HL 22: Focus Session: Young Semiconductor Forum

This poster session is part of the Young Semiconductor Forum, which is a platform for post-docs at all career stages to present themselves and their scientific ideas. The forum consists of an oral session with invited talks and immediately afterwards, a poster session, where further participants present a poster about their work and/or scientific vita. With this format, we hope to attract both postdocs and senior researchers and decision makers to join this forum: for postdocs, to give them a platform to present themselves, and for professors, to meet the next generation of scientists.

Organized by Alexander Holleitner and AGYouLEAP (Susanne Liese, Alexander Schlaich, Doris Reiter und Christoph Kastl).

Time: Tuesday 11:00–15:30 Location: Poster F

HL 22.1 Tue 11:00 Poster F

High-entropy thermoelectrics: what is the role of metavalent bonding? — •Nan Lin[1], Dongwang Yang[2], Yuan Yu[1], and Matthias Wuttig[1] — [1]Institute of Physics (IA), RWTH Aachen University, 52056 Aachen, Germany — [2]State Key Laboratory of Advanced Technology for Materials Synthesis and Processing, Wuhan University of Technology, Wuhan 430070, China

The design principle of high-entropy (HE) thermoelectrics is still elusive because forming a solid solution is the prerequisite to enhance the configurational entropy. Typical HE thermoelectrics have been mainly realized in chalcogenides such as PbTe and GeTe, etc. Interestingly, these chalcogenides also show an unconventional chemical bonding mechanism, termed metavalent bonding (MVB). Is there a strong coincidence of correlation between HE thermoelectrics and MVB? To answer this question, we designed PbQ-AgBiQ2 (Q = S, Se, Te) samples to study their microstructures and bonding mechanisms, as well as thermoelectric properties. We observe no obvious phase separations in these alloys. Atom probe tomography measurements also confirm the abnormal bond-breaking behavior, corroborating their bonding mechanism. Moreover, the maximum optical absorption decreases from Q = Te to Q = Se and then to Q=S due to the increased charge transfer. This also leads to the weakening of MVB. The thermoelectric properties decrease with increasing the charge transfer numbers from tellurides to sulfides. This work indicates that mixing metavalently bonded solids with a controlled degree of charge transfer could be an important avenue for designing HE thermoelectrics.

HL 22.2 Tue 11:00 Poster F

Shaped pulses for quantum dots- Innovations and future perspectives — •Vikas Remesh — Institute for Experimental Physics, University of Innsbruck, Technikerstr. 25d, 6020 Innsbruck, Austria

Shaped laser pulses have been remarkably effective in investigating and controlling various light-matter interactions spanning a broad area of research from laser technology to nanophotonics. In quantum technology, the pulse shaping techniques to generate complex spatiotemporal waveforms have found renewed interest, for instance in coherent control of quantum dots, spectrotemporal mode shaping for parametric down conversion source and so on. In this talk, I will navigate through the impact of pulse shaping techniques in nanospectroscopy and how it enabled us to demonstrate efficient preparation schemes in quantum dots, highlighting our recent works [1-4]. Afterwards, I will conclude with my vision on the future of nanophotonics-assisted-quantum technologies. [1] ACS Photonics 6, 2487 (2019), ACS sensors 6, 581 (2021) [2] Nano Letters 22, 6567 (2022) [3] Materials for Quantum Technology 3, 025006 (2023) [4] APL Photonics 8, 101301 (2023), arXiv:2305.20017

HL 22.3 Tue 11:00 Poster F

Membrane external-cavity surface-emitting lasers: A review at the first decade of research — •Hermann Kahle — Institute for Photonic Quantum Systems (PhoQS), Center for Optoelectronics and Photonics Paderborn (CeOPP) and Department of Physics, Paderborn University, 33098 Paderborn, Germany

