MON 23: Poster Session: Fundamental Aspects and Model Systems

Time: Monday 18:30–20:30 Location: ZHG Foyer 1. OG

MON 23.1 Mon 18:30 ZHG Foyer 1. OG

Heisenbergs Artikel von 1925 erklärt von Studierenden für Studierende — •Noah Stiehm[1,2], Bernward Lauterbach[1], Aaron Flötotto[1] und Osamah Sufyan[1] — [1]junge DPG, Regionalgruppe Ilmenau — [2]FFNI e.V., c/o Technische Universität Ilmenau, Weimarer Straße 32, 98693 Ilmenau

Mit seinem Artikel „Über quantentheoretische Umdeutung kinematischer und mechanischer Beziehungen." legt Heisenberg 1925 den Grundstein für die Formulierung der Quantenmechanik. Der Inhalt ist prinzipiell für Physikstudierende schon früh im Studium (Kenntnisse über Fourier-Reihen und theoretische Mechanik sind nötig) greifbar. Gewissermaßen haben Studierende heute, durch Kenntnisse über Matrizen und Intuition zu diskreten Zuständen und Übergängen, bereits einen Vorsprung.

Dennoch ist der Zugang zu Heisenbergs Argumenten und Folgerungen größtenteils schwierig, z.B. aufgrund ad-hoc eingeführter, ungewohnter und inkonsistenter Notation, verkürzt dargestellten Gedankengängen, sowie fehlendem historischen Kontext. An der TU Ilmenau hat sich eine Gruppe Studierender damit beschäftigt, den Artikel nachzuvollziehen, um ihn im Anschluss ihren Kommiliton:innen nahe zu bringen. Aus diesem Prozess haben wir Kommentare und Gedankenstützen destilliert, und zusammen mit historischem Begleitmaterial zu einer Poster-Ausstellung geformt. Anhand dieser können interessierte Studierende die Entstehung der Quantenmechanik miterleben.

MON 23.2 Mon 18:30 ZHG Foyer 1. OG

A Short Story of Linear Quantum Mechanic AI and Global Relativistic Electrodynamics (1826-1925) — •Ulrich Christian Fischer — Alumni of the MPIBC Göttingen

Riemann's collected papers contain a 5-d Potential $Vehxyz$, with the irreducible dimension ezh of mass eh with the quantization $\alpha(eh)$ of the electron [arXiv:1609.05218]. We consider a finite motion of the hydrogen Molecule H_2, with the order Parameter ($n = 1e$) of one proton and a molecular weight ($m = 2$), against the chemiosmotic Proton motive force $\left[Pmf = \frac{1}{4}eV\right]$. V acts as Activation barrier $A\left(v = \frac{h}{4}\right)$ against the permutation of a Hydrogen molecule in a polymeric String S_n of Hydrogen molecules. A string S_n consists of a number n of Proton - Electron Pairs. The Quaternion $P_{2n} = Q^2_{eh}he$ [M.Atiah] with a number k of Neutrons has a molecular weight $P_{2n} = P_{m-k} = S(n) = \frac{n}{m}Q^{2he}_{eh}$. With the Prime number P_n, this leads to the Mathematical Proof of the reciprocity principle of Max Born's Q-Physics, or of the Prime numbers P_n, and the order Parameter n, and the proof of Riemann's Hypothesis on the real Part $\left(x_{n0} = \frac{1}{2}\right)$ of the Zero of the [Zeta-function] $Z_0(x+iy) = \left[x_0 = \frac{1}{P_1} = \frac{1}{2} = \frac{n}{2P_n}\right] = x_{0n} = \frac{1}{2} = Z^2_{0n} - \left[\frac{n}{2P_n}\right]^2 = 0.$

MON 23.3 Mon 18:30 ZHG Foyer 1. OG

Influence of longitudinal laser modes on the generation of time varying interference pattern — •Jelena Jovanović, Saša Ivković, and Bratislav Obradović — University of Belgrade, Faculty of Physics, 11001 Belgrade, Serbia

The primary goal of this work was to explain the interesting effect of time varying interference obtained using a birefringent crystal and an unstabilized He-Ne laser. Used laser operates in two longitudinal modes with mutually orthogonal polarizations. These modes represent the range of allowed discrete frequency values that a laser resonator can support, each corresponding to a quantized energy level within the laser cavity. The intensities of the modes vary in time, resulting that interference patterns also change in time: interference fringes appear, then disappear and appear again, but with changed positions. To explain this phenomenon, a simple analysis of the polarization states of the laser modes, which propagate through the crystal as ordinary and extraordinary rays was performed. This experiment not only demonstrates classical interference and polarization effects, but also offers an accessible way to explore the quantum nature of longitudinal modes. It highlights how quantum principles manifest in seemingly classical optical setups, providing students with a hands-on opportunity to investigate fundamental aspects of quantum optics using an interesting experiment.

MON 23.4 Mon 18:30 ZHG Foyer 1. OG

An educational setup for measuring photons and particles with modern detectors — Anja Bitar, Andrea Brogna, Fabian Piermaier, Steffen Schönfelder, Stefan Schoppmann, and •Quirin Weitzel — PRISMA Detektorlabor, Johannes Gutenberg-Universität Mainz, 55128 Mainz, Germany

In quantum and particle physics, highly sensitive and complex detectors are used, which always reflect the latest technological standards. To introduce students to these, practical experiments for training purposes are required in addition to specialized lectures. In this work, we describe the construction of a small fully working particle detector for demonstration in educational context. It is based on a state of the art scintillator, read out with optical fibers attached to a Silicon Photomultiplier (SiPM), and can be used to detect, for example, muons from cosmic rays. Furthermore, SiPMs are excellent photon counting sensors allowing to explore the quantum nature of light when exposed to repeated fast flashes on the nanosecond scale. An adjustable Light Emitting Diode (LED) pulser is used here for this purpose. Our setup can be constructed with relatively moderate effort, provided that in addition a 3D-printer and suitable readout electronics (at least an oscilloscope) are available.

MON 23.5 Mon 18:30 ZHG Foyer 1. OG

Partial distinguishability in the interference of Gaussian states in linear unitary networks — •Matheus Eiji Ohno Bezerra and Valery Shchesnovich — Universidade Federal do ABC, Santo André, State of São Paulo, 09210-170 Brazil

Partial distinguishability of the photons is a fundamental property of the quantum interference and an important source of noise in photonic quantum information protocols, particularly in Boson Sampling schemes. It originates from the imperfect overlap in the internal degrees of freedom of the photons (polarization, spectral profile, arrival time, etc). This effect was first demonstrated in the Hong-Ou-Mandel experiment, where two single photons interfere in a beam splitter and the coincidence events vanish when they are perfectly indistinguishable. Let $|\psi_k\rangle$ the internal states of the photons, with overlaps given by $\langle\psi_i|\psi_j\rangle = r_{ij}e^{i\theta_{ij}}$. When looking to the partial distinguishability, in the two-photon interference, only the modulus r_{ij} is important; while in the interference of three and more single photons, the phases θ_{ij} play an important role. However, these effects of partial distinguishability have not been fully explored in the interference of Gaussian states. In this work, we investigate how the partial distinguishability and these internal phases influence the interference of Gaussian states, specifically coherent and squeezed states, when the photons from each source are partially distinguishable. We find that the coherent states exhibit a classical dependence on the individual phases θ_{ij}, whereas squeezed states display an additional collective dependence of the phase, reminiscent of the behavior seen in the single-photon interference.

MON 23.6 Mon 18:30 ZHG Foyer 1. OG

Proposed Experiments on Adequate Frames — •Jannik Fiege[1] and Hans-Otto Carmesin[1,2,3] — [1]Gymnasium Athenaeum, Harsefelder Straße 40, 21680 Stade — [2]Bahnhofstraße, 5 — [3]Universität Bremen, Fachbereich 1, Postfach 330440, 28334 Bremen

The International Astronomical Union, IAU, realized, that the frames provided by general relativity are insufficient for space flight. As a provisional approximate solution, the IAU proposed reference systems for the purpose of space flight. For instance, the IAU proposed a geocentric celestial reference system, GCRS, for space travel near Earth. In contrast, for space travel in the planetary system, the IAU recommended a barycentric (essentially heliocentric) celestial reference system. More generally and fundamentally, the concept of adequate frames has been proposed, adequate frames have been derived, and exact space navigation for each location in spacetime has been developed (Carmesin 2025). These results are predictive and should be tested. For it, we propose various experiments and observations, suited for different equipment.

H.-O. Carmesin (2025): On the Dynamics of Time, Space and Quanta - Essential Results for Space Flight and Navigation. Berlin: Verlag Dr. Köster.

MON 23.7 Mon 18:30 ZHG Foyer 1. OG

Volume Portions Provide the Map of the Exact Quantum

Frames of the Planetary System — •Hans-Otto Carmesin — Universität Bremen, Fachbereich 1, Postfach 330440, 28334 Bremen — Studienseminar Stade, Bahnhofstr. 5, 21682 Stade — Gymnasium Athenaeum, Harsefelder Straße 40, 21680 Stade

A space paradox shows that space is an average of microscopic volume portions. These imply the quantum postulates, as well as gravity and curvature in spacetime. It is very valuable and insightful that the volume portions show how the quantum postulates are derived from spacetime and how they are applied to spacetime: In this manner, exact quantum frames of spacetime are derived for each location in the planetary system (Carmesin 2025). These frames are represented in a new map of the planetary system. Moreover, these frames provide the absolute zero of the kinematic time dilation. Predictions are derived, have been tested empirically, and can additionally be tested by space flights in various manners.

MON 23.8 Mon 18:30 ZHG Foyer 1. OG

Analysis of the Evolution of Universal Time Dilation and Dark Energy — •Jacky David Yang[1] and Hans-Otto Carmesin[1,2,3] — [1]Universität Bremen, Fachbereich 1, Postfach 330440, 28334 Bremen — [2]Studienseminar Stade, Bahnhofstr. 5, 21682 Stade — [3]Gymnasium Athenaeum, Harsefelder Straße 40, 21680 Stade

We analyze the concept and the universal/global evolution of time. Our elaboration uses the global Euclidean geometry of the universe. We model the universe on the basis of homogeneity (ΛCDM model) and of heterogeneity (linear growth theory). Measurement values of cosmological parameters are used, see Planck Collaboration (2020). Hereby, the model of the heterogeneous universe depends on the volume dynamics (Carmesin 2024). Thereby, we take care of the Hubble tension. The aim is the analysis of the universal time dilation. We transform the calculable H_0 - values into calendar dates. Moreover, differences between respective times of both models are derived, in order to determine the time dilation. The results are presented by graphs, tables and formulas, so our results are visualized intuitively. Therefrom, the time evolution and the age of the universe are obtained, Furthermore, the time evolution of the dark energy Ω_Λ is analyzed and visualized. It is derived from the time evolution of the universal/global time dilation.

