Master Thesis Topic

Magnetic properties and phase diagram of large-scale layered magnets using SQUID magnetometry

Background and Motivation

Layered magnets can be seen as ideal platforms for exploring magnetism in the 2D limit. To establish their potential in future technologies, the realization of high-quality magnetic layered materials exhibiting ferromagnetism (FM) and/or antiferromagnetism close to room temperature is urgently needed. Recently, we have successfully synthesized at wafer-scale using molecular beam epitaxy on the one hand side a metastable α-$FeGe_2$ layered phase (not found as a bulk material) and on the other hand side layered Fe_5GeTe_2 as well as Fe_3GaTe_2 films. The first one shows a ferromagnetic to anti-ferromagnetic phase transition (supported by density functional theory) below room temperature and the letter ones are 2D conductors exhibiting itinerant ferromagnetism with Curie temperature values around or even above room temperature.

Objective

The aim of the project is to investigate the magnetic properties and to establish the magnetic phase diagram of α-$FeGe_2$ and/or Fe_5GeTe_2 (Fe_3GaTe_2) films. In principle, there is room for two individual projects.

Methodology

The structural properties of the films are characterized in-house by electron and X-ray diffraction as well as atomic force microscopy to confirm superior growth results. The superconducting quantum interference device (SQUID) is an excellent tool to study fine details of the magnetic properties with respect to magnetic field and temperature. The recently acquired, state-of-the-art SQUID magnetometer at PDI allows the study of samples at magnetic fields up to 7 T in a temperature range from 1.4K up to 400K.

During the project, your tasks will include:

1. Learn the principles of SQUID magnetometry and the sample preparation for the SQUID measurements.
2. Perform SQUID measurements on a variety of α-$FeGe_2$ and/or Fe_5GeTe_2 films prepared by different growth conditions (thickness, growth temperature)
3. Additionally the student will gain insight in the growth process and other magnetic characterization techniques such as magneto-transport.

Expected Outcomes

The expected main results of the project are:

- Understanding of the magnetic properties and establishing the magnetic phase diagram of α-$FeGe_2$ and/or Fe_5GeTe_2 (Fe_3GaTe_2) films.
- Correlation of the magnetic properties with the structural properties of the films.

Skills and Requirements

- Background in solid state physics, materials science, or related fields.
- Experience or interest in magnetism and magnetic materials.
- High motivation, excellent interpersonal and project management skills.

Opportunities and Benefits

- Supportive environment with experts for various scientific sub-fields.
- International and culturally diverse community.
- Location in the heart of Berlin with excellent public transport connections.
- Subsidized travel ticket.

Contact

Dr. Jens Herfort
+49 30 20377-344
herfort@pdi-berlin.de

For further details or clarification, please feel free to contact us. Lab tours are also available for interested applicants.