Membrane external-cavity surface-emitting lasers (MECSELs) have emerged as a derivative of vertical-external-cavity surface-emitting lasers (VECSELs). The pursuit of higher output power, particularly in materials with moderate performance characteristics, has driven the innovation of creating extremely thin amplifier membranes within a nearly ideal thermal environment. These gain membranes, sandwiched between transparent heat spreaders, containing nothing else but the active region of a VECSEL (no substrate, no monolithically integrated DBR), caught much attention in recent years. Inserting the gain element into a cavity completes the MECSEL, which has already enabled access to laser wavelengths previously unattainable by VECSELs and has facilitated watt-level output power at room temperature. Furthermore, the MECSEL approach fundamentally enables the production of high-power lasers of the highest beam quality whenever it is possible to produce an LED. Beyond that, the membrane approach offers numerous additional advantages.

A comprehensive discussion of these advantages will be provided, as well as a review of the developments that have contributed to the success of MECSELs. The conclusion will give an overview of the most recent findings and a glimpse into future developments in this field.

HL 22.4 Tue 11:00 Poster F

Tunable White-Light Emission from Self-Trapped Excitons in Low-Dimensional Hybrid Perovskites — •Philip Klement[1], Lukas Gümbel[1], Johanna Heine[2], and Sangam Chatterjee[1] — [1]Institute of Experimental Physics I, JLU Gießen, Germany — [2]Department of Chemistry, Universität Marburg, Germany

Lead halide perovskites and related main group metal halide materials hold immensie potential for advanced solar cells and LEDs. Efficient light emission in these materials relies on self-trapped excitons, where excitations create temporary defects that trap excitons within the crystal lattice. However, the complex interplay of factors like ground- and excited-state distortions, lattice softness, and electron-phonon coupling hinders designing these materials for specific optical properties. Here, we study various antimony and bismuth halide compounds with systematic variations in composition, anion dimensionality, connectivity, and chiral organic cation. The unique crystal structure of these compounds facilitates the formation of self-trapped excitons, resulting in broad photoluminescence emission with large Stokes shifts, which we correlate with structural parameters. Challenging conventional wisdom, we present single layers of a 1D hybrid perovskite, questioning the belief that atomically thin 2D materials require in-plane covalent bonding. The thickness-dependent exciton self-trapping induces a pronounced shift in emission energy, revealing distinctive exciton physics. Furthermore, we investigate charge carrier diffusion using temporally and spatially resolved photoluminescence spectroscopy. Our findings deepen the comprehension of emission processes in hybrid materials.

HL 22.5 Tue 11:00 Poster F

Doping-control of excitons and magnetism in few-layer CrSBr — •Farsane Tabataba-Vakili[1,2], Huy Nguyen[1], Anna Rupp[1], Kseniia Mosina[3], Anastasios Papavasileiou[3], Patrick Maletinsky[4], Mikhail Glazov[5], Zdenek Sofer[3], Anvar Baimuratov[1], and Alexander Högele[1,2] — [1]Fakultät für Physik, Munich Quantum Center, and Center for NanoScience (CeNS), Ludwig-Maximilians-Universität München, München, Germany — [2]Munich Center for Quantum Science and Technology (MCQST), München, Germany — [3]Department of Inorganic Chemistry, University of Chemistry and Technology Prague, Prague, Czech Republic — [4]Department of Physics, University of Basel, Basel, Switzerland — [5]Saint Petersburg, Russia

In 2D magnets, phenomena distinct from bulk magnetism have been revealed, such as sensitivity to charge doping and electric field in few-layer CrI3. Air-stable CrSBr stands out as an antiferromagnetic semiconductor with excitons coupled to the magnetic order and exciton-magnon coupling. I will present our work on doping-control of excitons and magnetism in few-layer CrSBr. We demonstrate that both exciton and magnetic transitions are sensitive to field-effect charging, exhibiting bound exciton-charge complexes and doping-induced metamagnetic transitions. We further visualize magnetic domain formation induced by magnetic field or charge-doping at the metamagnetic transition all-optically by raster-scan reflectance imaging. Our work identifies few-layer CrSBr as a rich platform for exploring collaborative effects of charge, optical excitations, and magnetism.

