MA 19: Magnetic Imaging and Sensors

Time: Tuesday 14:00–15:15 Location: H20

MA 19.1 Tue 14:00 H20

Green synthesis of R-type hexagonal ferrite magnetic nanoparticles and their electrochemical sensor for levofloxacin — •SAJJAD HUSSAIN — Centre of Excellence in Solid State Physics, University of the Punjab, Lahore

The usage of Levofloxacin (LEV) has increased in recent years for the treatment of bacterial infections in both human and veterinary fields. In this context, there has been a significant demand for the development of a highly sensitive and cost-effective approach to LEV quantification. In this study, R-type hexagonal ferrite nanoparticles (SrSn2Fe4O11-NPs) were prepared by an auto-ignition methodology and various analytical techniques were used for the material characterization, including X-ray diffraction (XRD), Field emission scanning electron microscopy (FE-SEM), X-ray photoelectron spectroscopy (XPS), Brunauer Emmett and Teller (BET) analysis, dynamic light scattering (DLS), and vibrating sample magnetometer (VSM) analysis. The characterization confirmed that the prepared material has a crystalline structure single-phase with a crystalline size of 35.02 nm. The R-type hexagonal ferrite nanoparticles were immobilized on a glassy carbon electrode (GCE) by a simple drop-casting approach to developing an efficient electrochemical sensor (SrSn2Fe4O11-NPs) for sensitive and selective LEV detection through an extended concentration range (0.06 * 10*6 to 170 * 10*6 M) and a low detection limit of (41.5nM). The developed sensor was applied successfully to quantitatively determine LEV in clinical samples and pharmaceutical preparations with excellent recoveries from 95.2 to 102.5 %.

MA 19.2 Tue 14:15 H20

Signatures of Berezinskii-Kosterlitz-Thouless transitions in magnetic films in Nitrogen Vacancy Magnetometry — •Mark Potts and Shu Zhang — Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

Nitrogen vacancy magnetometry provides sensitive measurements of the correlation functions of magnetic degrees of freedom in a material. Recent experiments have applied this technique in the study of two dimensional thin films, candidates for realising the topological Berezinskii-Kosterlitz-Thouless phase transition. We present calculations of frequency dependent relaxation rates for nitrogen vacancy centres coupled to an XY-type magnetic film, and identify features characteristic of the transition to quasi-long ranged order, and show that algebraic spin correlations are inherited by the relaxation rate as a temperature dependent power-law at low frequencies.

MA 19.3 Tue 14:30 H20

Development of an Ultra High Vacuum and Low Temperature Scanning NV Magnetometer — •Sandip Maity[1], Ricardo Javier Peña Román[1], Dinesh Pinto[1,3], Klaus Kern[1,3], and Aparajita Singha[2,1] — [1]Max Planck Institute for Solid State Research, Stuttgart, German — [2]Technische Universität Dresden, Dresden, Germany — [3]Institut de Physique, École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland

The nanoscale spatial resolution and calibration-free quantifiable magnetic field measurement capabilities of nitrogen-vacancy (NV) centers have enabled us to investigate the properties of magnetic spin textures with high magnetic sensitivity through scanning probe microscopy across a wide range of temperatures and pressure. I will be discussing the development of a scanning probe magnetometer capable of imaging magnetic nanostructures under ultra-high vacuum and low temperature. Moreover, we have integrated commercial NV tips with a home-built tip holder equipped with an AFM amplifier and microwave excitation on the tip (not on the sample), allowing us to have a magnetic image of any sample region without restriction. To exploit the quantifying nature of NV magnetometry using Optically Detected Magnetic Resonance, a coherent microwave (MW) delivery to the probe is mandatory. I will also discuss different means of delivering MW to the NV probes through different designs of the tip holders and how effective they are in coherently manipulating the NV spin states.

MA 19.4 Tue 14:45 H20

On-surface Spin Characterization using Shallow NV Centers in Diamond — •Olga Shevtsova[1,2], Atharva Paranjape[2], Lisa Ebo[2,3], Bernhard Putz[4], Ulrich Ziener[4], Marvin Grünhagen[5], Rainer Herges[5], and Aparajita Singha[1,2] — [1]Technische Universität Dresden, Dresden, Germany — [2]Max-Planck-Institut für Festkörperforschung, Stuttgart, Germany — [3]Universität Konstanz, Konstanz, Germany — [4]Universität Ulm, Ulm, Germany — [5]Christian-Albrechts-Universität zu Kiel, Kiel, Germany

As interest in quantum systems surges due to their potential applications in quantum computing, information storage, and sensing, molecular spins emerge as promising candidates for these technologies. Unlike conventional systems such as superconducting qubits and trapped ions, molecular spins offer unique advantages in stability, tunability, and scalability. However, key challenges remain in assessing their coherent properties, which are crucial for practical application. Existing techniques face limitations in terms of environmental requirements, complexity, and invasiveness. In this context, Nitrogen-Vacancy (NV) centers in diamonds emerge as a highly suitable solution, as they can operate at a wide range of temperatures and provide non-invasive optical readout. This study aims to leverage on the capabilities of NV-center-based sensors to probe the coherent properties of molecular spins, thus providing insights into their viability as stable and controllable components for future quantum technologies.

MA 19.5 Tue 15:00 H20

Imaging magnetic vortices in a van der Waals magnet at room temperature with scanning NV magnetometry — •Carolin Schrader[1], Elias Sfeir[1], Mário Ribeiro[2], Giulio Gentile[2], Alain Marty[2], Céline Vergnaud[2], Frédéric Bonell[2], Isabelle Robert-Philip[1], Matthieu Jamet[2], Vincent Jacques[1], and Aurore Finco[1] — [1]Laboratoire Charles Coulomb, Université de Montpellier, CNRS, Montpellier, France — [2]Université Grenoble Alpes, CEA, CNRS, IRIG-SPINTEC, Grenoble, France

Two-dimensional van der Waals (vdW) magnets have gained significant attention for their potential application in spintronics, however, this would require room temperature magnetism and large-scale fabrication. Recently, ferromagnetic order at room temperature has been demonstrated in thin Fe_5GeTe_2 grown by Molecular Beam Epitaxy (MBE). Here, we employ scanning NV magnetometry to quantitatively image the magnetic texture in MBE-grown Fe_5GeTe_2 at the nanoscale. We use the single spin of the nitrogen-vacancy (NV) defect in diamond to investigate the effect of patterning on the magnetic order and demonstrate the stabilisation of magnetic vortices in various micron-sized structures at room temperature. Upon application of an external magnetic field of a few mT we obtain a single ferromagnetic domain in these structures, which allows us to extract a saturation magnetisation of about 160 kA/m. Our results show the role of confinement for the stabilisation of complex magnetic structures in 2D magnets and highlight the potential of the room temperature vdW magnet Fe_5GeTe_2 for applications in spintronics.