H.-O.Carmesin (2024): How Volume Portions Form and Found Light, Gravity and Quanta. Berlin: Verlag Dr. Köster.
Planck Collaboration (2020): Planck 2018 results. VI. Cosmological parameters. Astronomy and Astrophysics, pp 1-73.

MON 23.9 Mon 18:30 ZHG Foyer 1. OG

Comparative Investigation of the Newtonian Gravitational Field and the Exact Gravitational Field — •Amboer Jiaer Li[1] and Hans-Otto Carmesin[1,2,3] — [1]Universität Bremen, Fachbereich 1, Postfach 330440, 28334 Bremen — [2]Studienseminar Stade, Bahnhofstr. 5, 21682 Stade — [3]Gymnasium Athenaeum, Harsefelder Straße 40, 21680 Stade

Understanding gravitational fields is fundamental to celestial mechanics and space exploration. This project investigates the differences between the classical Newtonian gravitational field and the relativistic exact gravitational field (Carmesin 2024, 2025), using Mercury as a test case. The gravitational acceleration is computed for both models over varying distances, using Python. Preliminary findings aim to assess the validity of Newtonian gravity in practical applications and explore the necessity of relativistic corrections in scenarios requiring high accuracy. This research provides insights into the limitations of classical mechanics in planetary science and informs future computational approaches for interplanetary missions.

MON 23.10 Mon 18:30 ZHG Foyer 1. OG

Factorization of multimeters: a unified view on nonclassical quantum phenomena — •Tim Achenbach[1,2], Andreas Bluhm[3], Leevi Leppäjärvi[2], Ion Nechita[4], and Martin Plávala[5] — [1]Naturwissenschaftlich-Technische Fakultät, Universität Siegen, Walter-Flex-Straße 3, 57068 Siegen, Germany — [2]Faculty of Information Technology, University of Jyväskylä, 40100 Jyväskylä, Finland — [3]Univ. Grenoble Alpes, CNRS, Grenoble INP, LIG, 38000 Grenoble, France — [4]Laboratoire de Physique Théorique, Université de Toulouse, CNRS, UPS, France — [5]Institut für Theoretische Physik, Leibniz Universität Hannover, Hannover, Germany

Quantum theory exhibits various nonclassical features, such as measurement incompatibility, contextuality, steering, and Bell nonlocality, which distinguish it from classical physics. These phenomena are often studied separately, but they possess deep interconnections. This work introduces a unified mathematical framework based on commuting diagrams that unifies them. By representing collections of measurements (multimeters) as maps to the set of column-stochastic matrices, we show that measurement compatibility and simulability correspond to specific factorizations of these maps through intermediate systems. We apply this framework to put forward connections between different nonclassical notions and provide factorization-based characterizations for steering assemblages and Bell correlations, including a perspective on the CHSH inequality witnessing measurement incompatibility.

MON 23.11 Mon 18:30 ZHG Foyer 1. OG

Development and Study of an Optical Quantum Processing Unit, OQPU — •Ruder Jannes[1] and Hans-Otto Carmesin[1,2,3] — [1]Universität Bremen, Fachbereich 1, Postfach 330440, 28334 Bremen — [2]Studienseminar Stade, Bahnhofstr. 5, 21682 Stade — [3]Gymnasium Athenaeum, Harsefelder Straße 40, 21680 Stade

The ongoing advancement of optical technologies opens new possibilities for enhancing the performance of classical computer architectures. This contribution presents the design and current status of implementation of a novel computer chip called the OQPU. The aim of this chip is to combine the advantages of optical computations, particularly the processing of information through light with quantum mechanical principles, to enable more efficient data processing. The OQPU utilizes laser beams whose states can be precisely manipulated and exhibit properties similar to qubits. Unlike single-photon approaches, this method provides a cost- and resource-efficient alternative while still harnessing quantum effects such as superposition and interference. The OQPU aims to overcome practical limitations in scalability, temperature and stability faced by many quantum devices. The development process focuses on validating the physical principles and optimizing the device structure. Challenges such as maintaining coherence and integrating optical components with classical electronics are addressed. Potential applications range from quantum-enhanced algorithms for complex problem-solving to faster optical data transmission systems. This work represents a significant step towards practical quantum-enhanced computing devices.

MON 23.12 Mon 18:30 ZHG Foyer 1. OG

Higher-dimensional entanglement detection and quantum channel characterization using moments of generalized positive maps — •Bivas Mallick[1], Ananda G. Maity[1,2], Nirman Ganguly[3], and Archan S. Majumdar[1] — [1]S. N. Bose National Centre for Basic Sciences, Block JD, Sector III, Salt Lake, Kolkata 700 106, India — [2]Networked Quantum Devices Unit, Okinawa Institute of Science and Technology Graduate University, Onna-son, Okinawa 904 0495, Japan — [3]Department of Mathematics, Birla Institute of Technology and Science Pilani, Hyderabad Campus, Hyderabad, Telangana-500078, India

Higher-dimensional entanglement is a valuable resource for several quantum information processing tasks, and is often characterized by the Schmidt number and specific classes of entangled states beyond qubit-qubit and qubit-qutrit systems. We propose a criterion to detect high-dimensional entanglement, focusing on determining the Schmidt number of quantum states and identifying significant classes of PPT and NPT entangled states. Our approach relies on evaluating moments of generalized positive maps which can be efficiently simulated in real experiments without the requirement of full-state tomography. We demonstrate the effectiveness of our detection scheme through various illustrative examples. As an application, we explore the implications of our moment-based detection schemes in identifying useful quantum channels such as non-Schmidt number breaking channels. Finally, we present an operational implication of our proposed moment criterion through its manifestation in channel discrimination tasks.

MON 23.13 Mon 18:30 ZHG Foyer 1. OG

Splitting and connecting singlets in atomic quantum circuits — •Lars Fischer, Zijie Zhu, Yann Kiefer, Samuel Jele, Marius Gächter, Giacomo Bisson, Konrad Viebahn, and Tilman Esslinger — Institute for Quantum Electronics & Quantum Center, ETH Zurich, 8093 Zurich, Switzerland

Large scale quantum computation relies on the configurable connection of qubits by system-wide error free transportation of quantum states. In this talk we present one way to coherently shuttle and manipulate quantum states in optical dynamical superlattices. By preparing atomic spin singlet pairs of fermionic potassium-40 in a lattice potential, we use a bi-directional quantized Thouless pump to transport, coherently split, and separate atomic pairs. We report a single-shift fidelity in our pumping mechanism of 99.78(3)% over 50 lattice sites.

Additionally, we implement tunable $(\text{SWAP})^{\alpha}$-gates with strongly repulsive interactions. When atoms moving in opposite directions meet on a double well, they undergo a superexchange interaction that continuously swaps their internal spin states. We use this gate set to coherently manipulate the quantum states in our system and interconnect large fractions of spin-singlet pairs. By applying a magnetic field gradient we observe multi-frequency singlet-triplet oscillations, which reveal complex final states from controlled quantum circuits. The presented scheme can be used as a tool to study full-system entanglement, quantum processing and sensing, and atom interferometry in optical lattices.

MON 23.14 Mon 18:30 ZHG Foyer 1. OG

Efficient detection of genuine multipartite entanglement using moments of positive maps — •Saheli Mukherjee[1], Bivas Mallick[1], Sahil Gopalkrishna Naik[1], Ananda G. Maity[1,2], and Archan S. Majumdar[1] — [1]S.N. Bose National Centre for Basic Sciences, Kolkata-700106, West Bengal, India — [2]Networked Quantum Devices Unit, Okinawa Institute of Science and Technology Graduate University, Onna-son, Okinawa 904-0495, Japan

Genuine multipartite entanglement (GME) represents the strongest form of entanglement in multipartite systems, providing significant advantages in various quantum information processing tasks. In this work, we propose an efficient and experimentally feasible scheme for detecting GME, based on the truncated moments of positive maps. Our method avoids the need for full state tomography, making it scalable for larger systems. We provide illustrative examples of both pure and mixed states to demonstrate the efficacy of our formalism in detecting inequivalent classes of tripartite genuine entanglement. Finally, we present a proposal for realising these moments in real experiments.

MON 23.15 Mon 18:30 ZHG Foyer 1. OG

Scalable Entanglement Quantification in Quantum Many-Body Systems with a Graph Neural Network — •Susanna Bräu, Martina Jung, and Martin Gärttner — Institut für Festkörpertheorie und Optik, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, 07743 Jena

Entanglement is a fundamental feature of quantum mechanics and plays a central role in quantum computing, quantum communication, and quantum information theory. Quantifying entanglement between different parts of a system - via measures such as entanglement entropy or quantum mutual information - usually requires full knowledge of the quantum state. However, due to the curse of dimensionality, quantum state tomography is infeasible for larger systems, limiting the accessible system sizes. Therefore, we propose a supervised machine learning approach to estimate entanglement features based on a set of measurement snapshots of the system. For that, we develop a permutation invariant graph neural network (GNN) that is parameter-efficient, being linear in the system size. Our scalable GNN incorporates the mini-set architecture, developed by Kim et al. [1], who divided the input into smaller sets which the model processes in parallel. By attending the output of each mini-set in a permutation invariant manner, high order correlations can be extracted. In this way, we aim to improve the scaling such that the GNN can be applied to larger data sets or be used to increase the time over which the model can accurately predict entanglement features in the future.

[1] Kim, H. et al. arXiv:2405.11632 [quant-ph] (Nov. 2024).

MON 23.16 Mon 18:30 ZHG Foyer 1. OG

Quenching on the circle: how compactification curbs entanglement growth in coupled rotors — •Stefan Aimet[1] and Spyros Sotiriadis[2] — [1]Freie Universität Berlin, Berlin, Germany — [2]University of Crete, Heraklion, Greece

Compact topology fundamentally constrains quantum dynamics. After a global frequency quench to zero, coupled harmonic oscillators display unbounded entanglement growth because their position variables live on the real line and the associated metastable zero modes diffuse indefinitely. Recasting these variables instead as angular coordinates compactified on a circle maps the system to coupled quantum rotors whose phase-space support and hence entanglement entropy saturates at late times. We analyse how compactification curbs entanglement growth. Our findings identify compactification as a generic mechanism that tames entanglement divergence and motivate experimental realisations.