HL 22.6 Tue 11:00 Poster F

Straintronics with van der Waals materials — •Emeline Nysten — Physikalisches Institut, Universität Münster, Germany

Surface acoustic waves (SAWs) have proven to be a multifaceted and efficient tool for the control of semiconductor nanostructures optical properties and the dynamical transport of charge carriers [1]. By integrating 2D semiconducting transition metal dichalcogenides (TMDCs) onto SAW-devices, we are able to investigate and control their interesting optoelectronic properties. Firstly, by systematically studying the SAW-modulated emission of a WSe_2 monolayer in the time domain, we unravel the impact of ubiquitous inhomogeneities in 2D TMDCs on charge carrier dynamics, outperforming conventional static photoluminescence measurements. Secondly, the study of the photogated SAW-induced acousto-electric effect in WSe_2 provides detailed insight into the underlying charge carrier dynamics and the nature of the contact between electrode and 2D semiconductor. Finally, I will discuss perspectives to employ SAW to selectively manipulate emergent phenomena like interfacial ferroelectricity and exciton dynamics in van der Waals heterostructures. [1] Delsing et al., "The 2019 surface acoustic waves roadmap" J. Phys. D:Appl. Phys. 52(35):353001 (2019)

HL 22.7 Tue 11:00 Poster F

Elucidating the mechanism of spectral diffusion in colloidal quantum dots — Frieder Conradt, Vincent Bezold, Volker Wiechert, Steffen Huber, Stefan Mecking, Alfred Leitenstorfer, and •Ron Tenne — University of Konstanz, Konstanz, Germany

Thanks to their exceptional tunability and ease of integration into semiconductor-based devices, colloidal quantum dots (CQDs) have found widespread technological implementations such as display technology. To expand this success into quantum applications, spectral stability and coherence, two closely linked topics, need to be addressed. I will describe recent efforts in answering two fundamental questions: what are the time scales of spectral fluctuations in the emission of a CQD and what is their underlying cause? We perform high-resolution photoluminescence spectroscopy of single particles at low temperatures as a function of an applied electric bias. Doing so, we provide the first direct evidence that spectral fluctuations are straightforwardly derived from the sensitivity of the emission spectrum to spurious electric fields, thus identifying the quantum-confined Stark effect as their physical mechanism.

HL 22.8 Tue 11:00 Poster F

Guided light in Angstrom thin samples - 2D van der Waals materials as a platform for novel optical devices and fundamental research — •Patryk Kusch, Mira Kressler, and Stephanie Reich — Fachbereich Physik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin

Van der Waals materials, like graphene and transition metal dichalcogenides (TMDCs), offer exciting physical properties to explore such as high charge mobility, mechanical strength, and strong light emission. Particularly, monolayers of TMDCs are direct semiconductors that exhibit strong optical absorption by tightly bound excitons, quasiparticles formed by a bound state of an electron, and a hole within one monolayer. The binding energy is often so strong (several 100 meV) that they can be excited under ambient conditions. Furthermore, TMDCs promote the waveguiding of light. As we showed waveguided modes can propagate over several tens of micrometers through a 60 nm thin slab of MoS_2, which is interesting for the realization of novel optical devices. Here we demonstrate that light can be guided in Ångstrom thin WS_2 by imaging waveguided modes in real space with the scattering type scanning near-field optical microscope. The guided light couples with excitons, leading to the formation of exciton-polaritons, quasi-particles that are currently the focus of many scientific studies. We get access to their dispersion relation by taking nanoimages of the propagating polaritons at different excitation energies around the A and B exciton. It impressively shows that the coupling strength between guided light and excitons is in the strong coupling regime.

