with a narrow bandwidth and an adjustable photon count. We implement off-resonant excitation on DBATT molecule and detect the near-sodium resonance photons after a Faraday filter. The photons are generated with a "button press" style and are triggered. The single photon purity is well proved by the auto-correlation function. The photon number per "button press" can be adjusted by tuning an external electric field.

Q 55.26 Thu 17:00 Tent B

Organic molecule photon number adjustable quantum emitters — •Yijun Wang, Subhabrata Ghosh, Maximilian Luka, and Ilja Gerhardt — Institut für Festkörperphysik, Leibniz Universität Hannover, Appelstraße 2, D-30167 Hannover, Germany

We utilize single molecule microscopy under cryogenic conditions to implement non-classical photon sources. Our near-sodium-resonant photon emitters allow for triggered photon emission with a narrow bandwidth and an adjustable photon number per trigger. We implement off-resonant excitation on DBATT molecules and detect the near-sodium resonant photons behind an atomic vapor filter based on the Faraday effect. The photons are generated in a "press-button" style. Our emitters could behave as very good single photon emitters. The single photon purity is well justified by the low value of $g^{(2)}(0)$. Alternatively, we can adjust the photon number per "press-button" by the DC Stark shift.

Q 55.27 Thu 17:00 Tent B

Organic molecule photon number adjustable quantum emitters — •Yijun Wang, Subhabrata Ghosh, Maximilian Luka, and Ilja Gerhardt — Institut für Festkörperphysik, Leibniz Universität Hannover, Appelstraße 2, D-30167 Hannover, Germany

We utilize single molecule microscopy under cryogenic conditions to implement non-classical photon sources. Our near-sodium-resonant photon emitters are based on organic molecules, and allow for triggered photon emission with a narrow bandwidth and an adjustable photon number per trigger. We implement off-resonant excitation on DBATT molecules and detect the near-sodium resonant photons behind an atomic vapor filter based on the Faraday effect. The photons are generated in a "press-button" style. The single photon purity is well justified by the low value of $g^{(2)}(0)$. Alternatively, we can adjust the photon number per trigger by the DC Stark shift.

Q 55.28 Thu 17:00 Tent B

Homogeneous etching of nanofabricated waveguide structures in 4H-SiC for quantum information applications — •Nithin Thomas Alex, Marcel Krumrein, and Jörg Wrachtrup — 3rd Institute of Physics, IQST, and Research Centre SCoPE, University of Stuttgart, Germany

Silicon Carbide (SiC) is a wide bandgap semiconductor used abundantly in high power electronics applications. It has also found its way into the quantum industry as it can host color centers with great spin-optical properties. Integration of these defects into nanophotonic structures, such as waveguides and photonic crystal cavities (PCCs), is key to implement quantum network nodes. Even though the research in this field is making steady progress, proper fabrication techniques for the scalability of these structures still needs to be addressed. The current techniques, such as using a Faraday cage, for fabricating waveguides and PCCs with a triangular cross-section[1] lack homogenous etching on the wafer scale. To overcome these challenges, we have been testing various recipes in the state-of-the-art reactive ion beam etching (RIBE) device from OXFORD instruments, called Ionfab 300+.

[1] S. Majety, V. A. Norman, L. Li, M. Bell, P. Saha, and M. Radulaski, *Quantum photonics in triangular-cross-section nanodevices in silicon carbide,* Journal of Physics: Photonics, vol. 3, p. 34008, 2021.

Q 55.29 Thu 17:00 Tent B

Optimizing Sensing using NV-centers via Spin-to-Charge conversion — •Tobias Feuerbach, Nimba Pandey, Oliver Opaluch, and Elke Neu-Ruffing — Rheinland Pfälzische Technische Universität Kaiserslautern, Fachbereich Physik, Erwin-Schroedinger-Str., Bau 56, Raum 278

Quantum sensing leverages quantum mechanics to achieve unprecedented levels of precision in measuring physical quantities. Nitrogen-vacancy (NV) centers in diamond are among the most promising candidates in this fast-emerging field. They can be used to measure magnetic fields, pressure and temperature, for example. Single NV centers at room temperature have been shown to enable measurement sensitivity in the $nT/\sqrt{Hz}$ range and nanoscale resolution at the same time [1]. Despite the versatility and sensitivity of diamond-based sensors, the inherent noise of the readout process restricts their potential. The classical readout relies on spin state dependent fluorescence and thus is limited by photon shot noise. Spin-to-charge conversion (SCC) based methods offer a remedy to this issue and achieve higher readout contrast and better readout fidelity. Previous works have shown a five-fold improvement in the sensitivity using SCC based readout [2]. In this work, we present the basic idea of SCC based readout, and demonstrate the setup design required to enable the method. The primary goal of the work is to utilize SCC based methods to study the host material along with its application for different sensing protocols.