MON 23.17 Mon 18:30 ZHG Foyer 1. OG

Photonic simulation optimized for quantum field dynamics — •Robin Alexander Strahlendorf, Mauro D'Achille, and Martin Gärttner — Institut für Festkörpertheorie und Optik, Friedrich-Schiller-Universität Jena, Max-Wien Platz 1 07743 Jena

Photonic multimode systems offer great potential as quantum simulators of quantum field theories. The dynamics of free field theories, corresponding to quadratic Hamiltonians, can be decomposed into a sequence of passive optical elements and squeezing transformation. It is difficult to scale an optical circuit to large number of modes and depths due to the inherent loss of the optical elements.

We tackle this problem by exploiting the freedom in designing an optical circuit for a given unitary evolution. In particular, we aim to minimize the number of gates, thereby reducing the overall simulation error. For this, we simulate realistic noise models and compare the robustness of the different decomposition schemes with respect to common types of errors.

MON 23.18 Mon 18:30 ZHG Foyer 1. OG

Fractal Zeta Universe and Atoms — •Otto Ziep — 13089 Berlin — Independent Research

Fractal universes and atoms are assigned to k-components or stable orbiting laps of simplest cycles of elliptic invariants. Cosmological redshift, expansion of the universe, origin of cosmic rays, cosmic microwave background, quantum entanglement and the cosmological constant problem are resolvable easily by fractal universes of bifurcating spacetime. Quantum entanglement is explainable by a highly correlated pseudo-congruent k-component in bifurcating spacetime. A one-dimensional complex contour around nontrivial zeros of zeta and L-functions is capable to create a zero-energy universe- action functional. Gauge coupling parameter fit into Gaussian periods of fixpoints. Many experiments in natural history support a fractal zeta universe.

[1] O. Ziep, A quantum entangled fractal superfluid universe, Journal of High Energy Physics, Gravitation and Cosmology, vol. 11, 3, (2025)
[2] O. Ziep, Fractal Universe and Atoms, Scholars Journal of Physics, Mathematics and Statistics, Vol.12, No. 4 (2025)
[3] O. Ziep, Cosmic Rays, Aerosol-Photosynthesis and Vegetational Air Ions, Manuscript in preparation, 2025

MON 23.19 Mon 18:30 ZHG Foyer 1. OG

Fully Dynamical Analysis of Coulomb Breakup Experiments for the Determination of the α(d, γ)6Li cross section — •Monica Sanjinez Ortiz and Pierre Capel — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, D-55099 Mainz, Germany

In the modelling of Big Bang nucleosynthesis, the cross sections of reactions leading to the formation of light nuclei play a fundamental role. For the synthesis of 6Li, in particular, the radiative capture process α(d, γ)6Li is of utmost importance. From experiments, the direct determination of the cross section is difficult at low energy, and there exists only one set of direct measurements in the energy range of interest. Coulomb breakup has been considered as an alternative method to infer the low-energy cross section of reactions for astrophysics as it corresponds to the time reversed process of radiative captures. In the past, two experiments of 6Li breakup onto 208Pb have been performed: at 26A MeV and at 150A MeV. With a fully dynamical reaction model based on the eikonal approximation, we report here on a new theoretical analysis of this breakup reaction. Our results indicate that the breakup cross section at 150A MeV is nuclear dominated with marked interferences with the Coulomb component. Accordingly, it is difficult to infer radiative capture cross sections from data at this energy. Similarly, the analysis of the reaction at 26A MeV points towards a nuclear dominated contribution at forward angles. Nevertheless, at low beam energy and large scattering angles, the reaction seems Coulomb dominated, suggesting a way to overcome the aforementioned difficulty.

MON 23.20 Mon 18:30 ZHG Foyer 1. OG

Floquet-Engineering of Feshbach Resonances in Ultracold Lithium Gases — •Louisa Marie Kienesberger, Alexander Guthmann, Felix Lang, and Artur Widera — Physics Department and Research Center OPTIMAS, University of Kaiserslautern

Magnetic Feshbach resonances are a key tool for tuning interactions in ultracold atomic systems. In our recent work [1], we demonstrate that periodic modulation of the magnetic field enables the creation of Floquet-Feshbach resonances in a two-component gas of fermionic lithium-6, providing dynamic control over resonance positions.

We experimentally map out the structure of Floquet-dressed scattering states and confirm the theoretical predictions for their positions and widths. Our observations include clear signatures of higher-order resonances, revealing a rich spectrum of interaction control not accessible via static fields alone. Additionally, we show that inelastic atom losses can be strongly suppressed by introducing a second modulation frequency at exactly the second harmonic.

In conclusion, Floquet-Engineering of Feshbach resonances opens new pathways for precise control of scattering in ultracold gases. As a prominent application, it enables the realization of Bound States in the Continuum (BICs) through interference at avoided crossings between Floquet-Feshbach resonances, which will be discussed in a separate talk.

[1] A. Guthmann, F. Lang, L. M. Kienesberger, S. Barbosa, A. Widera , Floquet-Engineering of Feshbach Resonances in Ultracold Gases, arXiv 2503.05454 (2025).

MON 23.21 Mon 18:30 ZHG Foyer 1. OG

Hydrodynamic Effects in Cryogenic Buffer Gas Cells — •Nick Vogeley[1], Bernd Bauerhenne[2], and Daqing Wang[1] — [1]Institut für angewandte Physik, Uni Bonn — [2]Experimentalphysik I, Uni Kassel

We report a screening of design geometries for cryogenic buffer gas beam cells operating in the hydrodynamic extraction regime with moderate throughput $J \approx 50$ sccm. We performed steady-state slip-flow simulations for helium at $T = 4.5$ K and included a localized heat source to represent the ablation or injection point of the species of interest. In a subsequent direct-simulation Monte Carlo diffusion model we tracked the trajectories of these particles to compare the performance for different buffer gas injection geometries. While most prior studies focused on box-like or cylindrical cells, we investigated hydrodynamic effects such as vortex formation within a spherical cell and assessed whether these could be utilized to improve extraction efficiency. In addition to the observed enhancement in extraction yield and reduced deposition on inner walls, we identified indicators for experimental verification of these effects in time-of-flight measurements.

MON 23.22 Mon 18:30 ZHG Foyer 1. OG

Controlling the rotational quantum states of chiral molecules — •Elahe Abdiha, JuHyeon Lee, Shilpa Yadav, Sejun An, Boris G Sartakov, Gerard Meijer, and Sandra Eibenberger-Arias — Fritz-Haber-Institut der Max-Planck-Gesellschaft; Berlin, 14195, Germany

We present recent experimental advances targeted at full enantiomer-specific control of the quantum states of chiral molecules using enantiomer-specific state transfer (ESST). In theory, ESST can reach 100We will also present our ongoing efforts to address the intrinsic limitation of ESST due to orientational degeneracy of the rotational states by incorporating theoretically tailored pulse schemes [4].

[1] Eibenberger et al., Phys. Rev. Lett. 118, 123002 (2017)
[2] Pérez et al., Angew. Chem. Int. Ed. 56, 12512 (2017)
[3] Lee et al., Nat. Commun. 15, 7441 (2024)
[4] Leibscher et al. Commun. Phys. 5, 110 (2022).

MON 23.23 Mon 18:30 ZHG Foyer 1. OG

Hanbury Brown-Twiss interference of electrons in free space — •Florian Fleischmann[1], Mona Bukenberger[2], Anton Classen[3], Marc-Oliver Pleinert[1], and Joachim von Zanthier[1] — [1]Friedrich-Alexander- Universität Erlangen-Nürnberg, Quantum Optics and Quantum Information, 91058 Erlangen, Germany — [2]ETH Zürich, Depart- ment of Environmental Systems Science, 8092 Zürich, Switzerland — [3]University of Utah, Health Science Core, UT 84112 Salt Lake City, USA

We investigate the spatial second-order correlation function of two electrons originating from two nanotips in a Hanbury Brown-Twiss like setup. First, we consider semi-classically the effects of the Pauli exclusion principle and Coulomb repulsion on the expected correlation pattern. This is followed by a full quantum-mechanical treatment of the problem, where we separate the system into relative and center-of-mass coordinates in analogy to the Hydrogen atom ansatz. While the center-of-mass system is described as a free particle, the relative system contains the Coulomb scattering process which translates into an effective one-particle problem. We expand the respective initial state of the electrons in the eigenstates of the corresponding Hamiltonian and evolve the system in time. After the scattering process, the function is evaluated in the far field. We present the formal solution of the problem and discuss the current state of the numerical investigations.

MON 23.24 Mon 18:30 ZHG Foyer 1. OG

Photon Bose-Einstein Condensates: Polarization properties and tailored potential landscapes — •Sven Enns[1], Julian Schulz[1], Kirankumar Karkihalli Umesh[2], Frank Vewinger[2], and Georg von Freymann[1,3] — [1]Department of Physics and Research Center OPTIMAS, RPTU Kaiserslautern-Landau, 67663 Kaiserslautern, Germany — [2]Institute of Applied Physics, University of Bonn, 53115 Bonn, Germany — [3]Fraunhofer Institute for Industrial Mathematics ITWM, 67663 Kaiserslautern, Germany

We experimentally investigate polarization properties of harmonically trapped photon gases in a dye-filled microcavity and their dependence on the polarization of the pump beam. Our results demonstrate the interplay between the timescales of thermalization, rotational diffusion of the dye molecules and photon lifetime in the cavity. In agreement with previous theoretical work [1], we show that symmetry breaking occurs when stimulated emission becomes the dominating process.

Furthermore, we investigate photon gases in potential landscapes using the technology of Direct-Laser-Writing (DLW), a 3D laser lithography technology that enables the fabrication of three-dimensional polymer structures at the sub-micron scale. By printing these structures onto the cavity mirrors potential landscapes for the photon gas are created. This allows for the investigation of many fields, such as quantum thermodynamics [2] and properties of coupled photon gases.

[1] R. I. Moodie, P. Kirton, and J. Keeling, Phys. Rev. A 96 (2017).
[2] Karkihalli Umesh, K., J. Schulz, J. Schmitt, M. Weitz, G. von Freymann and F. Vewinger, Nature Physics 20, 1810-1815, (2024).