HL 22.9 Tue 11:00 Poster F

Electrolytes at semi-conducting materials: From first principles to coarse-grained models — •Alexander Schlaich — SC SimTech, University of Stuttgart

The structure and dynamics of liquid electrolytes at semi-conducting materials is fundamental for applications ranging from energy storage via electrocatalysis to functional and responsive materials. However, modeling such systems is intricate since electrostatic interactions * and possibly charge transport * require to consider quantum-mechanical effects, whereas structural re-arrangements, charge transport and slow dynamics demand for long time- and length-scales. In this contribution I will summarize the work in my group showing how first-principle information can be incorporated to semi-classical molecular models to cover relevant scales. We further develop based on this information continuum models to target application-scale problems, i.e., bridge to full range from the micro- to the macro-scale. I will give an outlook showing examples from CO2-reduction in confined systems to coupled ionic-electronic transport in systems of conjugated polymers. I will also elaborate on our efforts making the corresponding workflows F.A.I.R. (findable, accessible, interoperable and reusable) by strict documentation and especially by including also the analysis of data, which too often is still neglected in discussions about scientific software.

HL 22.10 Tue 11:00 Poster F

Route toward simulating semiconductor interfaces and surfaces: from crafting an XC potential to applications — •Tomáš Rauch — Institut für Festkörpertheorie und -optik, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, 07743 Jena, Germany

Since 2018 I have been part of the project “Developing an e-lab for interfaces on demand – dandelion” funded by the VW Foundation. My work toward describing structural and electronic properties of inhomogeneous systems with ab initio methods consisted of several steps which I will present in my talk. First, having to describe heterostructures with large supercells using DFT, I crafted [1], implemented, and benchmarked [2] a new XC potential suitable for the particular problem. Further, finding the commonly used concept of projected DOS not sufficient for strongly reconstructed interfaces or surfaces, I developed a program to calculate local DOS from the output of the VASP code [3]. Finally, I will present my results for specific cases, including CdTe shells on InSb, thin $SrTiO_3$ covering Si, and surfaces of CuI [4].

[1] T. Rauch *et al.*, J. Chem. Theory Comput. **16**, 2654 (2020).

[2] T. Rauch *et al.*, Phys. Rev. B **101**, 245163 (2020); T. Rauch *et al.*, J. Chem. Theory Comput. 17, 4746 (2021); A. Ghosh *et al.*, J. Chem. Phys. **157**, 124108 (2022).

[3] L. Lodeiro and T. Rauch, Comp. Phys. Commun. **277**, 108384 (2022)

[4] G. Badawy *et al.*, Adv. Sci. **9**, 2105722 (2022); T. Rauch *et al.*, Phys. Rev. B **107**, 115303 (2023)

HL 22.11 Tue 11:00 Poster F

Exciton-exciton interactions in van der Waals heterobilayers — •Alexander Steinhoff[1], Edith Wietek[2], Matthias Florian[3], Tommy Schulz[1], Takashi Taniguchi[4], Kenji Watanabe[4], Shen Zhao[5], Alexander Högele[5], Frank Jahnke[1], and Alexey Chernikov[2] — [1]Institute for Theoretical Physics, University of Bremen, Germany — [2]Institute of Applied Physics, Technische Universität Dresden, Germany — [3]University of Michigan, Department of Electrical Engineering and Computer Science, Ann Arbor, USA — [4]National Institute for Materials Science, Tsukuba, Japan — [5]Fakultät für Physik, Ludwig-Maximilians-Universität München, Germany

Exciton-exciton interactions are key to understanding non-linear optical and transport phenomena in van der Waals heterobilayers, which emerged as versatile platforms to study correlated electronic states.

We present a combined theory-experiment study of excitonic many-body effects based on first-principle band structures and Coulomb interaction matrix elements. We demonstrate that dipolar blue shifts are almost perfectly compensated by many-body effects, mainly by screening-induced self-energy corrections. Moreover, we identify a crossover between attractive and repulsive behavior at elevated exciton densities.

Our results revise the established picture of dipolar repulsion dominating exciton-exciton interactions in van der Waals heterostructures and open up opportunities for their external design.