[1] Wrachtrup et al., Phys. Rev. Lett., vol.102, p.057403, Feb 2009.
[2] Walsworth et al., Phys. Rev. Appl., vol.11, p.064003, Jun 2019.

Q 55.30 Thu 17:00 Tent B

Ultrafast single-photon detection at high repetition rates based on optical Kerr gates under focusing — •Amr Farrag[1], Abdul-Hamid Fattah[1], Assegid Mengistu Flatae[1], and Mario Agio[1,2] — [1]Laboratory of Nano-Optics and Cμ, University of Siegen, 57072 Siegen, Germany — [2]National Institute of Optics (INO), National Research Council (CNR), 50125 Florence, Italy

The ultrafast detection of single photons' emitters is currently bound by the limited time resolution (a few picoseconds) of the available single-photon detectors. Optical Kerr gates can offer a faster time resolution, but until now they have been applied to ensembles of emitters. Here, we demonstrate through a semi-analytical model that the ultrafast time-resolved detection of single quantum emitters can be possible using an optical Kerr shutter at GHz rates under focused illumination. This technique provides sub-picosecond time resolution, while keeping a gate efficiency at around 85%.

Q 55.31 Thu 17:00 Tent B

Mobile quantum sensing setup based on Nitrogen-Vacancy centers in diamond — •Wanrong Li[1], Oliver Gerull[1], Mike Johannes[1], Florian Böhm[1], Masazumi Fujiwara[2], and Oliver Benson[1] — [1]Humboldt-Universität, Berlin, Germany — [2]Okayama University, Okayama, Japan

Nitrogen-Vacancy (NV) defect centers in diamonds have exhibited remarkable quantum properties with diverse applications in quantum technology and sensing. Here we introduce a mobile setup designed for efficient quantum sensing such as on-site magnetometry based on the exceptional sensitivity of NVs to magnetic fields at the nanoscale. We measured the Optically Detected Magnetic Resonance (ODMR) [1] spectra of NVs, by sweeping the microwave frequency and monitoring the fluorescence signal. The positions and shapes of the dips in the spectrum provide information about the NV center's electron spin properties, enabling precise measurement for magnetic field variations. The versatility of this setup allows for exploration not only of ensembles of NVs but also at the single NV level. Additionally, the setup enables T2 (spin-spin relaxation time) measurements [2], providing insights into the coherence times of the spin states. Looking ahead, this mobile platform has the potential to serve as a robust tool for conducting sensing in biophysics research, and other studies that strictly required on-site measurements.

References:
[1] M. Fujiwara et al., Phys. Rev. Res. 2, 043415 (2020).
[2] F. Böhm, Ph.D. thesis, Humboldt-Universität zu Berlin (2022).

Q 55.32 Thu 17:00 Tent B

Using low-cost Blu-Ray Optical Pickup Units for Measurement of Single Photon Emission from NV-Centers — •Simon Klug[1], Jonas Homrighausen[1], Peter Glösekötter[2], and Markus Gregor[1] — [1]Department of Engineering Physics, University of Applied Science, Münster, Germany — [2]Department of Electrical Engineering and Comuputer Science, University of Applied Science, Münster, Germany

Color centers in diamonds have proven to be promising quantum emitter candidates for many applications in quantum information and quantum sensing. Not only do they serve as efficient single photon sources at room temperature, but they also enable the analysis of spin dynamics and spin coherence times. Conventional detection approaches using high-NA microscope objectives and intricate piezo positioning systems [1] have turned out to be expensive and sophisticated [2]. In response to these challenges, our setup utilizes Blu-Ray optical pickup units (OPUs) [3] and offers a cost-effective solution to enhance access to single-photon research. These OPUs have built-in aspheric lenses and positioning mechanisms which we utilize to identify emitters and successfully measure single photon emssion from NV nanodiamonds.

[1] B. Rodiek et al., Optica, vol. 4, no. 1, Jan. 2017.
[3] T. Schröder et al., Opt. Express, vol. 20, no. 10, May 2012.
[4] T.-J. Chang et al., Commun. Phys., vol. 4, no. 1, Feb. 2021.