MON 23.25 Mon 18:30 ZHG Foyer 1. OG

Rabi-like mode conversion in nonlinear photonic meta atoms — •Oliver Melchert[1,2], Shihao Zhang[1,2], Ihar Babushkin[1,2], Uwe Morgner[1,2], and Ayhan Demircan[1,2] — [1]Institute of Quantum Optics, Leibniz Universität Hannover, Hannover, Germay — [2]PhoenixD, Leibniz Universität Hannover, Hannover, Germay

We investigate the interaction dynamics of optical pulses in the higher-order nonlinear Schrödinger equation with mixed domains of normal and anomalous dispersion. This system enables one-dimensional nonlinear photonic meta atoms, i.e. composite solitary waves that support direct optical analogues of quantum mechanical bound states: the stationary atom potential is defined by the refractive index change induced by a fundamental soliton; its bound modes are realized by a weak co-propagating pulse. Coupling of both pulses is achieved via cross-phase modulation accross a vast frequency gap. Here, we demonstrate Rabi-like transfer of energy between the bound modes, driven by periodic oscillations of the atom potential in terms of a nonfundamental soliton. Coupled-mode theory shows that the underlying resonance phenomenon is reversible and parity maintaing. Beyond the quantum analogy we observe phase-matched coupling to resonant radiation, resulting in exponentially slow decay of the bound energy.

MON 23.26 Mon 18:30 ZHG Foyer 1. OG

The effects of Casimir interactions in experiments on gravitationally-induced entanglement — •Jan Bulling, Marit O. E. Steiner, Julen S. Pedernales, and Martin B. Plenio — Institut für Theoretische Physik, Ulm, Germany

The detection of gravitationally induced entanglement between two macroscopic bodies has recently emerged as a promising approach to probe the non-classical nature of gravity. Experimental proposals typically suggest placing the center-of-mass of two levitated particles in spatially delocalized Schrödinger-cat states or squeezed Gaussian states. According to standard arguments, a quantum theory of gravity is expected to generate entanglement between their positional degrees of freedom due to the gravitational interaction between the two masses. To ensure that the observed entanglement arises solely from gravity, all other interactions - particularly electromagnetic forces - must be suppressed. Therefore, the use of a conductive Faraday shield between the particles is often proposed.

In this work, we investigate the impact of short-range Casimir forces arising between the particles and the newly introduced shield on the entanglement generation. We show that stochastic variations in the initial state preparation across multiple experimental runs, as well as thermal vibrations of the shield, can destroy measurable entanglement.

MON 23.27 Mon 18:30 ZHG Foyer 1. OG

Testing two cornerstones of quantum theory with multi-particle interference — •Marc-Oliver Pleinert and Joachim von Zanthier — Quantum Optics and Quantum Information Group, Friedrich-Alexander-Universität Erlangen-Nürnberg, Staudtstr. 1, 91058 Erlangen, Germany

From the start, quantum mechanics has been questioned due to its counter-intuitive aspects. One example is the use of complex numbers, one building block of quantum theory, which has been criticised already by Schrödinger. Another example is Born's rule relating detection probabilities to the modulus square of the wave function, which initially was only added as a footnote.

Altogether, quantum theory permits interference between indistinguishable paths but, at the same time, restricts its order. Single-particle interference, for instance, is limited to the second order, that is, to pairs of single-particle paths. Recently, we introduced particular multi-particle interference tests of these two cornerstones of quantum mechanics: (i) generalised Sorkin tests of the order of interference and thus Born's rule [1,2] and (ii) generalised Peres tests for the dimensionality of the number system with the aim of questioning whether complex numbers are sufficient for quantum theory [3].

[1] Phys. Rev. Research 2, 012051(Rapid Comm.) (2020)
[2] Phys. Rev. Lett. 126, 190401 (2021)
[3] Phys. Rev. Lett. 134, 060201 (2025)

MON 23.28 Mon 18:30 ZHG Foyer 1. OG

Probing High-Order Susceptibilities of monolayer MoS_2 via High Harmonic Generation: TDDFT approach — Yeganeh Alvankar[1,2], •Elnaz Irani[2], Hamid Talkhabi[2], and Mohammad Monfared[3] — [1]3ICMM, Centro Superior de Investigaciones Cientficas, Sor Juana Ines de la Cruz, 3 Cantoblanco, 28049 Madrid, Spain — [2]Department of Physics, Faculty of Basic Sciences, Tarbiat Modares University, P.O. Box 14115-175, Tehran, Iran — [3]Institute of Theoretical Physics, Leibniz University Hannover, Appelstraße 2, 30167 Hannover, Germany

High-harmonic generation (HHG) is a powerful method for probing high-order nonlinear optical responses in solids, across both perturbative and non-perturbative regimes.

Here, we use time-dependent density functional theory (TDDFT) to calculate the nonlinear susceptibilities ($\chi^{(5)}, \chi^{(7)}, \chi^{(9)}$) of monolayer MoS_2 via HHG. Simulations employ intense ultrafast laser pulses ($\lambda_0 = 600, \text{nm}$) with peak intensities from 0.2-1.2 TW/cm^2.

Our results exhibit power-law scaling $\text{Yield}_N = A_N I^N$ and interband polarization, enabling direct extraction of higher-order susceptibilities. We also observe strong crystal orientation dependence, with anisotropic behavior across harmonic orders, emphasizing the role of polarization control in 2D material characterization.

Unlike previous methods (e.g., attosecond streaking) that inferred lower-order susceptibilities indirectly, HHG directly reveals higher-order responses without broad spectra or indirect analysis. Quantifying such nonlinearities is key to advancing ultrafast photonics.

MON 23.29 Mon 18:30 ZHG Foyer 1. OG

Limits of the anomalous-velocity description for currents in solid state systems driven by ultrafast pulses — •Jelena Schmitz, Adrian Seith, Jan Wilhelm, and Ferdinand Evers — Institute of Theoretical Physics and Regensburg Center for Ultrafast Nanoscopy, University of Regensburg, Germany

The current response of solids to electric fields $\mathbf{E}(t)$ is often described using a quasi-classical current approximation including an anomalous velocity term containing the Berry curvature $\mathbf{\Omega}_n(\mathbf{k})$ [1],

$$\mathbf{j}(t) = \int_{\mathrm{BZ}} \frac{\mathrm{d}\mathbf{k}}{(2\pi)^d}\, \mathfrak{q} \sum_n (\partial\epsilon_n(\mathbf{k})/\partial_{\mathbf{k}} + \mathfrak{q}\,\mathbf{E}(t)\times\mathbf{\Omega}_n(\mathbf{k}))\, f_n^{(0)}(\mathbf{k})\,, \qquad (1)$$

where $f_n^{(0)}(\mathbf{k})$ denote the (initial) band occupations and $\epsilon_n(\mathbf{k})$ the dispersion. To test the limits of the quasi-classical descriptions for ultrafast and strong driving fields, we compare Eq. (1) with results from a quantum mechanical calculation using the Semiconductor Bloch equations (SBE) [2,3]. By deriving Eq. (1) from the SBE, we determine the parametric regime of validity of the quasi-classical description. The small dimensionless parameters that control the domain of applicability are weak fields and slow driving in comparison to the system dependent effective gap. We confirm our analytic predictions by comparing Eq. (1) to numerically exact solutions of the SBE using a two band massive Dirac Hamiltonian as our model system. [1] Xiao, D. et. al., Rev. Mod. Phys. 82, 1959 (2010) [2] Schmitt-Rink, S. et. al., Phys. Rev. B 37, 941 (1988) [3] Wilhelm, J. et. al., Phys. Rev. B 103, 125419 (2021) [4] https://github.com/ccmt-regensburg/CUED/

MON 23.30 Mon 18:30 ZHG Foyer 1. OG

Entering the overcritical regime of nonlinear Breit-Wheeler pair production by superintense, tightly focused laser pulses colliding with bremsstrahlung γ-rays — •Ingo Elsner, Alina Golub, Selym Villalba-Chavez, and Carsten Müller — Institut für Theoretische Physik I, Heinrich-Heine-Universität Düsseldorf

Nonlinear Breit-Wheeler pair production in collisions of a tightly focused high-intensity laser pulse with GeV bremsstrahlung photons is theoretically studied in an overcritical field regime, where the quantum nonlinearity parameter substantially exceeds unity [1]. We investigate under which conditions the attenuation of the γ-beam due to the production process must be taken into account and how much the second generation of created pairs contributes to the total yield. In the considered interaction regime, it is shown that the relevant range of bremsstrahlung frequencies is generally very broad and that – for sufficiently large values of the quantum nonlinearity parameter – an optimum domain of frequencies far below the spectral end point emerges. We also demonstrate that it is beneficial for achieving optimum pair yields to increase the interaction volume by a wider laser focus at the expense of decreased field intensity.

[1] I. Elsner, A. Golub, S. Villalba-Chávez and C. Müller, Phys. Rev. D 111, 096012 (2025)

MON 23.31 Mon 18:30 ZHG Foyer 1. OG

Universal Behavior of Tunneling Time and Disentangling Tunneling Time and Barrier Time-Delay in Attoclock Experiments — •Ossama Kullie[1] and Igor Ivanov[2] — [1]Department of Mathematics and Natural Sciences. University of Kassel, 34132 Kassel, Germany. — [2]Department of Fundamental and Theoretical Physics, Australian National University, Australia

In previous work [1,2,3], we have shown in our model that the (tunnel-ionization) time-delay measured in the attoclock experiment can be precisely described in the adiabatic and nonadiabatic field calibrations. Furthermore, the barrier (tunneling) time-delay itself can be determined from the difference between the time-delays of the adiabatic and nonadiabatic tunnel-ionization, which shows excellent agreement with the experimental results. Remarkably, the tunneling time-delay exhibits a universal behavior with disentangled contributions. Furthermore, we find that in the weak measurement limit, the barrier time-delay corresponds to the Larmor-clock time-delay and the interaction time within the barrier region [1]. We further discuss quantum superluminality in the framework of the attoclock [4].

[1] O. Kullie, J. Phys, Commun. 9, 015003 (2025).
[2] O. Kullie and I. Ivanov, Annals of Physics 464, 169648 (2024).
[3] O. Kullie, Annals of Physics 389, 333 (2018).
[4] O. Kullie and I. A. Ivanov, in preparation.