HL 22.12 Tue 11:00 Poster F

Non-Hermitian Physics in multiterminal devices — Kyryl Ochkan[1], Viktor Könye[1], Louis Veyrat[1], Anastasiia Chyzhykova[1], Romain Giraud[1], Dominique Mailly[2], Antonella Cavanna[2], Ulf Gennser[2], Ewelina Hankiewicz[1], Bernd Büchner[1], Jeroen Van den Brink[1], Jan Carl Budich[1], Ion Cosma Fulga[1], and •Joseph Dufouleur[1] — [1]Würzburg-Dresden Cluster of Excellence ct.qmat, Dresden, Germany — [2]Centre de Nanosciences et de Nanotechnologies, CNRS, Université Paris-Saclay, Palaiseau, France

One of the simplest examples of non-Hermitian topology is encountered in the Hatano-Nelson (HN) model, a one-dimensional chain where the hopping in one direction is larger than in the opposite direction. We present here the first experimental observation of non-Hermitian topology in a quantum condensed-matter system made of a multi-terminal quantum Hall device etched in a high mobility GaAs/AlGaAs two-dimensional electron gas ring. In our device, we directly measure and evidence the non-Hermitian skin effect. We also compute for our experimental device two topological invariants that are found to be more robust than the Chern number. We finally use the unique properties of our system and continuously tune the system configuration between open and periodic boundary conditions [1]. We also present the latest developments with regard to the application to electronic devices that can be used as topological ohmmeters [2].

[1] K. Ochkan et al. (arXiv:2305.18674, Nature Physics - in press) [2] V. Könye, et al. (arXiv:2308.11367, under review)

HL 22.13 Tue 11:00 Poster F

Where physics meets biology — •Susanne Liese — Faculty of Mathematics, Natural Sciences, and Materials Engineering: Institute of Physics, University of Augsburg, Augsburg, Germany

All biological processes are governed by physical principles. A fundamental understanding of biological functionality therefore requires an in-depth understanding of the underlying biophysical mechanisms. Using mathematical and numerical modeling, we can explore questions at the intersection between physics, biology, and chemistry. These studies include diverse aspects such as the binding dynamics of multivalent pathogen-inhibitor interactions and the intricate formation and interactions within both membrane-bound and membraneless organelles. In this presentation, I will present how these models serve as a key to deciphering the underlying action and organizational principles that drive the formation and self-organization of biological and soft matter systems.

HL 22.14 Tue 11:00 Poster F

Efficient Narrow-Beam Hexagonal Boron-Nitride Single-Photon Source — •Johann A. Preuss[1], Helge Gehring[1,2], Robert Schmidt[1], Lin Jin[1,2], Daniel Wendland[1,2], Johannes Kern[1], Wolfram H.P. Pernice[1,2,3], Steffen Michaelis de Vasconcellos[1], and Rudolf Bratschitsch[1] — [1]University of Münster, Institute of Physics and Center for Nanotechnology, 48149 Münster, Germany — [2]University of Münster, Center for Soft Nanoscience, 48149 Münster, Germany — [3]Kirchhoff-Institute for Physics, University of Heidelberg, 69120 Heidelberg, Germany

Robust quantum light sources are important for creating quantum networks. Hexagonal boron nitride (hBN) and other 2D materials host single-photon emitters that offer bright emission, even at room temperature, rendering them promising for quantum applications. However, efficient photon collection is difficult due to their wide-angled emission pattern. To enhance light collection, we 3D-printed polymer microlenses onto individual hBN nanocrystals, to collimate single-photon emission into a low-divergent beam. Photoluminescence and photon correlation measurements demonstrate that our ultra-low fluorescence photoresin does not alter the spectrum of the emitters and preserves the single-photon character of the emitted light. Importantly, by analyzing the emission pattern, we show that the lenses efficiently collimate the emission to angles below 5°, enabling the use of collection lenses with low numerical apertures or direct coupling into optical fibers.

