MA 19: Characterization and Instrumentation

Time: Monday 17:15–19:00 Location: HSZ 101

MA 19.1 Mon 17:15 HSZ 101

Measuring Antiferromagnets with a SQUID Setup in Magnetically Shielded Environments — •Michael Paulsen[1], Jörn Beyer[1], Michael Fechner[2], Klaus Kiefer[3], Bastian Klemke[3], Julian Lindner[3], and Dennis Meier[4] — [1]Physikalisch-Technische Bundesanstalt, Berlin, Germany — [2]Max Planck Institute for the Structure and Dynamics of Matter, CFEL, Hamburg, Germany — [3]Helmholtz-Zentrum Berlin, Berlin, Germany — [4]Norwegian University of Science and Technology, Trondheim, Norway

Antiferromagnets possess zero net dipole magnetization. While predictions of higher order magnetizations have been made for Cr_2O_3, few confirmed measurements exist. In this contribution, we present low-temperature measurements gained on different systems with antiferromagnetic order in very low magnetic backgrounds using a dedicated SQUID setup. In particular, we discuss our results on exterior quadrupolar magnetic fields and relate the distinct quadrupolar magnetic signals to the microscopic spin arrangement in our model systems.

MA 19.2 Mon 17:30 HSZ 101

Optimally Controlled Pulses on NV Centers — •Thomas Reisser[1,3], Marco Rossignolo[2,4], Ressa S. Said[2], Tommaso Calarco[1,3], Simone Montangero[4], and Fedor Jelezko[2] — [1]Institute for Quantum Control, PGI-8, Forschungszentrum Jülich GmbH, Jülich — [2]Institute for Quantum Optics, Ulm University, Ulm — [3]Institute for Theoretical Physics, University of Cologne, Cologne — [4]Dipartimento di Fisica e Astronomia, Università degli Studi di Padova, Padova

Nitrogen vacancy centers in diamond display remarkable features such as optical polarizability and the read-out of their state at room temperature. Sensitivity to temperature and electric and magnetic fields enables their application for quantum sensing. Unexpected noise sources and long-term drifts of the driving magnetic field strength affect its interaction with the qubit. Long pulse schemes for quantum state preparation are not always suitable due to limited lifetimes. Hence, we designed optimally controlled pulses to drive the nitrogen vacancy center to a target state with robustness against frequency detuning within the transfer time of a standard square pulse. This can be achieved by a time-dependent variation of the applied pulse amplitude. Simulations showed further improvement in robustness for simultaneous carrier frequency modulation. As a next step, closed-loop optimization could be performed, where the simulated model is replaced by direct measurements on the NV center in the laboratory. Therefore, the remote dressed chopped random basis algorithm software (RedCRAB) is included in Qudi, a software suite for experiment control.

MA 19.3 Mon 17:45 HSZ 101

Optical magnetometer based on NV centers in diamond for calibration of superconducting vector magnets — •Severine Diziain[1], Nicole Raatz[2], Sebastien Pezzagna[2], Robert Staacke[2], Roger John[2], Lukas Botsch[1], Bernd Abel[3], Jan Meijer[2], and Pablo Esquinazi[1] — [1]Universität Leipzig, Felix-Bloch-Institut für Festkörperphysik, SUM, Leipzig, Germany — [2]Universität Leipzig, Felix-Bloch-Institut für Festkörperphysik, AQS, Leipzig, Germany — [3]Leibniz-Institut für Oberflächenmodifizierung e. V., Leipzig, Germany

Due to their ability to generate highly stable fields, superconducting vector magnets are commonly used for the characterization of magnetic properties of materials developed for spintronic applications. Because of flux trapping, the magnitude of the generated magnetic fields depends on the previous magnetization of the magnet and can not be determined by the applied current but must be measured. Usually vectorial magnetic field measurements are performed with three Hall sensors that have to be calibrated at all temperatures since their Hall voltage and offset are temperature dependent. This calibration can not be easily done inside a magnet that has been already energized because of remanent fields. Here we present an alternative that consists in measuring vectorial magnetic fields with a single optical magnetometer based on NV centers in diamond. These magnetometers allow for an easy reset of the vector magnet and therefore can be calibrated in-situ. Additionally since a single detector is enough to measure a vectorial field instead of three Hall sensors a better accuracy is obtained.

MA 19.4 Mon 18:00 HSZ 101

Scanning thermal gradient microscopy as a tool to read and write domains in non-collinear antiferromagnets — •Helena Reichlova[1], Tomas Janda[2], Joao Godinho[3], Anastasios Markou[4], Dominik Kriegner[4], Richard Schlitz[1], Jakub Zelezny[3], Zbynek Soban[3], Mauricio Bejarano[5], Helmut Schultheiss[5], Petr Nemec[2], Tomas Jungwirth[3], Claudia Felser[1], Joerg Wunderlich[3], and Sebastian T.B. Goennenwein[1] — [1]Institut für Festkörper- und Materialphysik and Würzburg-Dresden Cluster of Excellence ct.qmat, TU Dresden — [2]Faculty of Mathematics and Physics, Charles University in Prague — [3]Institute of Physics, Academy of Science of the Czech Republic — [4]Max Planck Institute for Chemical Physics of Solids — [5]Institute of Ion Beam Physics and Materials Research, HZDR

