Q 24: Quantum Information (Solid State Systems)

Time: Monday 16:15–17:45 Location: K 1.020

Q 24.1 Mon 16:15 K 1.020

Scalable coupling of nearly lifetime-limited quantum emitters to diamond nanocavites — •Tim Schröder[1,2], Matt E. Trusheim[1], Michael Walsh[1], Sara Mouradian[1], Luozhou Li[1], Jiabao Zheng[1], Marco Schukraft[1], Mikkel Heuck[1], Alp Sipahigil[2], Ruffin E. Evans[3], Denis D. Sukachev[3], Christian T. Nguyen[3], Jose L. Pacheco[4], Ryan M. Camacho[4], Edward S. Bielejec[4], Mikhail Lukin[3], and Dirk Englund[1] — [1]RLE, Massachusetts Institute of Technology, USA — [2]Niels Bohr Institute, University of Copenhagen, Denmark — [3]Depart of Physics, Harvard University, USA — [4]Sandia National Laboratories, USA

Long-lived solid-state spin systems can serve as quantum memory in quantum information applications. Crucial for their integration in large-scale quantum architectures is their coupling to coherent photons. Here, we present the targeted creation of single silicon vacancy centres (SiV) with up to 25% conversion yield via Si focused ion beam implantation with <50 nm positioning accuracy relative to a nanocavity mode maximum. An inhomogeneously broadened ensemble linewidth of ∼51 GHz and close to lifetime-limited single-emitter transition linewidths are measured. Furthermore, targeted implantation of nitrogen vacancy (NV) centres into cavity mode maxima through self-aligned lithography enables an average of 1.1 ± 0.2 NVs per cavity with cavity-fed spectrally selective intensity enhancement of up to 93.
[1] T. Schröder, M. E. Trusheim, M. Walsh et al., Nature Communications 8, 15376 (2017). [2] T. Schröder, M. Walsh, J. Zheng et al., Opt. Mater. Express, OME 7, 1514 (2017).

Q 24.2 Mon 16:30 K 1.020

Deterministische Einzel-Ionen Implantation zur Erzeugung von Seltene-Erden Farbzentren — •Karin Groot-Berning[1,2], Georg Jacob[2], Sebastian Wolf[2], Felix Stopp[2], Thomas Kornher[3], Roman Kolesov[3], Jörg Wrachtrup[3], Kilian Singer[1] und Ferdinand Schmidt-Kaler[2] — [1]Experimental Physik, Universität Kassel, Heinrich-Plett- Straße 40, 34132 Kassel, Germany — [2]QUANTUM, Institut für Physik, Universität Mainz, Staudingerweg 7, 55128 Mainz, Germany — [3]3. Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart

Wir berichten über die erfolgreiche Erzeugung von ^{141}Pr-Farbzentren in Yttrium-Aluminium-Granat (YAG) mittels Implantation. Dazu nutzen wir eine lineare Paulfalle als deterministische Einzel-Ionenquelle. Zum Laden von Fremdatomen ist die Fallenapparatur zusätzlich mit einer komerziellen Ionenquelle ausgestattet. Mittels eines Nd:YAG Laserpulses bei 532 nm wird Praseodym von einem Metalltarget ablatiert und in der Ionenquelle durch Elektronenstoß ionisiert. Die Ionen werden auf 500 eV beschleunigt und in die Falle geschossen. Dort wird das $^{141}Pr^{+}$-Ion gefangen und durch ein $^{40}Ca^{+}$-Ion sympathetisch gekühlt. Mit einer Extraktionsspannung von 5.9 keV werden die $^{141}Pr^{+}$-Ionen aus der Falle beschleunigt, vom Calcium Ion getrennt und durch eine elektrostatische Einzellinse auf die Probe fokussiert [1]. Der gemessene Strahlradius beträgt für Praseodym 23.1 ± 7.7 nm. Wir weisen die gebildeten Zentren im YAG mittels eines *upconversion* Mikroskops nach.
[1] Jacob et al., Phys. Rev. Lett. 117, 043001 (2016)

Q 24.3 Mon 16:45 K 1.020

Thin vacancy as a novel candidate for quantum information processing — •Mathias H. Metsch[1], Petr Siyushev[1], Takayuki Iwasaki[2], Mutsuko Hatano[2], Shinobu Onoda[3], Junichi Isoya[4], and Fedor Jelezko[1] — [1]Institute for Quantum Optics, Ulm University, D-89081 Germany — [2]Department of Electrical and Electronic Engineering, Tokyo Institute of Technology , Meguro, Tokyo 152 - 8552, Japan — [3]Takasaki Advanced Radiation Research Institute, National Institutes for Quantum and Radiological Science and Technology, 1233 Watanuki, Takasaki, Gunma 370-1292, Japan — [4]Research Centre for Knowledge Communities, University of Tsukuba, Tsukuba, Ibaraki 305-8550, Japan