HL 22.15 Tue 11:00 Poster F

Field-induced hybridization of moiré excitons — •Anvar Baimuratov — Fakultät für Physik, Munich Quantum Center, and Center for NanoScience (CeNS), Ludwig-Maximilians-Universität München, Geschwister-Scholl-Platz 1, 80539 München, Germany

We study experimentally and theoretically the hybridization among intralayer and interlayer moiré excitons in a MoSe2/WS2 heterostructure. Using a dual-gate device and cryogenic white light reflectance and narrow-band laser modulation spectroscopy, we subject the moiré excitons in the MoSe2/WS2 heterostack to a perpendicular electric field, monitor the field induced dispersion and hybridization of intralayer and interlayer moiré exciton states, and induce a cross-over from type I to type II band alignment. Moreover, we employ perpendicular magnetic fields to map out the dependence of the corresponding exciton Landé g-factors on the electric field. Finally, we develop an effective theoretical model combining resonant and non-resonant contributions to moiré potentials to explain the observed phenomenology, and highlight the relevance of interlayer coupling for structures with close energetic band alignment as in MoSe2/WS2.

HL 22.16 Tue 11:00 Poster F

Nonlinear dynamics: from machine tools to nanoresonators — •Ahmed A. Barakat and Eva M. Weig — Technical University of Munich, Munich, Germany

Exactly as stated by Nikola Tesla: ”If you wish to understand the universe, think of energy, frequency, and vibration”, this was the repeatedly proven conclusion through studying machine tools, wind turbines, microgyroscopes, microwave cavities and quantum systems. The theory of nonlinear dynamics has always been essential to accurately analyze oscillations since most physical processes are inherently nonlinear, however, allowing linearization under tight conditions. This mere fact was the primary motivation to delve into nonlinear dynamics after observing self-oscillations in lathes and aeroelastic wings. The focus, afterwards, was studying one of the most common nonlinear mathematical descriptions in micro and nanosystems, those combining the ubiquitous cubic nonlinearities and parametric effects in multi-modal systems, forming the so-called Mathieu-Duffing systems. This theoretical study was exploited to explain the oscillatory behavior of microgyroscopes. Recently, this study has been extended to studying the modal coupling in nanomechnical string resonators, which showed a similar behavior under parametric excitation. Most interestingly is exploiting the parametric normal mode splitting phenomenon to study the coupling strength between both modes, which would be a novel approach that could be generalized to other two-mode, or two-level, systems.

HL 22.17 Tue 11:00 Poster F

Towards SiC as a Platform for Hybrid Quantum Technologies — •Philipp Bredol, Felix David, and Eva Weig — Technical University of Munich, Chair of Nano and Quantum Sensors, 85748 Munich, Germany

Established nano electronic devices rely mostly on classical physics. Quantum effects offer to go beyond the possibilities of classical devices, but are difficult to exploit due to their fragile nature. Hybrid devices aim to combine the advantages of both worlds by combining quantum and classical elements. However, integration on a single hybrid chip is a challenging task, because materials and process chemistry have to be compatible.

Silicon carbide (SiC) is an exceptional material that is feasible for both classical and quantum electronics: Classical transistors are already being fabricated from SiC on an industrial scale for power electronics. At the same time, SiC hosts color centers with lifetimes competitive with the nitrogen-vacancy center in diamond, which makes it interesting for quantum sensing and quantum information applications. Last but not least, SiC is well suited for high-Q nanomechanics, which can mediate couplings between degrees of freedom that only weakly couple in a direct manner. We explore the possibilities of SiC based hybrid quantum technologies from the nanomechanical perspective. As a first step, we compare the nanomechanical properties of devices fabricated from the 3C and 4H SiC polytypes using various fabrication methods.

HL 22.18 Tue 11:00 Poster F

Broken symmetries in two-dimensional materials probed by nonlinear optoelectronic transport — •Christoph Kastl — Walter Schottky Institute and Physik-Department, Technical University of Munich, Germany — Munich Center for Quantum Science and Technology (MCQST), Munich, Germany