Q 55.33 Thu 17:00 Tent B

Artificial light-harvesting complexes based on silicon-vacancy color centers in diamond. — •Laurin Göb[1,2], Assegid Flatae[1,2], Florian Sledz[1,2], Lukas Strauch[1,2], Joel Ströhmann[1,2], and Mario Agio[1,2] — [1]Laboratory of Nano-Optics, University of Siegen, 57072 Siegen, Germany — [2]Cμ - Research Center of Micro- and Nanochemistry and (Bio)Technology, University of Siegen, 57068 Siegen, Germany

Light-harvesting complexes (LHC) are nanoscale structures found in photosynthetic organisms. They are ring-like structures used to efficiently absorb light and transport quantum excitations to induce chemical processes. Constructing artificial complexes, that mimic these natural phenomena, allow to develop new functional materials for quantum photonics. In this work, we introduce LHC based on silicon-vacancy color-centers in diamond coupled to gold nanostructures and study their photophysics.

Q 55.34 Thu 17:00 Tent B

Surface-supported single organic molecules demonstrate lifetime-limited linewidths — •Ashley Shin[1], Masoud Mirzaei[1,2], Alexey Shkarin[1], Johannes Zirkelbach[1], Jan Renger[1], Tobias Utikal[1], Stephan Götzinger[1,2,3], and Vahid Sandoghdar[1,2] — [1]Max Planck Institute for the Science of Light, 91058 Erlangen, Germany — [2]Department of Physics, Friedrich-Alexander University Erlangen-Nürnberg, 91058 Erlangen, Germany — [3]Erlangen Graduate School in Advanced Optical Technologies (SAOT), Friedrich-Alexander University Erlangen-Nürnberg, 91052 Erlangen, Germany

Polycyclic aromatic hydrocarbons (PAHs) have robust photophysics, synthetic tunablity, and facile handling properties, making them an excellent platform for molecular quantum optics. The PAH molecules are often embedded in crystals to minimize environmental dephasing, which limits non-optical access that otherwise can be useful for nanoprobe technologies or novel nanophotonic designs. In this work, we investigate dibenzoterrylene (DBT) molecules placed on top of pristine anthracene crystals. Despite being at the interface between vacuum and crystal, the DBT molecules demonstrate Fourier-limited linewidths at sub-Kelvin temperatures. The on-surface DBTs emit at higher frequencies and longer lifetimes from their embedded counterparts, while following a similar temperature-dependent dephasing trend. We report via a comprehensive set of fluorescence measurements that desired photophysical properties of DBTs as single quantum emitters are preserved on the surface.

Q 55.35 Thu 17:00 Tent B

Identifying Yellow Color-Centers in Hexagonal Boron-Nitride — •Pablo Tieben[1,2] and Andreas W. Schell[3] — [1]PTB, Bundesallee 100, 38116 Braunschweig, Deutschland — [2]LUH, Inst. f. Festkörperphysik, Appelstrasse 2, 30167 Hannover, Deutschland — [3]JKU, Inst. f. Halbleiter und Festkörperphysik, Altenberger Str. 69, 4040 Linz, Österreich

Single photon emitters are an essential resource for the rapidly developing field of quantum technologies. Color centers in hexagonal boron nitride (hBN) pose a suitable system for single photon generation due to their bright and stable photon emission at room temperature. Due to the large bandgap of the material a plethora of emitters across the visible and near-infrared spectrum have been discovered. Some emitters exhibit intricate level structures with the possibility for advanced optical control. Recently the origin of emitters in the yellow spectral region have been tied to carbon related defects, but the exact atomic composition remains elusive. Based on previously found connections between the emission and excitation characteristics of these emitters, we perform additional spectroscopic measurements under simultaneous excitation with multiple wavelengths. We analyze the emission spectrum, photon flux and temporal emission stability as well as the second-order autocorrelation for fixed primary and varying secondary excitation wavelength. The dependency of these properties on the secondary wavelength can reveal additional information about the underlying level structure. Paired with theoretical predictions for different carbon defects the atomic origin can be narrowed down even further.