MON 23.32 Mon 18:30 ZHG Foyer 1. OG

Kondo effect with singular baths: the role of electron-phonon interaction — •Max Fischer[1], Emin Moghadas[2], Niklas Witt[1], Alessandro Toschi[2], and Giorgio Sangiovanni[1] — [1]Institut für Theoretische Physik und Astrophysik and Würzburg-Dresden Cluster of Excellence ct.qmat, Universität Würzburg, 97074 Würzburg, Germany — [2]Institute of Solid State Physics, TU Wien, 1040 Vienna, Austria

In the context of dynamical mean-field theories, the hybridization function of the associated impurity model becomes singular at the Fermi level whenever the density of states vanishes at the Fermi level. One examples is the prominent twisted bilayer graphene where the flat bands form a 2D Dirac cone yielding a peak in the bath of the corresponding periodic Anderson model. This is at odds with standard examples of Kondo systems in which the hybridizations are assumed to be regular and well-behaved around the Fermi energy. By means of quantum Monte Carlo and renormalization group we study the crossover from Kondo to the local-moment regime solving an Anderson impurity model which combines a regular part with a tunable peak at the Fermi level. Furthermore, we couple the impurity electrons to a local Holstein-like degree of freedom and analyze the effect of the oscillator on the Kondo feature. We also investigate in which way the singularity in the bath influences the effects of retardation.

MON 23.33 Mon 18:30 ZHG Foyer 1. OG

DMRG on arbitrary geometries using Belief Propagation — •Hendrik Kühne[3] and Christian B. Mendl[1,2] — [1]School of Computation, Information and Technology, Technical University of Munich — [2]Munich Center for Quantum Science and Technology — [3]School of Natural Sciences, Technical University of Munich

Tensor networks have recently attracted much attention as a powerful tool for modeling systems in quantum many-body physics. Their contraction is a significant challenge however, especially in highly connected networks, as memory requirements become prohibitive and the optimal contraction order is increasingly hard to find. The belief propagation algorithm has emerged as an alternative to exact contraction. It offers great flexibility, being completely independent of the geometry in question, however its accuracy suffers in the presence of loops. On the other hand, in Quantum Chemistry, the DMRG algorithm is regarded as the gold standard in solving the ground state problem. Its behavior is well-understood in 1D, however maintaining the necessary canonical forms in higher dimensions becomes increasingly complex. This work proposes to combine Belief Propagation and DMRG, thereby extending DMRG to higher dimensions and arbitrary system geometries. We demonstrate the viability of BP-DMRG on the transverse-field Ising model, where it yields ground states reliably with high fidelity. We also discuss limitations that we incur by using belief propagation, and possible future directions for improving the accuracy and controllability of BP-DMRG.

MON 23.34 Mon 18:30 ZHG Foyer 1. OG

Quantum spin system as reservoir for quantum reservoir computing — •Lara Celine Ortmanns — Deutsches Zentrum für Luft- und Raumfahrt e.V., Linder Höhe, 51147 Köln, Germany

Reservoir computing (RC) is a well-known framework of machine learning, which is used to solve temporal learning tasks, such as temporal pattern recognition and prediction. So far, a variety of physical systems have been considered to implement the reservoir of the RC-scheme [1]. In this project, we investigate a quantum spin system as possible candidate for a quantum reservoir. More specifically, the system is described by the transverse-field Ising model with long-range spin-spin interaction. Additionally, we allow for transverse disorder. Depending on the ratio of involved coupling strengths (interaction and disorder), the system exhibits two dynamical phases, an ergodic and an MBL phase. We raise the question whether counteracting tendencies associated with the vicinity of the phase transition can increase the reservoir performance w.r.t. the ergodic phase for certain tasks.

[1] G. Tanaka et al., Neural Networks 115, 100-123 (2019)

MON 23.35 Mon 18:30 ZHG Foyer 1. OG

Topological insulator single electron transistor — •Omargeldi Atanov, Junya Feng, and Yoichi Ando — Physics Institute II, University of Cologne, Cologne, Germany

When a topological insulator (TI) Josephson junction is driven through a topological phase transition, the ground-state parity of the system is expected to change, potentially due to the fusion of Majorana bound state (MBS) pairs. Measuring the individual parity of MBS pairs is a critical step in understanding the mechanisms behind these parity changes and for more complex braiding operations. We present the successful fabrication and characterization of single electron transistors (SETs) based on bulk-insulating BiSbTeSe2 flakes, which also serve as the material for TI Josephson junctions. This approach simplifies the process flow of the devices and improves fabrication yield. Initial characterization of devices demonstrates well-formed Coulomb diamonds that confirms the robust charge quantization and SET performance. These results pave the way for integrating SETs with TI Josephson junctions and measuring MBS parity in the near future.

MON 23.36 Mon 18:30 ZHG Foyer 1. OG

Realization of topological Thouless pumping in a synthetic Rydberg dimension — •Johannes Deiglmayr[1], Martin Trautmann[1], and Inti Sodemann Villadiego[2] — [1]Felix-Bloch Institute, Leipzig University, Linnéstraße 5, 04103 Leipzig, Germany — [2]Institute for Theoretical Physics, Leipzig University, Brüderstraße 16, 04103 Leipzig, Germany

Synthetic dimensions provide the opportunity to investigate regimes outside those of more traditional quantum many-body platforms. Rydberg states of atoms are a particularly promising platform to engineer Hamiltonians in such synthetic dimensions due to the large number of states and the readily available technologies for manipulating their couplings and for detecting them.

We will present the realization of topological quantum pumping in a synthetic dimension by engineering a one-dimensional Rice-Mele chain within the Rydberg states of cesium atoms [1]. The Thouless protocols for topological pumping is implemented, and the adiabaticity of transport is investigated.

[1] M. Trautmann, I. Sodemann Villadiego, and J. Deiglmayr, Phys. Rev. A **110**, L040601 (2024)

MON 23.37 Mon 18:30 ZHG Foyer 1. OG

Illumination dependent hot polaron photovoltaics in strongly correlated perovskite manganites — •Annika Dehning, Birte Kressdorf, Jörg Hoffmann, and Christian Jooss — Institute of Materials Physics, University of Göttingen, Germany

Highly correlated materials offer new pathways to stabilize hot-carriers after optical excitation and thus might enable overcoming the Shockley-Queisser (SQ) limit. In metal-oxide perovskites excited polaronic states can be stabilized up to ns-lifetime through the enhanced coupling between phonons and charges in the charge/orbital (CO) ordered state. Understanding the mechanisms behind hot polaron photovoltaics (PV) challenges because of the complex interplay between electronic degrees of freedom and structure. It requires knowledge about the cold quantum ground state and how it is affected by lattices, temperature and excitations. Light induced excitations are studied here in dependence of temperature, photon energy and power in $Pr_{1-x}Ca_xMnO_3$ and Ruddlesden-Popper $Pr_{1-x}Ca_{1+x}MnO_4$ (RP-PCMO). Single-crystalline epitaxial thin films are prepared on Nb:$SrTiO_3$ substrates with ion beam sputtering. XRD, AFM, SEM, EDX and TEM are employed to characterize the films, their ordering and the p-n junction. It is demonstrated that the PV response correlates with the appearance of CO order and it is measured up to 320K in RP-PCMO. The characteristic PV-parameters reveal spectral and power density dependencies that do not follow the SQ-theory. An approach to describe the PV-response based on hot carrier contributions via scaling laws is presented.

MON 23.38 Mon 18:30 ZHG Foyer 1. OG

Testing Nonlinear Quantum Theories with PHIP-Based Nuclear Spin Ensembles — •Xiaoyi Yang, Martin Korzeczek, and Martin B. Plenio — Ulm University, Institute of Theoretical Physics, Albert-Einstein-Allee 11, 89081 Ulm, Germany

We propose and analyze a quantum simulation of nonlinear quantum dynamics inspired by gravitational interaction models and a mathematical framework due to Weinberg, using parahydrogen-induced polarization (PHIP) NMR. The platform leverages hyperpolarized hydrogen and carbon-13 nuclei to realize an effective Hamiltonian incorporating both linear J-coupling and nonlinear mean-field self-interaction. Under specific initial conditions and symmetry constraints, the system reproduces the dynamics predicted by a nonlinear quantum gravity-inspired model. The resulting evolution exhibits Duffing-type behavior and transitions between dynamical topologies, with solutions described by Jacobi elliptic functions. Notably, the presence of controlled nonlinearity reveals an amplified sensitivity to small differences between quantum states, offering a potential mechanism for distinguishing nonorthogonal states within a closed quantum system. Our results highlight PHIP NMR as a viable experimental testbed for probing nonlinear extensions to quantum mechanics, with potential applications in quantum information processing, metrology, and foundational tests of quantum theory.

MON 23.39 Mon 18:30 ZHG Foyer 1. OG

Towards low-energy structured coherent electron and ion beams — •Prosenjit Majumder, Matias Eriksson, and Robert Fickler — Physics Unit, Photonics Laboratory, Tampere University, Tampere, Finland

In recent years, structured matter waves particularly structured electron beams have attracted growing interest due to their potential in advanced microscopy and quantum experiments. Spatially coherent field-emission electron sources are well-established, enabling precise control over electron beam wavefronts and facilitating developments in electron microscopy and spectroscopy. Our research focuses on developing a tunable low-energy source capable of structuring both electron and ion beams. The setup features a cryogenically cooled nanotip field/gas field ion emission source followed by a 2-meter free propagation region. This configuration is designed to generate transversely coherent beams, with coherence lengths of several micrometers for ions suitable for shaping with nanofabricated electrostatic elements.

We aim to investigate the physics of low-energy vortex electrons and ions using electrostatic chopsticks as a minimally invasive shaping tool. Housed in a custom-built vacuum chamber, the setup includes electrostatic lenses, deflectors, and full-length magnetic shielding to suppress ambient magnetic interference. Realizing a spatially coherent ion source would mark a major advance, enabling new studies in composite charged wave systems and pushing the frontiers of ion-based microscopy and quantum technologies.

