AVS Quantum Science Workshop
Room Redondo - Session AQS-ThA1

AVS Quantum Science Workshop: NV Sensors for Quantum Sensing

Moderator: Andrew Yeats, Naval Research Laboratory

1:55pm **AQS-ThA1-1 AQS Workshop Welcome and Opening Remarks**,

2:00pm **AQS-ThA1-2 Quantum Sensing with NV Centers**, ***Erika Janitz***, *C. Degen,* ETH Zürich, Switzerland **INVITED**

The electronic spins of single atomic defects in diamond can serve as magnetic sensors with exquisite sensitivity and nanoscale spatial resolution. One such defect -- the nitrogen-vacancy (NV) center -- is particularly well-suited as it retains excellent spin coherence under a variety of experimental (including ambient) conditions with efficient mechanisms for optical spin initialization and readout. A primary focus of our group has been to optimize the sensing capability of near-surface (<10-nm-deep) NV centers for the development of a nanoscale-NMR platform aimed at structural determination of single molecules. I will discuss recent progress toward this goal, including diamond fabrication and surface treatments designed to improve detection sensitivity while simultaneously enabling highly generalizable molecular surface functionalization [1]. Currently, we are extending these techniques toward detecting conformational changes in biomolecules bound to the diamond surface. In parallel to NMR studies, our group has developed a scanning NV platform for imaging magnetic samples with ~50 nm spatial resolution at a wide range of temperatures (~350 mK [2] – room temperature). I will present recent results from this initiative, including images of nanoscale currents in graphene [3], antiferromagnetic materials [4], and superconductivity in nanostructures [2]. Finally, I will conclude with an outlook on extending this diamond-based sensing toolbox to study electric fields as well as opportunities for utilizing alternative diamond defects.

[1] Abendroth *et al.*, Nano Letters **22,** (2022).

[2] Scheidegger *et al.,* Applied Physics Letters **120**, (2022).

[3] Palm *et al.,* PRApplied **17**, (2022).

[4] Huxter *et al.,* Nature Communications **13,** (2022).

2:40pm **AQS-ThA1-10 Diamond Quantum Sensors: Sensitivity Frontier**, *V. Acosta,* ***Yaser Silani,*** University of New Mexico **INVITED**

Color centers in wide-bandgap semiconductors have emerged as a leading platform in the field of quantum sensing, broadly defined as the use of qubits to measure environmental parameters. In my lab at the University of New Mexico, we are using Nitrogen-Vacancy (NV) spin qubits in diamond to image magnetic phenomena in condensed-matter and biological systems over a broad range of length scales.

At the nanometer scale, we build super-resolution diamond magnetic microscopes to image, for example, super paramagnetic iron oxide nanoparticles used as bio-tags. At the micrometer scale, we embed diamond quantum sensors inside microfluidic chips to perform nuclear magnetic resonance spectroscopy at the length scale of single cells. At the millimeter scale, we use magnetic flux concentrators to detect femtotesla-level magnetic fields and perform nuclear quadrupole resonance of powders, with potential applications in chemical analysis, navigation, and the search for new elementary particles.

I will provide an overview of the field, discuss recent results and ongoing challenges, and outline future directions.

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