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Canted magnetism in modulated thin-film superlattices

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Interactions at interfaces of magnetic materials such as giant magnetoresistance (GMR) form the physical foundation of many technological devices in today's market. Although GMR technlogies are now somewhat dated, interactions at the interface between layers of oxide materials continue to demonstrate attractive mechanisms for technology applications due to the wide variety of available oxide materials as well as their ability to be well lattice-matched to form heterostructures.

Magnetic thin-film superlattices made of 15 repetitions of $La_{2/3}Sr_{1/3}MnO_3$ (LSMO) and $LaNiO_3$ (LNO) have been shown to exhibit a magnetic exchange interaction in LNO that is dependent upon its thickness n (where n is the number of unit cells of LNO) between LSMO layers [1]. At $n = 1$, the LSMO layers are ferromagnetically aligned with eachother. At $n = 3$ however, the LSMO layers are canted by 110° with respect to one another. This canting is reportedly driven by an emergent c-axis spin-helix in LNO that arises due to charge transfer at the interfaces between LNO and LSMO [2].

We have fabricated superlattices of similar quality to Ref. [1] using Reflected High Energy Electron Diffraction (RHEED) assisted Pulsed Laser Deposition (PLD), where RHEED is used to ensure unit-cell precision in layer thicknesses. These superlattices have been designed so they exhibit $n = 3$ and $n = 1$ interactions within the same superlattice in a modulated pattern. This modulation of the effective LNO exchange interaction in these samples creates a toy model of coupled magnetic layers to explore. The modulated design of these samples create "frustrated" environments where the effective exchange interaction is different on each side of an LSMO layer within the superlattice. We utilise polarised neutron reflectometry using PLAYPUS to reveal the complex magnetic profile of these modulated superlattices by measuring the non-spin-flip (R^{++}, R^{--}), and spin-flip (R^{+-}, R^{-+}) cross sections. Presented are the current progress and prospects in the fitting process of these complex datasets.

[1] J. Hoffman et al. Phys. Rev. X 6, 041038 (2016)
[2] G. Fabbris et al. Phys. Rev. B 98, 180401(R) (2018)

Level of Expertise

Student

Speakers Gender

Male

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No

Primary authors: PAULL, Oliver; WONG, Jackson (UNSw); SANDO, Daniel (School of Materials Science and Engineering, University of New South Wales); LEE, Wai Tung (Australian Nuclear Science and Technology Organisation); HOLT, Stephen (Australian Nuclear Science and Technology Organisation); VALANOOR, Nagarajan (UNSW Australia)

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