MON 23.40 Mon 18:30 ZHG Foyer 1. OG

Cavity QED experiments and lasing with cold trapped Yb atoms — •Ke Li[1], Saran Shaju[1], Gabriel Dick[1], Simon B. Jäger[2], and Jürgen Eschner[1] — [1]Universität des Saarlandes, Physik, 66123 Saarbrücken, Germany — [2]Universität Bonn, Physikalisches Institut, 53115 Bonn,Germnay

Cavity quantum electrodynamics with cold atoms enables the controlled interactions between atoms and photons, providing advanced applications in quantum technologies and fundamental science. In our research, 10^4 to 10^6 Ytterbium-174 atoms are magneto-optically trapped, using the ${}^1S_0$-${}^1P_1$ transition at 399 nm, inside a high-finesse cavity that couples to the ${}^1S_0$-${}^3P_1$ intercombination transition. We have observed lasing action in both single- and multi-mode emission [1]. Additionally, the collective strong coupling leads to complex atom-field dynamics and scattering phenomena, including vacuum Rabi splitting accompanied by additional fluorescence at atomic resonance [2]. Future research will be extended to studying the quantum dynamics of atom-cavity interactions on the ${}^1S_0$-${}^3P_0$ clock transition.

[1] H. Gothe et al., Physical Review A 99.1 (2019) 013415.
[2] S. Shaju et al. , arXiv:2404.12173 (2024).

MON 23.41 Mon 18:30 ZHG Foyer 1. OG

Coherent interactions of quantum emitters in a dielectric waveguide — •Grigory Kornilov, Alok Gokhale, Gregor Pieplow, Tim Schröder, Kurt Busch, and Francesco Intravaia — Humboldt-Universität zu Berlin, Berlin, Germany

Robust theoretical modeling of quantum emitters in dielectric media is crucial for predicting their behavior in practical applications. Existing models often simplify the system to a one-dimensional regime, thereby failing to accurately capture the influence of quantum noise and radiative losses on the emitters' intrinsic properties and overall system performance. Especially in nanoscopic devices, such as photonic integrated circuits with embedded solid-state quantum emitters, these effects can significantly impact measurement outcomes.

Utilizing a Green's-tensor approach in combination with the theory of open quantum systems, we present a fully three-dimensional quantum electrodynamics description of a quantum emitter embedded in a dielectric structure. Specifically, we investigate negatively charged nitrogen vacancy centers (NVs) in a cylindrical diamond waveguide. We explore the interaction of a single NV with an incident light field as well as waveguide-mediated coherent interactions between multiple emitters. In particular, the latter analysis may inform future experiments seeking to harness such collective effects. We also show how our explicit treatment of phonon-mediated NV decay affects simulated experiments beyond a simple modification of the NV-waveguide coupling strength.

MON 23.42 Mon 18:30 ZHG Foyer 1. OG

Spin and energy dynamics in the disordered spin-1/2 XX ladder — •Lukas Peinemann, Kadir Çeven, and Fabian Heidrich-Meisner — Institut für Theoretische Physik, Georg-August-Universität Göttingen, Germany

Understanding the relaxation dynamics of closed many-body quantum systems is a central goal in the study of non-equilibrium quantum physics. Within linear response theory, we numerically calculate the spin and energy diffusion coefficients in the disordered two-leg spin-1/2 XX ladder at infinite temperature, employing the concept of quantum typicality. Using exact diagonalization, we determine the disorder-induced finite-size crossover from delocalized to many-body localized regime by analyzing the gap ratio and the von Neumann entanglement entropy. We examine how the hierarchy of spin and energy diffusion constants in the delocalized regime compares to that in other non-integrable spin models, such as the XXZ chain with a staggered magnetic field. Our numerical findings reveal an atypical hierarchy in the XX ladder, where spin diffusion exceeds energy diffusion - in contrast to the behavior observed in the other studied models. This reversed hierarchy persists throughout the entire delocalized regime, with both diffusion constants decreasing systematically as disorder is increased. Moreover, our results suggest that increasing the inter-leg coupling leads to a convergence of the spin and energy diffusion coefficients.

We acknowledge funding from the Deutsche Forschungsgemeinschaft (German Research Foundation) within the research unit FOR5522 (Project No. 499180199)

MON 23.43 Mon 18:30 ZHG Foyer 1. OG

Ultrastrong coupling limit to quantum mean force Gibbs state for anharmonic environment — •Prem Kumar and Sibasish Ghosh — Optics and Quantum Information Group, The Institute of Mathematical Sciences, C.I.T. Campus, Taramani, Chennai 600113, India.

The equilibrium state of a quantum system can deviate from the Gibbs state if the system-environment (SE) coupling is not weak. An analytical expression for this mean force Gibbs state (MFGS) is known in the ultrastrong coupling (USC) regime for the Caldeira-Leggett (CL) model that assumes a harmonic environment. Here, we derive analytical expressions for the MFGS in the USC regime for more general SE models. For all the generalized models considered here, we find the USC state to be diagonal in the basis set by the SE interaction, just like in the CL case. While for the generic model considered, the corresponding USC-MFGS is found to alter from the CL-result, we do identify a class of models more general than the CL model for which the CL-USC result remains unchanged. We also provide numerical verification for our results. These results provide key tools for the study of strong coupling quantum thermodynamics and several quantum chemistry and biology problems under more realistic SE models, going beyond the CL model.

MON 23.44 Mon 18:30 ZHG Foyer 1. OG

Minimal quantum models and non-standard heat transport — Helen Dorausch and •Carsten Henkel — Universität Potsdam, Institut für Physik und Astronomie

As the building blocks of coupled thermodynamical systems get smaller, quantum physics introduces curious challenges. We study simple examples based on oscillators coupled to heat baths. (1) A single, strongly damped oscillator driven by a laser provides a model for the plasmon resonance of a single particle. We study it with a quantum jump simulation that provides a quite different steady-state picture with strong spikes in the local bath temperature (the electron gas in the particle itself). (2) A two-site oscillator chain connected to baths with different temperatures permits to dis-spell a purported violation of the second law [1, 2]. We analyse carefully the role of the rotating-wave approximation adopted in the coupling (or not). The symplectic (canonical) group Sp(4) is instrumental in getting a global picture.

[1] A. Levy and R. Kosloff, Europhys. Lett. 107 (2014) 20004
[2] C. Henkel, Ann. Phys. (Berlin) 533 (2021) 2100089

MON 23.45 Mon 18:30 ZHG Foyer 1. OG

Accessing Metastable Triplet States of Aromatic Molecular Emitters — •Max Masuhr, Bo Deng, Babak Behjati, Hazem Hajjar, and Daqing Wang — Institute of Applied Physics, University of Bonn, Wegelerstrasse 8, 53115 Bonn, Germany

Aromatic hydrocarbon molecules embedded in solid-state matrices have been shown to be an excellent platform for quantum optics applications. The triplet states of these molecules offer additional magnetic degrees of freedom, which are potentially interesting for quantum sensing and information. Here, we present our recent work focused on combined optical and microwave characterization of metastable triplet states of several molecule-host combinations.

MON 23.46 Mon 18:30 ZHG Foyer 1. OG

Exploring Electrical Transport in the 2D Quantum Material $FePSe_3$ — •Paul Perl[1], Lars Thole[1], Sonja Locmelis[2], and Rolf J. Haug[1] — [1]Institut für Festkörperphysik, Leibniz Universität Hannover, 30167 Hannover, Germany — [2]Institut für Anorganische Chemie, Leibniz Universität Hannover, 30167 Hannover, Germany

Thin-layer systems of the quantum 2D material iron phosphorus triselenide ($FePSe_3$) exhibit promising potential for use in innovative devices [1]. In this study, we investigate the electrical properties of flakes with thicknesses ranging from 14 nm to 28 nm, including activation energy and Schottky barriers with various contact materials, to develop a deeper understanding of the material's behavior. The bulk crystals were synthesized via chemical vapor transport, and the thin flakes were then exfoliated using the scotch tape method. Electrical contacts for the exfoliated flakes were created using electron beam lithography followed by physical vapor deposition. Additionally, we observe a memory effect induced by the application of a backgate voltage, suggesting potential for $FePSe_3$ in memory devices.

[1] Z. Zhao et al., npj 2D Mater. Appl. 9, 30 (2025)

MON 23.47 Mon 18:30 ZHG Foyer 1. OG

Novel Medium- and High-Entropy Telluride Thin Films via Hybrid Pulsed Laser Deposition — •Niklas Kohlrautz, Pia

Henning, Helmut Klein, Heidrun Sowa, and Jasnamol Palakkal — Institute of Materials Physics, University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

Medium- and high-entropy materials (MEMs and HEMs) are known for their great multifunctional properties, ranging from catalytic activity to magnetic order [1]. Moreover, tellurides (e.g., CrTe, FeGeTe, and CrGeTe) have gained large interest for their highly tunable magnetic properties, including room-temperature ferromagnetism and perpendicular magnetic anisotropy [2]. Toward the goal of synthesizing novel HEMs, we designed a hybrid Pulsed Laser Deposition (PLD) technique with Te molecular beam source attached. After primarily establishing the growth of $Cr_{(1+\delta)}Te_2$, we synthesized a novel MEM telluride, FeCrNiTe (FCNT), using a PLD target containing the transition metals and supplying Te via the beam source. Growth parameter optimization yielded high-quality epitaxial thin films. We present a detailed structural and physical characterization of a series of FCNT thin films deposited on $SrTiO_3(100)$ substrates. Orthorhombic crystal structure, highly homogeneous surface, semiconducting behavior, and a low magnetoresistance at low temperatures were identified in these novel MEM tellurides. This work pioneers the synthesis of many novel MEM and HEM tellurides that have potential in future spintronics devices.

[1] N. Oueldna, Materials Horizons 2024, 11(10), 2323-2354.
[2] A. Tschesche et al., R.S., doi.org/10.21203/rs.3.rs-4861088/v1.

MON 23.48 Mon 18:30 ZHG Foyer 1. OG

Deterministic single ion-implantation of Er into thin film lithium niobate — •Maranatha Andalis, Reiner Schneider, and Klaus D. Jöns — Institute for Photonic Quantum Systems (PhoQS), Center for Optoelectronics and Photonics Paderborn (CeOPP) and Department of Physics, Paderborn University, 33098 Paderborn, Germany

Incorporating rare earth ions (REIs) into lithium niobate-on insulators (LNOI) is of great interest in scalable photonic integrated circuits (PIC), enhancing the potential of LNOI with added functionalities enabled by the REIs. Erbium ions can be incorporated into LNOI using ion implantation and implemented at telecom wavelengths. Together with Ionoptika Ltd., we have customized a single ion implantation system called Q-One with up to 40 kV acceleration voltage. For most quantum applications, the site-selective implantation of a single REI is required. Our results show single Er ion implantation into LNOI with 85% efficiency using secondary electron emission detection. The Q-One single ion implanter, with its high-resolution mass-filtered focused ion beam, nanometer-precision stage, and choice of ion source, holds significant potential in deterministic ion implantation, crucial for scalable quantum technologies with REIs.

