Magnetic and Atomic Structure of Halfmetallic Heterostructures Investigated by Polarized Neutron Reflectometry and Scanning Transmission Electron Microscopy

The project aims to determine magnetic and electronic properties of emerging material interfaces between magnetic half-metals (HM), metals (M), semiconductors (S) and topological insulators (TI). Atomic scale structural and magnetic resolution will be achieved by combining state of the art Scanning Transmission Electron Microscopy (STEM) and Electron Energy Loss Spectroscopy (EELS) with Polarized Neutron Reflectometry (PNR).

New physical properties and mechanisms arise when two dissimilar materials are brought into intimate contact. The half-metallic material systems form the most promising candidates for future development of spintronic devices, due to the prospect of having 100% spin polarization at the Fermi level. The functionality of spintronic devices depends crucially on the atomic, magnetic and spin-electronic structure at the interface between the dissimilar materials in a heterostructure. Sub-nanometer spatial resolution provided by a combined STEM and PNR approach will provide correlations between functionality and magnetic structure of the interfaces and therefore suggest a roadmap for future design.

The main task of the student will be related to PNR experiments at the ILL. This will involve designing and conducting experiments on neutron scattering and analysing the data with customized protocols, and ultimately correlating the functional properties of the studied hetero-interfaces with their atomic and electronic structure obtained from STEM and EELS. Complimentary techniques will be applied to obtain a comprehensive understanding of the materials and interface characteristics.