

## Master Thesis Topic

# MOKE microscopy of van-der-Waals Ferromagnets

## Background and Motivation

The efficient manipulation of magnetic nanostructures is fundamental for applications such as high-capacity memory, computing, and sensing devices. In this context, 2D ferromagnetic materials are expected to play a crucial role in future spin-based devices (e.g., spin valves and random-access magnetic memories) with high energy efficiency and ultracompact dimensions.

Among a vast selection of 2D materials with magnetic order, Fe-Ge-Te (FGT) compounds like  $\text{Fe}_3\text{GeTe}_2$  and  $\text{Fe}_5\text{GeTe}_2$  offer a great prospect. FGTs are itinerant ferromagnetic metals whose magnetic properties can be tuned via electrostatic gating, strain or doping. Moreover, the weak van der Waals interactions between interlayers allows the fabrication of vdW heterostructures combining FGT and other 2D crystals for the realization of novel devices with integrated magnetic, optical, and electronic functionalities.

## Objective

The aim of this project is to analyze magnetic textures in epitaxial FGT films using magnetooptical Kerr (MOKE) microscopy. The key objectives are:

1. **Mounting of MOKE microscope:** Set up a MOKE microscope with sensitivity to out-of-plane magnetization.
2. **Analyzing the magnetization of FGT thin films:** Systematic study of the spatial magnetization distribution via MOKE images under different temperatures and magnetic fields.

## Methodology

During the project, your tasks will include:

1. Mount and optimize the required components for the acquisition of optical images with microscopic resolution and magnetic sensitivity.
2. Acquire MOKE images in epitaxial FGT films placed in a cryostat equipped with superconducting magnets for the application of both in-plane and out-of-plane magnetic fields.
3. Analysis of the MOKE images to determine the dependence of magnetic textures on temperature, as well as on the strength and orientation of the external magnetic field.

## Expected Outcomes

The expected main results of the project are:

- Understand the formation and nature of magnetic textures in epitaxial FGT films under different experimental conditions.
- Determine the experimental conditions under which lattices of topological spin structures can be formed in FGT films.

## **Skills and Requirements**

- Background in solid state physics, materials science, or related fields.
- Experience or interest in magnetism and magnetic imaging techniques.
- 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**

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