Q 47: Quantum Technologies – Sensing II

Time: Thursday 11:00–13:00 Location: P 5

Q 47.1 Thu 11:00 P 5

Advancing geophysical research using optically pumped magnetometers — •Marco Decker[1,2], Rafael Rothganger de Paiva[1,3], Raquel Flores[1], Dimitrii Grigorev[1], and René Reimann[1] — [1]Quantum Research Center, Technology Innovation Institute, Abu Dhabi, UAE — [2]Department of Physics and Research center OPTIMAS, RPTU University Kaiserslautern-Landau — [3]Universidade Federal do ABC, Santo Andre, Sao Paulo, Brazil

Highly precise and accurate magnetic field sensing has real-world applications in biomedical imaging [1], positioning and navigation [2]. In this work, we present the magnetic analysis of rock samples without remanent magnetization using optically pumped magnetometry, opening applications in paleomagnetic research and geological exploration [3]. The core samples are placed inside a shielded environment with a known, uniform static magnetic field of up to 5 mT. Utilizing a commercial SERF magnetometer, we measure the samples magnetic susceptibillity with pT precision and millimeter-scale resolution. The setup is characterized with well-known test samples and then tested with real-world limestone samples. Linear and rotational translation enable the scanning of 2D cylindrical surface maps of the magnetic field, which can then be used to infer the samples internal magnetic properties. The analyzed data is in general accordance with dipole simulations, also confirming clear limitations of the setup.

[1] P. K. Mandal, Front. Comput. Neurosci. 12 (2018); [2] M. Muradoglu, arXiv, 2504.08167 (2025); [3] C. Deans, Appl. Opt. 57, 2346-2351 (2018)

Q 47.2 Thu 11:15 P 5

The boundary time crystal as a light source for quantum enhanced sensing beyond the heisenberg limit — •Malik Jirasek[1], Igor Lesanovsky[1,2], and Albert Cabot[3] — [1]Universität Tübingen, Tübingen, Germany — [2]University of Nottingham, Nottingham, United Kingdom — [3]Universitat de les Illes Balears, Palma de Mallorca, Spain

Modern precision measurements, such as interferometry for detecting gravitational waves, rely on the estimation of optical phases encoded in light fields. We propose to exploit the collectively enhanced output field of a driven-dissipative many-body open quantum system as a light source in order to improve the precision of estimating optical phases [1]. These systems can generate emission patterns that are drastically different than those of conventional sources, for example lasers. For instance, the output fields of time crystals can exhibit intricate time-correlations. We find, that these benefit the sensitivity of measurement protocols for phase shifts, which we show theoretically by employing a boundary time crystal (BTC) as a light source. The fundamental bound on the precision of such estimation shows scaling with system size of the BTC that surpasses the Heisenberg limit. This scaling can be partially harnessed by a protocol, in which the phase shifted light field is guided into an auxiliary replica system, which serves as a detector that is sensitive to non-trivial temporal correlations of the light.

[1] M. Jirasek, *et al.*, arXiv:2511.23416 (2025)

Q 47.3 Thu 11:30 P 5

Part 1: Optically Addressable Molecular Spins at 2D surfaces — •YanTung Kong, XuanKai Zhou, Cheuk Kit Cheung, Ruoming Peng, and Jörg Wrachtrup — 3. Physikalisches Institut, University of Stuttgart, 70569 Stuttgart, Germany

Optically addressable surface spins constitute a long-sought goal in quantum sensing, offering a pathway to probe quantum phenomena with atomic-scale precision. Here, we introduce a novel architecture in which pentacene spin molecules are anchored onto two-dimensional hexagonal boron nitride (hBN) and self-align with the underlying lattice. This configuration yields robust optically detected magnetic resonance (ODMR) signals from 4 K to room temperature. We further demonstrate ensemble spin sensing of Fe3GaTe2 (FGT), as well as controlled positioning of Pc molecules. This work represents the first demonstration of a surface molecular spin sensor that integrates long coherence, optical addressability, and interfacial functionality, thereby enabling quantum sensing capabilities beyond those of conventional solid-state spin systems.

Q 47.4 Thu 11:45 P 5

Nanodiamond surface chemistry for improved quantum coherence in zero-field — •Tulika Agrawal for the AK Weil MPIP-Collaboration — Max Planck Institute for Polymer Research, Mainz, Germany

Nitrogen vacancy (NV) in diamond results in the application of diamond in quantum technologies such as sensing, computing and navigation. This is possible due to the sublevels of NV center which can be manipulated with microwave/RF and yet optically detectable. NV center has been proven to be a promising candidate due to their long coherence times (T2) at room temperature. However, the T2 times of NVs suffer drastic reduction when they are in nanodiamonds (NDs) instead of bulk diamond. Moreover, NDs are functionalized with a variety of chemical groups to make them compatible for desired application. This surface modification can cause a significant impact on T2 times of NV centers. Therefore, it has become crucial to investigate deeper into the relationship between surface chemistry and T2 times. In this work, T2 times have been investigated in two types of functionalized NDs, nanogel coated NDs (NDNG) and polyglycerol coated NDs (NDPG). To obtain T2 times in zero magnetic field, two different pulse sequences, Hahn-echo and geometric spin, have been employed. While the conventional EPR study has shown a reduction in surface spin noises upon functionalization, T2 measurements have distinctly shown the change in T2 times from NG to PG.

