Optically Detected Magnetic Resonance (ODMR) measurements using single Nitrogen vacancy center in nano-diamond for highly (nanoscale) localized precise temperature- and magnet field measurement

The nitrogen-vacancy (NV) center in diamond has emerged as an exceptional nanoscale room temperature quantum sensor for temperature, chemical events (pH value, redox potential) pressure, external magnetic – and electric fields and for nuclear spins - inside and outside of the diamond lattice. When nuclear spins coherently coupled to such spins, an NV center constitutes a small quantum processor. Also strongly coupled nuclear spins are excellent candidates for quantum bits, weaker coupled nuclear spins are rather seen as bath spins responsible for dephasing, tough with some potential for quantum simulation with tailored spin baths. NV centers enable identification of such target spins with some target spins with spectral linewidth of several 100Hz at room temperature, yet they hamper achieving high-resolution NMR spectroscopy (e.g. chemical shift, J-coupling) necessary for structure determination.

Our group at the Leibniz Institute of photonic technology in Jena established an Optical Detection of Magnetic Resonance (ODMR) measuring station (see Fig.1). First results - which image single NV-centers and the spin resonance of a single NV-center - are shown in Fig.2. For optimization ODMR technique, tailored NV-center nano-diamonds and new research questions we collaborate with the Wrachtrup group in Stuttgart. The goal of the presented project should be the optimization of the setup for applications like measuring the local magnetic field of the ion current in axons between living “firing” neurons, measuring magnetic field coupling of nuclear spins nearby single NV center and measuring the temperature and pH-value inside of cells using NV center in nano-diamonds. In collaboration with the university of Stuttgart an optimization of $^{13}$C isotopes in nano-diamonds and an charge state control of NV-center should be reached. The candidate should be familiar with the theory of manipulating spins in nano-diamond NV-centers, with the concept of the ODMR technique and with terms and concepts of anti-bunching and Rabi oscillations are understood. Temperature- and magnetic field measuring concepts using NV centers in diamonds can be implemented. Ideally, the candidate has practical experience in laser- and microscope techniques, counting techniques, HF- and RF pulse generation, and pulse measuring. For implementation complex and fast controlling of laser pulses, HF and RF pulses, APD-counter and piezo stage, programming experience in C/phyton/matlab - and labview is also advantageous.

contact: ACP PI: Prof. Wolfgang Fritzsche, wolfgang.fritzsche@leibniz-ipht.de, Tel: 03641/206304
Institute Mentor: Dr. Frank Garwe, frank.garwe@leibniz-ipht.de, Tel: 03641/206416