We present scanning thermal gradient microscopy as a tool to visualize magnetic structure in a non-collinear antiferromagnet Mn_3Sn thin films [1]. The technique is based on a laser induced thermal gradient which is scanned over the sample surface. The out-of-plane thermal gradient generates an in-plane thermo-voltage via the anomalous Nernst effect, which depends on the domain orientation and therefore yields magnetic spatial contrast. We further show that a domain pattern can be modified via heat assisted writing. Our work opens a route not only to image domains in non-collinear antiferromagnets but also to prepare well-defined domain configurations. [1] Reichlova, et al., Nat. Comm. 10, 5459 (2019)

MA 19.5 Mon 18:15 HSZ 101

High-field thermal expansion and magnetostriction at the High Field Magnet Laboratory (HFML-EMFL) — •Steffen Wiedmann[1], Masoumeh Keshavarz[2], Lisa Rossi[1], Ben Bryant[1], and Robert Kuechler[3] — [1]Field Magnet Laboratory (HFML-EMFL), IMM, Radboud University, Nijmegen, the Netherlands — [2]Molecular Imaging and Photonics, Department of Chemistry, KU Leuven, Leuven, Belgium — [3]Max Planck Institute for Chemical Physics of Solids, Dresden, Germany

Thermal expansion and magnetostriction experiments are an important and very sensitive tool for the investigation of phase transitions in condensed matter. At the high Field Magnet Laboratory (HFML) in Nijmegen, capacitive dilatometry that allows to measure both quantities in magnetic fields up to 38 T and down to 0.3 K has been developed with a resolution down to 0.1 nm at highest magnetic fields [1].

We present the current setups at the HFML and show recent results of dilatometry experiments such as (i) thermal expansion in lead halide perovskite materials to identify their phase transitions temperatures down to 4.2 K [2] and (ii) negative thermal expansion in the high-field, half-magnetization plateau phase of the frustrated magnetic insulator CdCr2O4 [3].

An outlook for further technical development will also be given.

[1] R. Kuechler et al., Review of Scientific Instruments 88 (2017), 083903. [2] M. Keshavarz et al., Advanced Materials 31 (2019), 1900521. [3] L. Rossi et al., Physical Review Letters 123 (2019), 027205.

MA 19.6 Mon 18:30 HSZ 101

Looking deeper into matter and magnets - scalable recognition of inhomogeneities in video data — Illia Horenko[1], •Davi Rodrigues[2], Terence O'Kane[3], and Karin Everschor-Sitte[2] — [1]Universita della Svizzera Italiana, Faculty of Informatics, Via G. Buffi 13, TI-6900 Lugano, Switzerland — [2]Johannes-Gutenberg University of Mainz, Faculty of Physics, Staudinger Weg 9, 55128 Mainz, Germany — [3]Climate Forecasting, CSIRO Oceans and Atmosphere, Castray Esplanade, 7001 Hobart, Tasmania

We present two physics motivated tools which enhances significantly the data extraction from time-discretized measurement data, i.e. video data, compared to state-of-the-art computational methods. We show that these measures detect very subtle material inhomogeneities from magnetic imaging measurements - down to 1% difference in material parameters. We demonstrate the working principle of these measures based on the 2d inhomogeneous Ising model, micromagnetic simulation data as well as experimental magnetization dynamics imaging data.

More generally, we show that these measures - the latent temperature and the latent entropy - reveal information about the system's

memory and its stochasticity, respectively, and they are applicable on a broad range of fields including biology and climate research. Furthermore we prove that they outperform common statistical and machine learning instruments as the iteration costs (scaling and memory requirements) of the algorithm to compute these measures are independent of the data statistics size.

MA 19.7 Mon 18:45 HSZ 101

First Operational Experience and Characterization of a Superconducting Transverse Gradient Undulator for Compact Laser Wakefield Accelerator-Driven FELs — •Kantaphon Damminsek[1], Axel Bernhard[1], Julian Gethman[1], Maisui Ning[1], Anke-Susanne Müller[1], Sebastian Richter[2], Robert Rossmanith[3], Farzad Jafarinia[3], Florian Burkart[3], and Malte Kaluza[4] — [1]Karlsruhe Institute of Technology — [2]CERN — [3]DESY, Hamburg — [4]Helmholtz Institute Jena

A 40-period superconducting transverse gradient undulator (TGU) has been designed and fabricated at Karlsruhe Institute of Technology (KIT). Combining a TGU with a Laser Wakefield Accelerator (LWFA) is a potential key for realizing an extremely compact Free Electron Lasers (FELs) radiation source: LWFAs have an unprecedentedly high longitudinal electric field inside the laser-driven plasma wave; the TGU scheme is a viable option to compensate the challenging properties of the LWFA electron beam in terms of beam divergence and energy spread. In this contribution, we report on the operational experience of this TGU inside its own cryostat and show first results of the characterization measurement and the further plan for experiments at the SINBAD Facility (DESY, Hamburg) and the JETI200 Laser laboratory in Jena.