Department of Physics
Condensed Matter Physics
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UNIVERSITY OF OXFORD

CONDENSED MATTER PHYSICS SEMINAR

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Simpkins Lee Seminar Room, Department of Physics
(https://maps.app.goo.gl/WjG71uLF2D48n85B6)

Spin splitting on the surfaces of antiferromagnets

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There has been recent interest in combining the robustness and ultrafast dynamics of antiferromagnets (AFMs) with the exotic transport properties of spin-polarized band structures which are typical to ferromagnets. While the band structures of many AFMs are spin-degenerate, exceptions to this rule such as altermagnets have demonstrated the possibility to obtain spin polarization in bulk AFMs via selective symmetry breaking. In this talk, I discuss our recent results revealing an alternative source of spin-polarization in AFMs that could potentially be leveraged in applications [1]. Using symmetry analysis and density functional theory (DFT), we show that a ferromagnetic-like exchange splitting generically occurs on the projected band structures of surface cuts having symmetry-allowed net magnetization per unit area ("surface magnetization"), despite the AFM's vanishing bulk magnetization [2-4]. To determine the mechanisms underlying this type of spin splitting, we perform representative band structure calculations for different surface facets of linear magnetoelectric Cr2O3 and bulk altermagnet FeF2. Rather than being directly proportional to the magnitude of surface magnetization, we find that the size of spin-splitting arises from an interplay of single-site exchange splittings, inequivalent crystal field splittings for different sublattices on the surface, and inequivalent exchange splittings for different sublattices. As a result, particular surface terminations (e.g. (110) FeF2) can exhibit a surprisingly large spin splitting of >1 eV, despite a very small magnitude of surface magnetization. Even for bulk AFMs whose symmetries forbid a net spin polarization in the band structure, our findings of surface-localized spin splitting are expected to be relevant for any device architectures relying on interfaces, and for a wide variety of surface-sensitive measurements such as spin-polarized ARPES, magnetotranport, and electron spectroscopies.

[1] W. A. Schaarman and SFW, to be submitted.
[2] SFW, A. Urru, S. Bhowal, C. Ederer and N. A. Spaldin, Phys. Rev. X 14, 021033 (2024).
[3] O. Pylypovskyi, SFW, P. Makushko, I. Veremchuk, N. A. Spaldin, and D. Makarov, Phys. Rev. Lett. 132, 226702 (2024).
[4] SFW, A. Urru and N. A. Spaldin, Phys. Rev. X 15, 021094 (2025).

Host: Professor Marina Filip