MON 23.49 Mon 18:30 ZHG Foyer 1. OG

Probing Ultrafast Lattice Dynamics of Quantum Material Surfaces — •Alp Akbiyik[1], Felix Kurtz[1], Hannes Böckmann[1], and Claus Ropers[1,2] — [1]Max Planck Institute for Multidisciplinary Sciences, Göttingen, Germany — [2]4th Physical Institute, University of Göttingen, Germany

Correlated phenomena among quantum materials have attracted considerable interest in recent decades. However, their potential applications require a better understanding of and ability to manipulate the lattice dynamics coupled to electronic phenomena. Ultrafast LEED probes the surfaces of bulk or two-dimensional materials to observe structural phase transitions and lattice thermalization with a time resolution down to 1 ps [1]. While some bulk CDW systems, such as TaS2 and TiSe2 have been studied extensively in ULEED, our ongoing studies focus more on mono- and few-layer van der Waals (vdW) materials to investigate intriguing phonon dynamics and novel structural changes owing to dimensionality effect.

[1] G. Storeck et al., Structural Dynamics 7, 034304 (2020).

MON 23.50 Mon 18:30 ZHG Foyer 1. OG

Controlling Indistinguishability of cascaded emissions from QDs through an Open Cavity system — •Francesco Salusti[1], Mark Hogg[2], Timon Luca Baltisberger[2], Malwina Anna Marczak[2], Nils Heinisch[1], Rüdiger Schott[3], Sascha René Valentin[3], Andreas Dirk Wieck[3], Arne Ludwig[3], Stefan Schumacher[1], Richard Warburton[2], and Klaus Jöns[1] — [1]PhoQS Institute, CeOPP, and Department of Physics, Paderborn University, Paderborn, Germany — [2]Philosophisch-Naturwissenschaftliche Fakultät, Departement Physik, Basel, Switzerland — [3]Ruhr Universität Bochum, Faculty of Physics and Astronomy, Bochum, Germany

Cavity structures are effective tools for enhancing quantum light emitters. Tunable open cavities can be adapted to emitters like quantum dots, supporting key features for quantum communication such as on-demand emission, low multiphoton probability, and indistinguishable photons. Here we show that a tunable microcavity enhances photon pair generation from the biexciton exciton cascade, overcoming the limits of poor indistinguishability due to non-separability and time-correlation. We control exciton and biexciton emission rates via selective Purcell enhancement of the transitions using our tunable cavity. By imbalancing the lifetime ratio between biexciton and exciton photons (as suggested in E. Schöll et al. Phys.Rev.Lett.125, 233605(2020)), we achieve high Hong-Ou-Mandel visibility values for both photons emitted in the cascade. We show that the HOM visibility follows $V=(\tau_X)/(\tau_X+\tau_{XX})$, matching with theoretical predictions.

MON 23.51 Mon 18:30 ZHG Foyer 1. OG

Topological Phenomena in Folded Bilayer Graphene Heterostructures — •Hannes Kakuschke, Lina Bockhorn, and Rolf Haug — Institut für Festkörperphysik, Leibniz Universität Hannover, 30167 Hannover, Germany

Mono- and bilayer systems of graphene have been extensively researched due to their unique magnetic and electronic transport properties. In more recent work, folded graphene [1, 2] heterostructures exhibit fascinating phenomena. This is due to the topology of the folded region, causing effects such as snake states and zero line modes. However, in transport measurements of self-assembled, folded graphene [3, 4, 5], multiple effects occur simultaneously, complicating the analysis of individual contributions. To solve this problem, we use the dry transfer method to fold graphene around hBN, decoupling the overlapping graphene regions. In such heterostructures we observe topologically protected transport behaviour in the folded region.

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[2] J. C. Rode et al., 2D Mater. 6, 015021 (2018).
[3] L. Bockhorn et al., Appl. Phys. Lett. 118, 173101 (2021).
[4] S. J. Hong et al., 2D Materials 8, 045009 (2021).
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MON 23.52 Mon 18:30 ZHG Foyer 1. OG

Giant Stark-shift of a defect emitter in a strained WSe_2 monolayer — Felix Schaumburg[1], Fabian Stechemesser[1], Hendrik Mannel[1], Jeniffer König[2], Cornelius Dietrich[2], Corinne Steiner[3], Patricia Pesch[3], Axel Lorke[1], •Günther Prinz[1], Martin Geller[1], and Annika Kurzmann[2] — [1]Universität Duisburg-Essen, Duisburg, Deutschland — [2]Universität zu Köln, Köln, Deutschland — [3]RWTH Aachen, Aachen, Deutschland

The search for quantum emitters for quantum technologies is one of today's fastest-growing fields in research worldwide. Here, we investigate the electrical-field dependent optical emission of a two-dimensional (2D) heterostructure, based on tungsten diselenide (WSe_2). Hexagonal boron nitride layers provide electrical isolation, and few-layer graphene acts as a backgate electrode. The heterostructure was placed on a silicon substrate with SiO_2 nanopillars to create local strain. In the WSe_2 layer, defects have been introduced by 100 kV electron irradiation. μ-Photoluminescence (PL) measurements of single emitters show narrow emission lines and single photon emission.

By applying voltages to the graphene and the metallic top gate, an electric field can be introduced across the WSe_2. We will present μ-PL spectra of emitters depending on the gate voltage and observe a giant shift in wavelength up to 6 nm, when the gate voltage is changed by 1.5V. Additionally, the intensity of the emitters is strongly dependent on the absolute value of the gate voltage. The combination of defect engineering, strain-induced localization, and electric field control offers a promising route toward scalable quantum emitter platforms.

MON 23.53 Mon 18:30 ZHG Foyer 1. OG

Epitaxial Growth of Van der Waals Magnets $Cr_{1+\delta}Te_2$ — •Pia Henning, Anna Tschesche, Laura Pflügl, Tobias Meyer, and Jasnamol Palakkal — Institute of Material Physics, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077, Göttingen

Tunable magnetic materials in 3D and as well as in lower dimensions, exhibiting ferromagnetism and perpendicular magnetic anisotropy (PMA) are highly desired for application in future spintronic devices. In the course of that, thin films of transition metal dichalcogenides $Cr_{1+\delta}Te_2$ gained an increased interest, due to their highly tunable magnetic anisotropy and ferromagnetism with T_C ranging from 150 K to 350 K [1]. The stoichiometry, i.e. the intercalation of Cr species (δ) in between $CrTe_2$ layers, is the reason for the highly variable magnetic properties [1]. This makes the need for a sensitive control of δ in combination with a high-quality thin film growth critical. A hybrid deposition was used for growing $Cr_{1+\delta}Te_2$ thin films with various δ, combining Pulsed Laser Deposition (PLD) and Molecular Beam Epitaxy (MBE). Structural, magnetic and transport properties of the samples were evaluated, whereby Room-temperature ferromagnetism, PMA, anisotropic magnetoresistance and anomalous Hall effect are observed, showing a high tunability of properties relative to δ. This work emphasizes the potential of this hybrid deposition technique for growing transition metal dichalcogenide thin films paving the way for possible device applications.

[1] A. Tschesche, P. Henning, et al., Preprint on Research Square, https://doi.org/10.21203/rs.3.rs-4861088/v1

MON 23.54 Mon 18:30 ZHG Foyer 1. OG

Quantum Dynamics of Spin Polarization Transfer in NV-diamond Systems Probed by In-Situ ^{13}C NMR — •Tilen Knaflič, Mario Grüneberg, Enrique Sánchez-Ibáñez, Claudius Mullen, and Jaka Pribošek — Silicon Austria Labs, Villach, Austria

Dynamic nuclear polarization (DNP) is a powerful technique that significantly boosts nuclear spin polarization in solids, amplifying the sensitivity of nuclear magnetic resonance (NMR), which can serve as a foundation for new-generation quantum sensors. Several DNP mechanisms - such as the Overhauser effect, the solid effect and the cross effect - rely on quantum interactions between electron and nuclear spins, mediated by microwave-driven transitions and spin diffusion. These processes exploit the large thermal polarization of electron spins and efficient polarization transfer to nuclear spins, enabling quantum control over spin ensembles and enhancing signal detection in high-resolution spectroscopy and imaging.

In this work, we explore DNP in negatively charged nitrogen-vacancy (NV^-) centers in diamond, a quantum system with optically addressable spin states and long coherence times. We study the field dependence of the DNP process by performing hyperpolarization and in-situ inductive NMR detection of ^{13}C nuclei at different magnetic fields in the range between 10 mT and 1 T. Our results provide insights into the quantum dynamics of spin polarization transfer in NV-diamond systems and demonstrate the potential of DNP for enhancing NMR sensitivity across a range of magnetic field strengths.

MON 23.55 Mon 18:30 ZHG Foyer 1. OG

Geometrically Constrained Quantum Dynamics: A Numerical Study on a Comb — •Ognen Kapetanoski and Irina Petreska — Ss. Cyril and Methodius University in Skopje, Faculty of Natural Sciences and Mathematics, Institute of Physics, Skopje, Macedonia

We investigate the quantum dynamics of a particle constrained by a two-dimensional comb-like geometry using the time-dependent Schrödinger equation. This structure consists of a backbone and branching fingers, which models transport phenomena in heterogeneous and anisotropic media. Geometric constraints are implemented by implementing a Dirac delta function into the kinetic energy operator, approximated by a Gaussian. Spatial discretization is done using a finite-difference scheme and time evolution is computed with a fourth-order Runge-Kutta method. We compare Gaussian and comb-like wave functions to study how initial conditions affect the evolution of the probability density. The comb-like initial state shows strong localization near the backbone in early stages of time evolution. At later times, this localization disappears and the resulting probability distribution becomes similar to that of the Gaussian case. Numerical results are compared with analytical solutions, showing excellent agreement for short to intermediate time intervals. This method allows quantum transport modeling in finite domains and complex initial conditions where analytical solutions do not exist.

[1] O. Kapetanoski and I. Petreska, *Phys. Scr.* **100**, 025254 (2025).

