Q 34: Color Centers II

Time: Wednesday 14:30–16:15 Location: HS 1221

Invited Talk Q 34.1 Wed 14:30 HS 1221

Optically addressable nuclear spin registers with V2 center in 4H-SiC — •Vadim Vorobev — University of Stuttgart, Stuttgart, Germany

The V2 center is a promising platform for spin photon interface, with tolerable optical coherent properties in nanostructures with up to 20K temperature working conditions.

This becomes handy with extensive microwave and radiofrequency-based manipulation methods for controlling the nuclear spins.

The current progress with the detection of up to 5 nuclear spins and extensive characterization of their hyperfine tensor and control parameters will be presented. Finally, an outlook of potential ways to improve the technology will be presented.

Q 34.2 Wed 15:00 HS 1221

Implementation of the SUPER coherent control scheme with a tin-vacancy color center in diamond — •Mustafa Gökçe[1], Cem Güney Torun[1], Thomas K. Bracht[2], Mariano Isaza Monsalve[1], Sarah Benbouabdellah[1], Özgür Ozan Nacitarhan[1], Marco E. Stucki[1,3], Gregor Pieplow[1], Tommaso Pregnolato[1,3], Joseph H. D. Munns[1], Doris E. Reiter[4], and Tim Schröder[1,3] — [1]Humboldt University of Berlin, Berlin, Germany — [2]University of Münster, Münster, Germany — [3]Ferdinand-Braun-Institute, 12489 Berlin, Germany — [4]Technical University Dortmund, Dortmund, Germany

The creation of coherent single photons for quantum applications requires deterministic excitation, realized by resonant excitation. However, a challenge is filtering spectrally overlapping the excitation laser from emitted single photons. One method for separation is using cross-polarization microscopy, which results in 50% loss of emitted photons. A novel method of coherent excitation called the swing-up of the quantum emitter population (SUPER) has been introduced. This method incorporates two-color nonresonant pulses achieving full inversion to the excited state. The SUPER method enables spectral filtering. To implement the SUPER method, we built a spectral pulse engineering setup, which tailors pulses with desired spectral shapes. We demonstrate coherent single photon emission using non resonant pulses and replicate our results using a theoretical model. We employ this method using pulses in the picosecond pulse duration regime and pave the way for utilization of these gates for the investigation of ultrafast processes.

Q 34.3 Wed 15:15 HS 1221

Color centers in silicon carbide integrated into a fiber-based Fabry-Pérot microcavity — •Jannis Hessenauer[1], Jonathan Körber[2], Maximilian Pallmann[1], Jawad Ul-Hassan[3], Georgy Astakhov[4], Florian Kaiser[5], Jörg Wrachtrup[2], and David Hunger[1] — [1]Physikalisches Institut, Karlsruher Institut für Technologie, Germany — [2]3rd Institute of Physics, University of Stuttgart, Germany — [3]Department of Physics, Chemistry and Biology, Linköping University, Sweden — [4]Helmholtz-Zentrum Dresden-Rossendorf, Institute of Ion Beam Physics and Materials Research, Dresden, Germany — [5]MRT Department, Luxembourg Institute of Science and Technology & Department of Physics and Materials Science, University of Luxembourg, Belvaux, Luxembourg

Color centers in silicon carbide (SiC) have recently emerged as promising solid-state spin-photon interfaces. Among those, the two negatively charged silicon vacancy centers in 4H-SiC have been studied extensively, and showed narrow optical linewidths close to the lifetime limit. In this work, we integrate a few micron-thick SiC membrane with color centers into a cryogenic fiber-based Fabry-Pérot-resonator. We characterize the cavity performance and observe a high finesse, indicating low losses introduced by the membrane. We study the complex mode dispersion stemming from the hybridization of the membrane with the empty cavity and the strong birefringence of the material. Finally, we observe cavity-coupled emission of color centers by tuning the cavity resonance over a spectral region while monitoring the fluorescence.

Q 34.4 Wed 15:30 HS 1221

Quantum Non-linear Optics with Diamond Color Centers in Fiber-based Microcavities — •Julius Fischer[1], Yanik Herrmann[1], Julia M. Brevoord[1], Colin Sauerzapf[1], Leonardo G. C. Wienhoven[1], Laurens J. Feije[1], Matteo Pasini[1], Martin Eschen[1,2], Maximilian Ruf[1], Matthew J. Weaver[1], and Ronald Hanson[1] — [1]QuTech and Kavli Institute of Nanoscience, Delft University of Technology, 2628 CJ Delft, The Netherlands — [2]Netherlands Organisation for Applied Scientific Research (TNO), P.O. Box 155, 2600 AD Delft, The Netherlands

Quantum networks are promising for applications such as secure communication and distributed quantum computing. Diamond color center qubits like the Tin-Vacancy (SnV) center are excellent node candidates, but they have limited collectable coherent photon emission. Integration into a tunable, open microcavity can boost collection and coherent emission via the Purcell effect. We report on our results of coupling individual SnV centers to the microcavity. We achieve significant Purcell-enhancement, evidenced through lifetime reduction and linewidth broadening and demonstrate the first SnV-induced cavity transmission dip, which reaches 50 % on resonance. This effect is characterized depending on cavity detuning and probe power, and we show bunching in the photon statistics of the transmitted light. A detailed quantum optical model is used to explain the data. These results outline a key element for cavity quantum optics experiments and for efficient spin-photon interfaces.

Q 34.5 Wed 15:45 HS 1221

Heralded initialization of charge state and optical transition frequency of diamond tin-vacancy centers — •Julia Maria Brevoord, Lorenzo De Santis, Takashi Yamamoto, Matteo Pasini, Nina Codreanu, Tim Turan, Hans Beukers, Christopher Waas, and Ronald Hanson — QuTech and Kavli Institute of Nanoscience, Delft University of Technology, Delft 2628 CJ, Netherlands

Diamond Tin-Vacancy centers have emerged as a promising platform for quantum information science and technology. A key challenge for their use in more complex quantum experiments and scalable applications is the ability to prepare the center in the desired charge state with the optical transition at a pre-defined frequency. Here we report on heralding such successful preparation using a combination of laser excitation, photon detection, and real-time logic. We verify the power of this method by measuring strongly improved quantum optical performance, showing its direct relevance for future quantum applications that rely on photon interference such as remote entanglement generation.

Q 34.6 Wed 16:00 HS 1221

Electron-Phonon Coupling of Mechanically Isolated Defect Centers in Hexagonal Boron Nitride — •Patrick Maier, Michael Koch, and Michael Höse — Universität Ulm

Single Photon emitters are a crucial resource for novel quantum optic technologies. Hosted quantum emitters in hexagonal Boron Nitride (hBN) are promising candidates for the integration into hybrid quantum systems, which can be used in upcoming quantum optic technologies. One type of such emitter has shown the remarkable property of Fourier transform limited optical linewidth at cryogenic temperatures and even up to room temperature. [1,2]. This characteristic can be traced back to out-of-plane emitters, which do not couple to in-plane phonon modes. That leads to mechanical isolation of the defect centers orbitals [3]. Here, we present our most recent results towards understanding the origin of this mechanical decoupling.

[1] A. Dietrich et al., Physical Review B, Vol. 98 (2018) [2] A. Dietrich et al., Physical Review B, Vol. 101 (2020) [3] M. Hoese et al., Science Advances, Vol. 6 (2020)