Q 47.5 Thu 12:00 P 5

Magnetic Field Imaging in SiC Quantum Microscope — •Ayisha Suhana[1,2], Tatiana A. U Svetikova[1,2], Christoph Schneider[1], Manfred Helm[1,2], Andrei N Anisimov[1], and Georgy V Astakhov[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Technische Universitat Dresden, Dresden, Germany

Studying neuronal activity requires detecting ultra-weak, dynamic magnetic fields generated by neural electrical signals. Quantum sensors based on spin defects, specifically NV centers in diamond, have demonstrated applications from action-potential detection to battery-current monitoring and geological mapping. These advances motivate the exploration of wide-bandgap semiconductors, such as silicon carbide (SiC) and hexagonal boron nitride for scalable quantum sensing.

We used silicon vacancy centers in SiC for wide-field magnetic imaging using optically detected magnetic resonance with dual-frequency, microwave-free [1], and time-resolved sensing protocols. The magnetic fields from continuous and pulsed currents in a wire beneath the sample are reconstructed using a Python-based workflow. The quantum silicon carbide microscope achieves a 50 * 50-pixel field of view with 30 *m spatial and 50 ms temporal resolution, enabling magnetic field imaging in current-carrying structures [2], with potential applications in biomedical research.

[1] D. Simin et al., Phys. Rev. X 6, 031014 (2016) [2] A. Suhana et al., arXiv:2509.14888 (2025)

Q 47.6 Thu 12:15 P 5

High-Sensitivity NV-Diamond Magnetometry for Non-Invasive Detection of Magnetocardiography — •Michael Kübler, Jixing Zhang, Magnus Benke, Yi hua Wang, Cheuk Cheung, and Andrej Denisenko — 3rd Institute of Physics, University of Stuttgart, 70569 Stuttgart, Germany

We demonstrate detection of weak cardiac magnetic signals using high-sensitivity NV-diamond magnetometers enhanced by magnetic flux concentrators and CW-ODMR readout. With this scheme, we achieve effective sub-pT sensitivity and reliably detect temporal fluctuations corresponding to the propagation of cardiac action potentials. The signals show close agreement with conventional electrophysiology electrodes, but without direct tissue contact.

This method enables non-invasive and high-resolution monitoring of the heart's electrical activity, offering potential for early diagnosis and continuous real-time monitoring of cardiovascular health. These results highlight NV-diamond magnetometry as a promising platform for biomedical applications, bridging quantum sensing and clinical diagnostics, and supporting future integration into wearable devices for arrhythmia detection and other cardiovascular disorders.

Q 47.7 Thu 12:30 P 5

Calibrated Generation of Heralded Single Photons — •Daniel Borrero Landazabal and Kaisa Laiho — German Aerospace Center (DLR), Institute of Quantum Technologies, Wilhelm-Runge-Str. 10, 89081 Ulm, Germany

Heralded single-photon sources based on parametric down-conversion (PDC) are indispensable in many quantum sensing applications. To characterize such emitters conventionally the second-order correlation function $g_{\mathrm{h}}^{(2)}$ of the heralded state has been used. However, the practical deployment of such sources demands a more rigorous, loss-tolerant characterization. We employ a waveguided type-II PDC process pumped by a pulsed laser, generating orthogonally polarized photon pairs with a low optical mode number. After separating the photon pairs–signal and idler– from each other, the detection in idler with a superconducting nanowire single-photon detector heralds the target state in signal. By recording counts of coincidences and singles, we measure $g_{\mathrm{h}}^{(2)}$ and extract loss-tolerantly the mean photon number and photon-number parity with a high accuracy. The former delivers access to the residual multiphoton contamination, while the latter provides a direct measure of the non-classicality of the heralded states. We demonstrate that these figures of merit provide a stringent benchmark for a high-quality single-photon generation, surpassing the information delivered by $g_{\mathrm{h}}^{(2)}$ alone. Our results pave the way for the generation of calibrated single-photon probes and may find usage for example in quantum radiometry to achieve precision in quantum optics experiments.

Q 47.8 Thu 12:45 P 5

Multiparametric sensing with the nitrogen-vacancy color center in diamond — •Leon Advena[1], Tofianme Sorgwe[1], Florian Sledz[1], Mario Agio[1,2], and Assegid Mengistu Flatae[1] — [1]Laboratory of Nano-Optics, University of Siegen, 57072 Siegen, Germany — [2]National Institute of Optics (INO), National Research Council (CNR), 50125 Florence, Italy

Modern sensing applications increasingly require the simultaneous measurement of multiple physical parameters with high sensitivity. Nitrogen-vacancy centers in diamond present a promising solution to the various challenges associated with multiparametric sensing applications. These atomic-scale defects can be optically initialized, manipulated, and read out via laser excitation using optically detected magnetic resonance (ODMR). They are capable of operation under ambient and harsh conditions. Here, we demonstrate a simultaneous and internally cross-validated sensing platform capable of detecting both magnetic fields and temperature with sensitivities of around 500 $nT/\sqrt{Hz}$ and 10 $mK/\sqrt{Hz}$, respectively. Our method integrates ODMR, zero-phonon line (ZPL) spectral shifts, and linewidth broadening, each providing independent spectral signatures sensitive to distinct physical effects. This approach enhances measurement precision, enables internal consistency checks, and decouples intertwined phenomena such as temperature-induced variations in magnetization. The demonstrated technique significantly expands the functional capabilities of NV-based sensors, advancing their potential for high-precision metrology in complex environments.