MON 23.56 Mon 18:30 ZHG Foyer 1. OG

Geometrically Constrained Quantum Dynamics: A Numerical Study on a Comb — •Ognen Kapetanoski and Irina Petreska — Ss. Cyril and Methodius University in Skopje, Faculty of Natural Sciences and Mathematics, Institute of Physics, Skopje, Macedonia

We investigate the quantum dynamics of a particle constrained by a two-dimensional comb-like geometry using the time-dependent Schrödinger equation. This structure consists of a backbone and branching fingers, which models transport phenomena in heterogeneous and anisotropic media. Geometric constraints are implemented by implementing a Dirac delta function into the kinetic energy operator, approximated by a Gaussian. Spatial discretization is done using a finite-difference scheme and time evolution is computed with a fourth-order Runge-Kutta method. We compare Gaussian and comb-like wave functions to study how initial conditions affect the evolution of the probability density. The comb-like initial state shows strong localization near the backbone in early stages of time evolution. At later times, this localization disappears and the resulting probability distribution becomes similar to that of the Gaussian case. Numerical results are compared with analytical solutions, showing excellent agreement for short to intermediate time intervals. This method allows quantum transport modeling in finite domains and complex initial conditions where analytical solutions do not exist.

[1] O. Kapetanoski and I. Petreska, *Phys. Scr.* **100**, 025254 (2025).

MON 23.57 Mon 18:30 ZHG Foyer 1. OG

Towards a Quantitative Framework for Capacitance-Voltage Spectroscopy in Quantum Dot Ensembles — •Phil Julien Badura[1], Nico Frédéric Brosda[1], Ismail Bölükbaşı[1], Ibrahim Engin[1], Patrick Lindner[1], Sascha René Valentin[1], Andreas Dirk Wieck[1], Björn Sothmann[2], and Arne Ludwig[1] — [1]Lehrstuhl für Angewandte Festkörperphysik, Ruhr-Universität Bochum, D-44780 Bochum, Germany — [2]Fakultät für Physik and CENIDE, Universität Duisburg-Essen, Lotharstraße 1, D-47048 Duisburg, Germany

This study investigates an inhomogeneous ensemble of quantum dots coupled to a charge reservoir using capacitance-voltage spectroscopy. Experimental measurements reveal shifts in capacitance peak positions influenced by AC frequency and temperature, with frequency-dependent shifts remaining unexplained by existing models. To address this, we develop a master equation-based theoretical model incorporating energy-dependent tunneling effects, which successfully reproduces the experimental data. Our findings emphasize the role of energy-dependent tunneling in distinct regimes: at low temperatures, energy level dispersion dominates, while at high temperatures and frequencies, shifts arise from optimized sequences of in- and out-tunneling events.

MON 23.58 Mon 18:30 ZHG Foyer 1. OG

Magnetotransport measurements of magic angle twisted bilayer graphene — •Monica Kolek Martinez de Azagra and Thomas Weitz — 1. Institute of Physics, Georg-August University of Göttingen

Magic angle twisted bilayer graphene (MATBG) has in recent years been established as a powerful platform for exploring strongly correlated electron phenomena in two-dimensional materials [1]. The rich phase diagram of two graphene layers stacked on top of each other with a precise twist angle of 1.1° has been widely studied with a special emphasis on investigating the robust superconducting state, whose exact nature and origin have yet to be determined [2,3]. Here, we present our recent progress in the fabrication and electric characterization of high-quality, encapsulated MATBG devices, highlighting key experimental observations.

[1] R.Bistritzer, A. H. MacDonald, PNAS 108, 12233(2011).
[2] Y. Cao et al., Nature 556, 80 (2018).
[3] Y. Cao et al., Nature 556, 43 (2018).

MON 23.59 Mon 18:30 ZHG Foyer 1. OG

Autonomous conversion of particle exchange to quantum self-oscillations — •Sofia Sevitz[1], Federico Cerisola[2], Karen Hovhannisyan[1], and Janet Anders[1,2] — [1]University of Potsdam, Germany — [2]University of Exeter, UK

Particle-exchange autonomous machines continuously convert electronic transport into heat transfer between fermionic reservoirs. In typical set-ups, to collect the generated electrical power, an external resistive load is connected that inevitably yields some dissipation. To overcome these losses, we couple a mechanical resonator as an internal degree of freedom to the particle exchange machine hosted in a quantum dot. This way, part of the exchanged energy can be converted into self-oscillations. Here we explore the slow transport regime making use of a recently developed quantum model. Our analysis goes well beyond all previous work, which was limited to semiclassical treatment of the fast transport regime. First, we show that quantum self-oscillations are present in this slow regime and can be measured via the electrical particle current acting as a witness. Next, we study the thermodynamics of the setup and find that, under realistic conditions, self-oscillations occur only when the machine operates as a heater. Lastly, we establish an experimentally measurable performance metric which reveals that, counterintuitively, strong coupling between dot and resonator is detrimental to the conversion quality. The framework developed in this work can be readily implemented in a variety of nanoscale devices such as a suspended carbon nanotube with an embedded quantum dot.

MON 23.60 Mon 18:30 ZHG Foyer 1. OG

Electronic Phase Diagram of Rhombohedral-Stacked Thin Graphene Layers — •Sirri Batuhan Kalkan, Caroline Scheper, David Urbaniak, Monica Kolek Martinez de Azagra, Isabell Weimer, and Thomas Weitz — I. Institute of Physics, Georg-August University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Twisted bilayer graphene has emerged as a powerful system for studying flat band induced exotic quantum phase transitions, offering valuable insights into quantum phenomena [1]. However, the fixed angle between layers in this system limits the tunability of electronic correlations, prompting researchers to explore alternative approaches. Naturally occurring few-layer graphene systems provide a promising solution, as stacking failures in these systems can result in rhombohedral stacking. This configuration enables continuous control of interactions through external electric fields, offering a versatile platform for studying quantum phase transitions [2-3]. By identifying rhombohedral domains, fabricating devices, and conducting electrical characterization, in this work we discuss its electronic phase diagram that encompasses both superconducting and magnetic phase transitions.

[1] Yuan Cao et al. , Nature 556.7699 (2018): 43
[2] Haoxin Zhou et al., Nature 598.7881 (2021): 434
[3] Tonghang Han et al. , arXiv preprint arXiv:2408.15233 (2024).

MON 23.61 Mon 18:30 ZHG Foyer 1. OG

Towards magnetotransport measurements in rhombohedral multi-layer graphene — •David Paul Urbaniak, Christian Eckel, Sirri Batuhan Kalkan, and Thomas Weitz — 1st Institute of Physics, Faculty of Physics, Georg-August University Göttingen, Germany

The flat bandstructure of rhombohedral multilayer graphene enables the investigation of a variety of correlation-driven effects, including the fractional quantum Hall effect and its anomalous counterpart, recently observed in rhombohedral pentalayer graphene [1]. Recent observations have additionally revealed signatures of chiral superconductivity in rhombohedral tetra- and pentalayer graphene, along with the unprecedented discovery of a superconductor phase within an anomalous Hall phase in rhombohedral hexalayer graphene [2, 3]. This work presents the necessary steps for the fabrication of an in hexagonal boron nitride (hBN) encapsulated, dual gated device for the investigation of the aforementioned effects during magnetotransport measurements in the milli Kelvin regime. The fabrication techniques employed consist of Raman spectroscopy, scattering near field optical microscopy (SNOM), a nanolithography technique based on an atomic force microscope (AFM), and a dry transfer technique. Conclusively, preliminary measurements are presented.

[1] Zh. Lu et al., Nature 626, 759 (2024).
[2] T. Han et al., arXiv:2408.15233 (2024).
[3] E. Morissette et al., arXiv:2504.05129 (2025).

MON 23.62 Mon 18:30 ZHG Foyer 1. OG

Vacancies and Stone-Wales Defects in Twisted Bilayer Graphene: A Comparative Theoretical Study — •Fabian Dietrich and Eduardo Cisternas — Departamento de Ciencias Físicas, Universidad de La Frontera, Temuco, Chile

Twisted bilayer graphene (TBG) has emerged as a cornerstone in the exploration of strongly correlated electronic systems, exhibiting tunable quantum phenomena such as superconductivity and Mott insulating states. In this study, we present a comparative theoretical investigation of two key classes of structural defects - monovacancies and Stone-Wales (SW) defects - introduced into a TBG system with different twist angles.

Using density functional theory (DFT), we analyze the energetic stability, local geometric reconstruction, and electronic structure of these defects. Our results show that both types of defects significantly alter the local density of states (LDOS), introducing mid-gap states and modifying the flat bands characteristic of TBG. Notably, the influence of the defect type is highly sensitive to its registry within the Moiré supercell, with SW defects inducing less mid-gap perturbation than vacancies but more extensive topological rearrangements.

Our findings offer new insights into defect engineering in twisted van der Waals systems and have implications for designing quantum devices based on TBG with tailored electronic properties.

[1] F. Dietrich, U. Guevara, A. Tiutiunnyk, D. Laroze, E. Cisternas, Flatchem. 41 (2023) 100541.

MON 23.63 Mon 18:30 ZHG Foyer 1. OG

Parent State Modeling of Correlated and Topological Quantum Phases in Rhombohedral Multilayer Graphene — •Robert Schneider[1], David Urbaniak[1], Chiho Yoon[2], Sirri Batuhan Kalkan[1], Fan Zhang[2], and Thomas Weitz[1] — [1]1st Physical Institute, Faculty of Physics, University of Göttingen, Göttingen, Germany — [2]Department of Physics, University of Texas at Dallas, Richardson, TX, USA

Recently, a number of novel correlated and topological quantum phases in N-layer ABC-stacked graphene systems have been identified. Among them are anomalous Hall crystals with a non-trivial Chern number at vanishing magnetic field (Nature 608, 298-302), as well as chiral p-wave superconducting states that persist to unconventionally high magnetic fields (arXiv: 2408.15233). Even though they are fundamentally many-body quantum phenomena, the theoretical determination of the single-particle bands hosting these quantum phases is important in understanding the interplay between quantum geometry and many-body interactions. Examples of relevant effects are the formation of flat bands, the generation of a tunable band gap, and the possibility of a topological Lifshitz transition due to trigonal warping. This work shows how the parent states of these correlated and topological quantum phases can be accurately modeled using various computational methods including tight-binding models and density functional theory (arXiv: 2502.17555v1). Finally, an outlook into the interpretation of the obtained results for different rhombohedral multilayer graphene systems is presented.