I will present examples of (un)intentionally broken symmetries in van der Waal materials and the resulting nonlinear optoelectronic transport. For $MoTe_2$, photocurrent imaging reveals a disordered transition between the monoclinic phase to the low-temperature orthorhombic phase, where ultrafast photocurrents originate from the local breaking of the electronic symmetries (2D Mater. 2022, 9, 011002). In graphene-based circuits, we address gate-tunable, non-linear transport arising from strong spin-orbit coupling, which may be used to manipulate spin-polarized carriers by both optical and electrical means. In commensurate graphene/Bi_2Te_2Se interfaces, we find an enhanced helicity-dependent photocurrent due to the peculiar spin-orbit proximity of the commensurate alignment (ACS Nano 2022, 16, 12338-12344). In graphene/WTe_2, we demonstrate optical detection of current-induced spin polarisations related to a nonlinear anomalous Hall effect in the heterostructure (Nat. Commun. 2022, 13, 3152). Finally, I will discuss recent work towards top-down control of electronic symmetries by nanofabricaton of lateral superlattice structures in van der Waals materials. The research is supported through the European Union's Horizon Europe Research and Innovation Programme under Grant Agreement No 101076915 (2DTopS).

HL 22.19 Tue 11:00 Poster F

Ultrahigh frequency Brillouin spectroscopy in optophononic Fabry-Perot cavities and optomechanical study of 2D materials in fiber Fabry-Perot cavities — •Anne Rodriguez — Chair for Nano and Quantum Sensors, Technische Universität München, Garching, Germany

The fine control achieved over acoustic phonon dynamics enabled the engineering of interactions with other excitations [1,2]. During my PhD thesis (C2N, CNRS, Université Paris-Saclay) my research was mainly focused on the study of acoustic phonons in GaAs/AlAs multilayered cavities where both light in the near-infrared range and acoustic phonons in the 20 GHz range can be simultaneously confined. I developed experimental approaches for Brillouin spectroscopy that can integrate a widely tunable excitation-source to probe ultra-high acoustic phonons [3,4]. My work also involved theoretical research on topological 1D phononic resonators [5]. In October 2023, I joined the Nano and Quantum Sensor group (TUM) where I am working on optomechanics with transition metal dichalcogenides membranes. I aim to study the mechanical properties and the strain coupling with a quantum emitter embedded in the membrane [6] in a fiber Fabry-Perot cavity. This would be a step forward in the study of spin-optomechanics [7].

[1]M. Yuan et al., AVS Quantum Sci. 4, 035901 (2022). [2]Y. Chu et al., Science 358, 199 (2017). [3]A. Rodriguez et al., Opt. Exp. 29, 2637 (2021). [4]A. Rodriguez et al., ACS Phot. 10, 1687 (2023). [5]A. Rodriguez et al., PRB 108, 205301 (2023). [6]K. Barthelmi et al., APL 117, 070501 (2020). [7]L. He et al., Sci. Adv. 2, e1600485 (2016).

HL 22.20 Tue 11:00 Poster F

Ultrafast coherent control of single-photon emitters in hBN — Johann A. Preuss[1], Daniel Groll[1], Robert Schmidt[1], Thilo Hahn[1], Pawel Machnikowski[2], Tilmann Kuhn[1], Daniel Wigger[3], and •Steffen Michaelis de Vasconcellos[1] — [1]Universität Münster, Germany — [2]Wrocław University of Science and Technology, Poland — [3]Trinity College Dublin, Ireland

Single-photon sources are essential building blocks for quantum networks, and their coherent control remains a key challenge. Recently, single-photon sources in 2D van der Waals materials joined the family of solid-state quantum light emitters. In hexagonal boron nitride (hBN), optically active states have been discovered that efficiently emit single photons even at room temperature. This emitter's variable emission wavelength, narrow lines, and tunability make it promising for quantum sensing and wavelength division multiplexed quantum communications. Our study demonstrates femtosecond coherent state manipulation of individual hBN quantum emitters, showcasing resonant and phonon-assisted control mechanisms. The joint experiment-theory study explores the effects of different sources of spectral jitter on the ultrafast coherence dynamics and how the dephasing of optical and acoustic phonons affects the coherence. Our experiments on phonon-assisted ultrafast coherent control of individual hBN color centers are an important step towards hybrid quantum technologies that combine electronic and phononic excitations.