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Master student traineeship proposal

Title: *Resonant inelastic x-ray scattering with magnetic circular dichroism (RIXS-MCD) of iron oxide*

Abstract:

Resonant inelastic X-ray scattering with magnetic circular dichroism (RIXS-MCD) combines the high-resolution excitation information of RIXS with the magnetic sensitivity of X-ray magnetic circular dichroism[1]. While RIXS-MCD spectra contain rich insights into complex materials, their interpretation remains challenging --particularly for mixed-valence systems[2]. This project will focus on the prototypical magnetic material magnetite (Fe_3O_4). Magnetite is a ferrimagnet composed of Td-coordinated Fe^{3+} and Oh-coordinated Fe^{2+}/Fe^{3+} sublattices. At 120K magnetite undergoes the Verwey transition due to electronic ordering of the Oh sublattice. RIXS-MCD maps will be acquired of both the metallic and insulating phases of magnetite, in addition to other iron oxide references. Simulations will be done using Quanty[2]. Strategies will be developed to best tackle to challenge of mixed-valence systems.

The trainee will participate in all stages of the experimental process including the planning and preparation, data collection, and data analysis. The project falls within the domain of condensed matter physics and magnetism. During the project the trainee will gain hands on experience working with ultra-high vacuum, cryogens, and a superconducting magnet. Prior experimental experience is not necessary. Data analysis will be primarily python-based, and so knowledge of the programming language would be beneficial.

References:

[1] de Groot, Frank MF, et al., *Nature Reviews Methods Primers* 4(1), 45 (2024)
[2] Kim, BH, et al., arXiv:2412.07204v2 **[cond-mat.str-el]** (2026)
[3] Haverkort, M.W., *Journal of Physics: Conference Series*, 712(1), 012001 (2016)

Scientist in charge: Rachel Nickel

Beamline(s)/Host Group: ID32

Traineeship supervisor(s): Rachel Nickel

Access to Instruments/labs/computing/software: Experiments at ID32 + lab-based structural and magnetic characterization

Starting date and Duration: September/October, 6 months

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