UNIVERSITÄT LEIPZIG

Quantum Information Group
Felix-Bloch-Institute for Solid State Physics

PhD positions in quantum sensing (TV-L E13, 75 %)

We are an international and fast-growing research group at the Leipzig University and are looking for ambitious PhD students in the field of quantum science and technology. Our mission is to build diamond qubit systems and to apply them in real-world applications. This emerging technology stands at the intersection of quantum information, spin resonance, condensed matter, and life sciences.

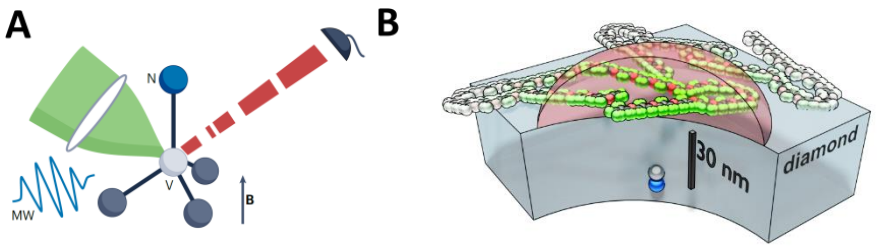

Figure: NV centers in diamond as quantum sensors. A Schematic representation of the (N) nitrogen (V) vacancy (NV) center in diamond. The qubit state can be read out via laser illumination and collection of fluorescence photons. Microwaves are used for qubit manipulation (Adapted from Aslam, N. et al. Nat Rev Phys 5, 157–169, 2023). B Sketch of NV based nanoscale NMR spectroscopy. The NV center electron spin, forming the quantum sensor, and its associated nuclear spin, the quantum memory, are located approximately 30 nm deep in the diamond lattice. The sample is placed above the diamond surface and could for example contain single molecules with multiple nuclear spins (Adapted from Aslam, N. et. al. Science 357, 67, 2017).

Research topics

We apply optically addressable defect (e.g. Nitrogen-vacancy, NV) centers in diamond as spin qubits. These spin qubits can be coupled to multiple nearby nuclear spins within the diamond, effectively forming a quantum register. This multi-qubit system allows the implementation of quantum algorithms and helps in enhancing the sensitivity and spectral resolution in nanoscale sensing. We want to apply these novel quantum sensors in various fields, such as material and life sciences.

Using these spin qubits, we have previously demonstrated the detection of NMR signals from samples at the nanometer scale, making it 15 orders of magnitude more sensitive than conventional NMR. This emerging nanoscale NMR technique allows single molecule spectroscopy at ambient conditions. Our goal is to couple the spin qubits to the nuclear spins of the molecule and learn about its structure. We also want to use this quantum sensing platform to study the dynamics of single cells under different physiological conditions. This interdisciplinary work will be carried out in collaboration with biophysics and life science groups at the Leipzig University.

More Information:

Aslam, N. et al. Nanoscale nuclear magnetic resonance with chemical resolution Science 357, 67 (2017). and Aslam, N. et al. Quantum sensors for biomedical applications. Nat Rev Phys 5, 157–169 (2023).

Requirements

You should hold a degree in physics or related field, and have strong social, organizational and communication skills. Prior experience with coding in Python or other programming languages is desirable.

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Next steps
Applications including a motivation letter, CV, Academic records and electronic contact of two references should be sent at the earliest possible time to Prof. Dr. Nabeel Aslam, nabeel.aslam@uni-leipzig.de

For more information, please visit our website:
https://home.uni-leipzig.de/quantumtechnology/

About quantum science and technology in Leipzig
Leipzig's tradition in quantum mechanics and applied quantum science goes back to the time of Werner Heisenberg, Friedrich Hund, Edward Teller, and Felix Bloch. Nowadays Leipzig is hosting a broad spectrum of research on quantum spin resonance in physics, chemistry, biology, and medicine. There are numerous groups at the Leipzig University, Max Planck and Leibniz Institutes working on cutting-edge research by applying electronic and nuclear spins in rather diverse contexts.

About the city of Leipzig
With outstanding architecture, vivid street art, and rich musical history, this German city has a great variety of sights that meet every taste. There are more than 50 museums and art collections in Leipzig which you can visit. Leipzig was the scene of many historical events. The Nikolaikirche Leipzig (St. Nikolai) became the symbol of the Peaceful Revolution in 1989. It is the place where developments took place that triggered what is referred to as the "Wende" (turnaround) in the autumn of 1989. From 16 to 19 October 1813, the so-called Battle of the Nations took place at the gates of the city of Leipzig. It led to Napoleon's defeat during the wars of liberation. The Monument to the Battle of the Nations in the south-east of Leipzig was erected in memory of the Battle of the Nations.