The negatively charged thin vacancy (SnV) center in diamond is another color center formed by an impurity of the fourth group of chemical elements. Along with silicon and germanium it forms defect centers of D3d symmetry that show good optical properties in combination with a spin $\frac{1}{2}$ qubit. Due to the much larger ground state splitting undesirable phonon interaction is reduced at higher temperatures which should lead to longer electron spin coherence comparable with silicon vacancy at mK temperatures. The combination of a potentially long lived spin $\frac{1}{2}$ qubit with a bright and narrow optical transition turns the SnV into an interesting candidate light matter interface applications.

Q 24.4 Mon 17:00 K 1.020

Towards electrical detection of nearly single NV defects — •Petr Siyushev[1], Emilie Bourgeois[2], Fedor Jelezko[1], and Milos Nesladek[2] — [1]Institute for Quantum Optics, Ulm University, D-89081 Ulm, Germany — [2]Institute for Materials Research, Hasselt University, B-3590 Diepenbeek, Belgium

Over the last decade, nitrogen-vacancy (NV) center in diamond has become a prominent candidate for magnetic field sensing, nanoscale NMR, and quantum information processing. However, readout of measured signals is done optically. This requires bulky systems for detection and counting photons. Implementation of realistic devices would require miniaturization of the system and preferably integration of the system into single chip for simple compatibility with existing electronics. Substitution of traditional optical readout by its electrical analog would allow realization of diamond electronic chip. Recently, we demonstrated electrical detection of electron paramagnetic resonance on ensemble of NV centers [1] as well as electrical readout of electron spin state [2]. This method is based on detection of charge carriers which are promoted to the conduction band by two-photon excitation process of NV center [3]. Although, detection of a signal from a single NV is possible, this remains challenging due to strong background produced by other impurities. Here, we show electrical detection of nearly single NV defects.

[1] E. Bourgeois et al., Nat. Commun. **6**, 8577 (2015)
[2] M. Gulka et al., Phys. Rev. Applied **7**, 044032 (2017)
[3] P. Siyushev et al., Phys. Rev. Lett. **110**, 167402 (2013)

Q 24.5 Mon 17:15 K 1.020

Measurement controlled quantum state engineering of a spin environment — •Durga Dasari[1,2], Stefan Jesenski[1], Johannes Greiner[1], Florian Kaiser[1], Sen Yang[3], and Joerg Wrachtrup[1,2] — [1]University of Stuttgart, Stuttgart, Germany — [2]Max Planck Institute for Solid State Research, Stuttgart, Germany — [3]The Chinese University of Hong Kong, Hong Kong

Quantum systems are inevitably coupled to their surrounding environment and are never completely isolated. Controlling such systems through measurements not only affects the system of interest but also its surroundings i.e, environment influences the measurement result and in turn the measurement influences the environment. This kind of back-to-back action adds new feature in steering the evolution of quantum baths through quantum measurements.

We explore this phenomena both theoretically and experimentally using solid state defect centers in diamond. Our studies indicate that there exists an optimal state of the environment which protects the coherence of the quantum system coupled to it and the statistics of the measurement results that lead to such engineered state follow Quantum Random Walk behavior. We will further show application of such measurement-controlled bath engineering towards machine learning and solving certain classical (NP-)hard problems.

Q 24.6 Mon 17:30 K 1.020

What it takes to shun equilibration — •Rodrigo Gallego[1], Henrik Wilming[1], Jens Eisert[1], and Christian Gogolin[2] — [1]Dahlem Center for Complex Quantum Systems, Freie Universitat Berlin, 14195 Berlin, Germany — [2]ICFO-Institut de Ciencies Fotoniques, The Barcelona Institute of Science and Technology, 08860 Castelldefels (Barcelona), Spain

Numerous works have shown that under mild assumptions unitary dynamics inevitably leads to equilibration of physical expectation values if many energy eigenstates contribute to the initial state. Here, we consider systems driven by arbitrary time-dependent Hamiltonians as a protocol to prepare systems that do not equilibrate. We introduce a measure of the resilience against equilibration of such states and show, under natural assumptions, that in order to increase the resilience against equilibration of a given system, one needs to possess a resource system which itself has a large resilience. In this way, we establish a new link between the theory of equilibration and resource theories by quantifying the resilience against equilibration and the resources that are needed to produce it. We connect these findings with insights into local quantum quenches and investigate the (im-)possibility of formulating a second law of equilibration, by studying how resilience can be either only redistributed among subsystems, if these remain completely uncorrelated, or in turn created in a catalytic process if subsystems are allowed to build up some correlations.