Q 55.36 Thu 17:00 Tent B

SiV centers in nanodiamonds for quantum networks — •Richard Waltrich[1], Marco Klotz[1], Andreas Tangemann[1], Lukas Antoniuk[1], Niklas Lettner[1], Viatcheslav Agafonov[2], and Alexander Kubanek[1] — [1]Institut für Quantenoptik Universitat Ulm — [2]Universite Francois Rabelais de Tours

The realization of a quantum network is of great interest. The combination of the good optical and spin properties of group IV defects in diamond with established technologies such as photonic structures brings the realization of a quantum network node within reach. We present measurements of characteristic properties of SiV centers in nanodiamonds compared to bulk diamond, showing key features for the realization of a quantum network node such as improved coherence times, spin control, and indistinguishable photons.

Q 55.37 Thu 17:00 Tent B

towards coherent dipole-dipole coupling: cryogenic single-molecule microscopy of dbatt dimers — •Siwei Luo[1,2], Michael Becker[1], Hisham Mazal[1], Alexey Sharkin[1], Aleksandr Oschepkov[3], Konstantin Amsharov[3], Tim Hebenstreit[1,2], Jan Renger[2,1], Vahid Sandoghdar[1], and Stephan Götzinger[1,2] — [1]Max Planck Insitute for the Science of Light, Erlangen, Germany — [2]Department of Physics, Friedrich-Alexander University Erlangen-Nürnberg (FAU), Erlangen, Germany — [3]Insitute 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 decay paths. Such pairs of molecules have only been found in the past by brute force methods, since molecules are usually randomly doped into the host matrix and high doping levels cannot be tolerated. To address this longstanding issue, our new approach is based on recent developments in organic chemistry where an organic linker with a known length of less than 2nm can connect two fused 2D acene emitters. Here we will present cryogenic single-molecule spectroscopy and localization microscopy studies on 2,3,8,9-dibenzanthanthrene (DBATT) dimers. By embedding these dimers in shock-frozen tetradecane matrices, they clearly demonstrate lifetime-limited linewidths and similar fluorescence spectra as single DBATT molecules. Our results are a first step towards a routine investigation of cooperative phenomena using molecular dimers.

Q 55.38 Thu 17:00 Tent B

Utilizing Integrated Single Photon Emitters on Waveguides for Testing Extended Quantum Theories — •Josefine Krause[1], Mohammad Nasimuzzaman Mishuk[1], Kabilan Sripathy[1], Najme Ahmadi[1], Sebastian Ritter[1], Mostafa Abasifard[1], Giacomo Corielli[3], and Tobias Vogl[1,2] — [1]Friedrich Schiller University Jena, Institute of Applied Physics, Albert-Einstein-Straße 15, 07745 Jena — [2]Technical University of Munich, TUM School of Computation, Information and Technology, Arcisstraße 21, 80333 München — [3]Consiglio Nazionale delle Ricerche (IFN-CNR), Istituto di Fotonica e Nanotecnologie, Piazza Leonardo da Vinci 32, 20133 Milano, Italy

Efficient utilization of quantum information processing, for example for satellite-based quantum communication, relies on the miniaturization and combination of components into compact, space-compatible structures. For this, we follow the hybrid approach of integrating quantum emitters hosted in two-dimensional materials onto a photonic chip containing femtosecond laser-written waveguides. The single photon source (SPS), which is a fluorescent defect in hexagonal boron nitride, operates at room temperature and has potential to outperform laser-based decoy quantum key distribution protocols with a higher data rate. The waveguides form a tunable three-path interferometer that offers to test the boundary of a fundamental postulate of quantum physics, being Born's rule, by measuring higher order interferences. Both this, and the purity of the SPS will be tested on a 3U CubeSat in microgravity as part of the QUICK3 mission.

Q 55.39 Thu 17:00 Tent B

Spin Properties of SiV Center in Nanodiamonds — •Kathrin Schwer[1], Marco Klotz[1], Andreas Tangemann[1], Richard Waltrich[1], Viatcheslav Agafonov[2], and Alexander Kubanek[1] — [1]Institut für Quantenoptik Universität 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 55.40 Thu 17:00 Tent B

Investigating exciton-plasmon interaction in an ion-exchanged glass covered by silver iodide nanoparticles — •Razieh Talebi — Department of Physics, University of Isfahan, 81747-73441 Isfahan, Iran — Department of Physics, University of Isfahan, 81747-73441 Isfahan, Iran

Silver nanoparticles embedded in dielectric or semiconductor films have attractive optical properties that make these materials to be used as plasmonic sensors and waveguides. The silver ions are doped in a thin layer of glass under ion-exchange process. Subsequently, the silver nanoparticles can form in this layer by post-annealing treatment which is tracked by in-situ XRD pattern. The exciton of semiconductors such as silver iodide can interact with the localized surface plasmon resonance of silver nanoparticles. The exciton-plasmon interaction in an ion-exchanged glass covered with silver iodide is investigated by absorption spectra at room temperature. The spectra of these materials before and after silver iodide nanoparticles are exposed, are compared.

