Q 58: Quantum Technologies – Color Centers I

Time: Thursday 14:30–16:30 Location: P 5

Q 58.1 Thu 14:30 P 5

Critical Discrete Time Crystal with 3D-dipolar-coupled Nuclear Spins in Diamond — •Christina Ioannou[1], Kai-Niklas Schymik[1], Dan Yudilevich[1], Madhumati Seetharaman[1], Benjamin Pingault[2], Francisco Machado[1], and Tim Taminiau[1] — [1]TU Delft, Delft, Netherlands — [2]Argonne National Laboratory/ University of Chicago, Chicago, USA

We investigate the thermalization dynamics under Floquet driving of a 3D-dipolar-coupled many- body system of 13C nuclear spins in diamond. Microscopic control and readout of 40 individual spins gives in depth insight into many-body dynamics and allows for the observation of novel non-equilibrium phenomena. In the case of a disordered Ising type Hamiltonian, with a local disorder term, long range interactions between spins cause the slow down of thermalization dynamics leading to a long lived critical discrete time crystal (DTC) order. We demonstrate the stability of the DTC order, attributed to critical dynamics and we analyze the underlying thermalization mechanism caused by two spin correlated decays.

Q 58.2 Thu 14:45 P 5

Exact Computation of Lock-In Amplifier Outputs for Arbitrary Frequency Modulations Using Gauss-Chebyshev Quadrature — •Dennis Lönard, Stefan Johansson, Alena Erlenbach, Jonas Gutsche, and Artur Widera — Department of Physics and State Research Center OPTIMAS, University of Kaiserslautern-Landau, 67663 Kaiserslautern, Germany

Lock-in detection is everywhere, from precision sensing to quantum experiments, but the theoretical treatment of frequency-modulated signals often relies on approximations for small modulation deviations. These approximations are especially prominent in fields like nitrogen-vacancy-center magnetometry and laser spectroscopy, where frequency modulation is used to generate an error signal for locking. These approximations break down precisely in the regime where optimal sensitivity is achieved, leading to inaccurate predictions of optimal modulation depth, lineshape, and ultimately experimental performance.

In this talk, we introduce an approximation-free numerical method based on Gauss-Chebyshev quadrature that computes lock-in amplifier outputs for any modulation waveform, modulation function, signal shape, or deviation. This method is exact, fast, and simple to implement, making it applicable to all lock-in-based experiments.

We demonstrate the approach using nitrogen-vacancy-center magnetometry, which reveals the true optimal modulation parameters beyond the commonly assumed small-modulation regime. An open-source Python package accompanies our work, providing a ready-to-use reference implementation.

Q 58.3 Thu 15:00 P 5

Optically Detected Magnetic Resonance on Carbene Molecular Qubits — •Simon Roggors[1,2,3], Nico Striegler[1,2,3], Thomas Unden[1], Oleksiy Khavryuchenko[1,4,5], Alon Salhov[1,6], Jochen Scharpf[1], Martin B. Plenio[3,7], Alex Retzker[6], Fedor Jelezko[2,3], Matthias Pfender[1], Philipp Neumann[1], Tim R. Eichhorn[1], Tobias A. Schaub[1,2,3], and Ilai Schwartz[1] — [1]NVision Imaging Technologies GmbH, Wolfgang-Paul-Str. 2, Ulm 89081, Germany — [2]Institute for Quantum Optics (IQO), Ulm University — [3]Center for Integrated Quantum Science and Technology (IQST), Ulm — [4]Shupyk National Healthcare University of Ukraine — [5]Institute of Organic Chemistry of the National Academy of Sciences of Ukraine — [6]Racah Institute of Physics, The Hebrew University of Jerusalem — [7]Institute of Theoretical Physics, Ulm University

Solid-state quantum systems that integrate optical and spin degrees of freedom are central to emerging quantum technologies, yet their scalability and tunability remains challenging. Molecular qubits embedded in crystalline host matrices offer a promising path forward due to their engineerable optical and spin properties. Here, we introduce ground-state triplet carbenes as fully organic systems that enable spatially precise photoactivation, exhibit large zero-field splitting, and provide clear optical initialization and readout of their spin states with high fluorescence contrast. These systems also maintain remarkably long coherence times at cryogenic temperatures, underscoring their potential as versatile and scalable building blocks for future quantum applications.

Q 58.4 Thu 15:15 P 5

Engineering New Family of Chlorine-Based Emitters in Silicon Carbide for Telecom Band — •Ashin Varghese Mathews[1,2], Andrei Anisimov[1], Kalliopi Mavridou[1], Ulrich Kentsch[1], Manfred Helm[1,2], and Georgy Astakhov[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, 01328 Dresden, Germany — [2]Technische Universität Dresden, Germany 01069

Efforts to find silicon carbide (SiC) color centers emitting in the telecom O- and C-bands are crucial for quantum communication [1]. While existing defects like Vanadium (V) are promising (O-band emission, coherent control), they require sub-Kelvin temperatures [2]. Theoretical work proposed the chlorine-vacancy (ClV) center as a new, NV-like defect covering 1330nm to 1590nm [3].

This work reports the first experimental observation of ClV centers. Photoluminescence studies show that their emission, spanning the O- and C-bands, is inherently compatible with telecom infrastructure and remains stable up to 30 K. This establishes ClV centers as a highly potential family of SiC defects for scalable quantum technologies [4]. In order to enhance the optical collection efficiency of the ClV, nanopillars are fabricated with different diameters for optimization and the results are presented within this study.

[1] Z. Mu, et al., Adv. Quantum Technol. 4, 2100076 (2021) [2] T. Astner, et al., Quantum Science and Technology 9(3), 035038 (2024) [3] O. Bulancea-Lindvall, et al., Phys. Rev. B 108, 224106 (2023) [4] A. N. Anisimov, et al., arXiv.org, quant-ph, arXiv:2510.25008 [quant-ph] (2025)

Q 58.5 Thu 15:30 P 5

Optical Integration of single NV-centers for Quantum Computing and Sensing — •Lucas Kirchbach[1,2], Andreas Giese[1], Julian Staniewski[2], Manuel Riedmann[2], Robert Bruss[1], Bernd Braun[1], and Andreas Stute[1,2] — [1]Technische Hochschule Nürnberg Faculty AMP, Nürnberg, Germany — [2]Technische Hochschule Nürnberg Faculty EFI, Nürnberg, Germany

Single Nitrogen-Vacancy centers (NV-centers) in diamond can be operated at ambient conditions as qubits in quantum memories and nanoscale quantum sensors. At TH Nürnberg, we plan to deterministically generate single NV-centers via femtosecond-laser pulses and integrate them into photonic platforms via 3D-printed microoptics and fs-written waveguides. This presentation gives a summary about our activites: The design and analysis of micro-lens systems to be manufactured via Two-Photon Polymerization on top of individual, self-written NV-centers for increased photon-collection efficiency, the programming of a spatial light modulator for wavefront optimization, the setup of a confocal scanning fluorescence microscope that addresses individual NV-Centers and laser material processing that allows to shape the diamond surface and to fabricate waveguides in the diamond for efficient optical coupling.

Q 58.6 Thu 15:45 P 5

Towards large-scale characterization of color centers in diamond through automated photoluminescence excitation measurements — •Marie L. Sturm[1], Maarten H. van der Hoeven[1], Malo Bézard[1,2], Julian M. Bopp[1,2], and Tim Schröder[1,2] — [1]Department of Physics, Humboldt-Universität zu Berlin, 12489 Berlin, Germany — [2]Ferdinand-Braun-Institut (FBH), Gustav-Kirchhoff-Str. 4, 12489 Berlin, Germany

Spectrally indistinguishable single-photon emitters are a fundamental requirement for generating entanglement in photonic quantum networks. Identifying such emitters demands precise knowledge of their optical transition frequencies and linewidths.

We demonstrate a scalable characterization approach for color centers in diamond based on automated photoluminescence-excitation (PLE) spectroscopy. A large-scale characterization capability can be enabled by full automation of the experimental control, including tuning of a continuous-wave laser with MHz frequency precision. By exciting a large field of view rather than addressing individual emitters, the overall characterization throughput can be significantly enhanced.

Using this technique, we investigate the spectral homogeneity of tin-vacancy centers in diamond. This method enables identification of spectrally indistinguishable emitters for deterministic integration into quantum devices and is applicable to various solid-state platforms,

paving the way for scalable on-chip quantum-photonic architectures.

Q 58.7 Thu 16:00 P 5

Creation and cavity coupling of a single SnV- center in nanodiamond — •Selene Sachero[1], Robert Berghaus[1], Florian Feuchmayr[1], Emilio Corte[2], Elena Nieto Hernandez[2], Jens Fuhrman[1], Sviatoslav Ditalia Tchernij[2], Fedor Jelezko[1], and Alexander Kubanek[1] — [1]Ulm university, Ulm, Germany — [2]Turin university, Turin, Italy

Efficient coupling between quantum emitters and optical cavities is essential for scalable quantum photonic technologies. Group IV vacancy centers in diamond, particularly the negatively charged tin-vacancy center, have emerged as promising candidates due to their spectral stability, high Debye-Waller factor and large orbital splitting in ground-states. Reduction of the diamond host size to the nanoscale enables new opportunities in terms of integration and scalability. However, creating optically coherent quantum emitters in nanodiamonds remains a major challenge. Here, we present the fabrication of tin- vacancy (SnV^-) centers by means of ion implantation and describe the optical properties of the created color centers. We achieve high-purity single-photon emission via resonant excitation and strong coherent drive. Moreover, we demonstrate controlled coupling of a single SnV^- center in a nanodiamond to a fully tunable Fabry-Perot microcavity. At 4 K, lifetime reduction due to the Purcell effect is achieved. The obtained results demonstrate the potential of SnV^- centers in nanodiamonds as a coherent single-photon source for quantum networks

Q 58.8 Thu 16:15 P 5

SiV color centers in diamond as Quantum Network Nodes — •Leonie Eggers[1,2], Donika Imeri[1,2], Konstantin Beck[1], Nick Brinkmann[1,2], Florian Rickert[1], Sunil Kumar Mahato[1,2], Rikhav Shah[1], and Ralf Riedinger[1,2] — [1]Zentrum für Optische Quantentechnologien, Universität Hamburg, 22761 Hamburg — [2]The Hamburg Centre for Ultrafast Imaging, 22761 Hamburg, Germany

Silicon vacancy color center(SiV) in diamond, when combined with nanophotonic cavities, are a promising platform for network-based quantum solid-state processors. This is due to their spin transition being photonically addressable and a high noise tolerance. Pairing these processors with a fiber network can enable efficient long-distance quantum communication. It also presents a modular approach to building larger quantum processors. Here we present our experimental platform and first results.