Q 55.41 Thu 17:00 Tent B

Fluorescence resonance energy transfer near plasmonic nanostructures — •Shubhadeep Mondal and Markus Lippitz — University of Bayreuth

Fluorescence resonance energy transfer (FRET) plays a key role in photosynthesis, photovoltaics, biosensing, light sources, and more. It describes the nanoscale energy transfer between fluorophores, taking into account the near-field non-radiative dipole-dipole (donor-acceptor) interaction. Our goal is to study the coupling between quantum emitters and the influence of the nanoscale environment on it, for which it is crucial to design a photonic environment to control the FRET rate and efficiency. FRET can be measured by its influence on donor lifetime and acceptor brightness, but the plasmonic environment also modifies both signals by the Purcell effect and fluorescence quenching. We will discuss our experimental setup and data analysis to disentangle these effects.

Q 55.42 Thu 17:00 Tent B

Metal-enhanced photosensitization in riboflavin functionalized gold nanoparticles: photophysical mechanisms and application in bioimaging — •Jelena Pajovic[1], Radovan Dojcilovic[2], Dragana Tosic[2], Matthieu Refregiers[3], Dusan Bozanic[2], and Vladimir Vladimir[2] — [1]Faculty of Physics, University of Belgrade, Belgrade, Serbia — [2]Vinca Institute of Nuclear Sciences - National Institute of the Republic of Serbia, University of Belgrade, Belgrade, Serbia — [3]Centre de Biophysique Moleculaire, Orleans, France

Photodynamic therapy relies on the photogeneration of reactive oxygen species in complex environments by photosensitizing (PS) molecules. However, challenges persist in enhancing the PS processes while decreasing the concentration of the agents employed. This study explores the integration of PS biomolecules onto plasmonic nanoplatforms to increase their efficiency. Specifically, we report on the influence of gold nanoparticles on the PS activity of riboflavin molecules. The physical characterization of riboflavin-functionalized gold nanoparticles was conducted to better understand their electronic interactions that lead to enhanced singlet oxygen generation. The effects of the functionalized nanoparticles on live bacteria and hepatocellular carcinoma cells were investigated by fluorescence bioimaging. Preliminary findings indicate higher cell death rates in both organism systems, suggesting the nanoparticles' potential as efficient PS agents.

Q 55.43 Thu 17:00 Tent B

Nonlinear emission properties of inverted plasmonic nanostructures — •Valentin Dichtl, Thorsten Schumacher, and Markus Lippitz — Experimental Physics III, University of Bayreuth

The nonlinear third-order material response of noble metals allows the shaping of the third-harmonic near-field around a plasmonic nanostructure [1]. The corresponding spatial emission pattern of the third-harmonic hot spots changes drastically when the fundamental wavelength is slightly tuned by a linear resonance of the nanorod.

However, third harmonic generation (THG) also leads to high temperatures in the structure and its surroundings. These temperatures tend to be high enough to destroy more complex samples. Therefore, structures with the same emission characteristics but a higher ratio of THG to temperature are needed.

To overcome this, we are inspired by Babinet's principle. In this sense, a rod antenna can be replaced by a slit in a thin gold film. The surrounding gold should now be more effective in diffusing heat than a single rod. This poster compares the (nonlinear) emission properties of plasmonic nanostructures and their complementary counterparts.

[1] Wolf, D. *et al.* Shaping the nonlinear near field. *Nat. Commun.* 7:10361 (2016). doi: 10.1038/ncomms10361

Q 55.44 Thu 17:00 Tent B

Optical Interferometry for precise phase measurement — •Dahi Ibrahim — Engineering and Surface Metrology Lab., National Institute of Standards, Tersa St., El haram, El Giza, Egypt

Precision measurements are important across all fields of science. Optical phase measurements which can be used to measure distance, position, displacement, acceleration, and optical path length are of particular interest. In this research, we have demonstrated an optical phase measurement using a polarization interference microscope with temporal stability down to 1.3 nm for one hour. The microscope is based on the measurement of the Stokes parameters S2 and S3. The Stokes parameters describe the polarized light incident to the camera. The microscope was used to calibrate a groove structure of 60 nm nominally. The axial and lateral measurements of the groove structure are presented. The axial depth measurement is performed based on the ISO 5436 profile analysis. Since the ISO 5436 profile analysis doesn't provide a direct measurement of the lateral step height/depth standards, a Hamming area model is proposed to perform this task. For the axial measurement, the computed results show that the depth of the groove structure is 59.7 +- 0.6 nm. For the lateral measurement, the computed results show that the difference between the two line edges of the groove structure is 151.7 +- 2.5 nm. The results lead the way to new high-precision measurement applications.

Q 55.45 Thu 17:00 Tent B

Optical properties of biosynthesized nanoscaled Eu2O3 for red luminescence and potential antidiabetic applications — •Hamza Mohamed — UNISA, Cape Town, South Africa

This contribution reports on the optical properties of biosynthesised Eu2O3 nanoparticles bioengineered for the first time by a green and cost effective method using aqueous fruit extracts of Hyphaene thebaica as an effective chelating and capping agent. The morphological, structural, and optical properties of the samples annealed at 500*C were confirmed by using a high-resolution transmission electron microscope (HR-TEM), x-ray diffrac tion analysis (XRD), UV*Vis spectrocopy, and photoluminescence spectrometer. The XRD results confirmed the characteristic body-centered cubic (bcc) structure of Eu2O3 nanoparticles with an average size of 20 nm. HRTEM revealed square type morphology with an average size of *6 nm. Electron dispersion energy dispersive x-ray spectroscopy spectrum confirmed the elemental single phase nature of pure Eu2O3. Furthuremore, the Fourier transformed infrared spectroscopy revealed the intrinsic characteristic peaks of Eu*O bond stretching vibrations. UV*Vis reflectance proved that Eu2O3 absorbs in a wide range of the solar spectrum from the VUV*UV region with a bandgap of 5.1 eV. The luminescence properties of such cubic structures were characterized by an intense red emission centered at 614 nm. It was observed that the biosynthesized Eu2O3 nanoparticles exhibit an efficient red-luminescence and hence a potential material as red phosphor.

Q 55.46 Thu 17:00 Tent B

Single mode coupled emission of cw and resonant excited GaAs quantum dots — •Martin Kernbach[1], Sophia Fuchs[2], Julian Siller[2], and Andreas W. Schell[1] — [1]Johannes Kepler University Linz — [2]Leibniz University Hannover

Advanced quantum technologies like computing or sensing demand for deterministic bright sources of single indistinguishable photons. In order to provide quantum light of isolated systems properly usable for quantum applications, an efficient excitation and extensive collection in a single mode is required. Single molecules and cavity confined quantum dots are convenient sources. The coupling to the excited state is maximized on resonance, but challenges the usability of the emitter due to the effort for separation of the optical excitation mode from the mode of emission. A temporal, spacial, spectral, or combined method for separation is typically used.

Here we present a realization of a single emitter under resonant excitation in a confocal setup with a polarization filtered emission coupled into a single mode fiber. The optical path is free beam along a one meter long stick which dives the objective lens and scanning stage into a liquid helium reservoir. For resonant cw excitation of GaAs semiconductor quantum dots a SNR of polarization suppression up to 400 and count rates of 2 Mcps are archived by using a collecting lens with NA 0.68 only. Under this scheme further investigations regarding the blinking behavior are possible as well as probing alternative emitters like single molecules.

Q 55.47 Thu 17:00 Tent B

Squeezed States for Gaussian Boson Sampling From a KTP Waveguide Resonator — •Jonas Sichler, Christine Silberhorn, and Michael Stefszky — Paderborn University, Integrated Quantum Optics, Institute of Photonic Quantum Systems (PhoQS), Warburger Str. 100, 33098 Paderborn, Germany

Gaussian boson sampling (GBS) stands at the forefront of quantum computational research, offering the possibility of demonstrating quantum computational advantage and may also be suitable for solving complex problems beyond the reach of classical computers. The generation of suitable squeezed states is essential in harnessing the quantum advantages of this architecture, but is a technically challenging feat.

Here, we investigate the possibility of producing the required single-spectral mode, single-mode squeezed states using a resonator assisted type 0 parametric down-conversion (PDC) process in KTP waveguides. We present our findings on cavity parameter optimisation and initial experimental results.