MA 18: Functional Antiferromagnetism

Time: Tuesday 14:00–15:30 Location: H19

MA 18.1 Tue 14:00 H19

Switching of magnetic domains in a noncollinear antiferromagnet at the nanoscale — •Atul Pandey[1,2], Prajwal Rigvedi[1], Edouard Edouard[3], Jitul Deka[1], Jiho Yoon[1], Wolfgang Hoppe[2], James M. Taylor[2], Stuart S. P. Parkin[1], and Georg Woltersdorf[1,2] — [1]Max Planck Institute of Microstructure Physics, Weinberg 2, 06120 Halle, Germany — [2]Institute of Physics, Martin Luther University Halle Wittenberg, Von Danckelmann Platz 3, 06120 Halle, Germany — [3]Max Planck Institute for Chemical Physics of Solids, Nothnitzer Straße 40, 01187 Dresden, Germany

Antiferromagnets that display very small stray magnetic field are ideal for spintronic applications. Of particular interest are non-collinear, chiral antiferromagnets of the type Mn_3X (X=Sn, Ge), which display a large magnetotransport response that is correlated with their antiferromagnetic ordering. The ability to read out and manipulate this ordering is crucial for their integration into spintronic devices. These materials exhibit a tiny unbalanced magnetic moment such that a large external magnetic field can, in principle, be used to set the material into a single antiferromagnetic domain. However, in thin films of Mn_3Sn, we find that such fields induce only a partial magnetic ordering. By detecting two orthogonal in-plane components of the magnetic order vector, we find that the non-switchable fraction has a unidirectional anisotropy. This also enables us to visualize switching along multiple easy axes in Mn_3Sn. Studying the switching at the nanoscale allows us to correlate the pining behavior to crystal grain boundaries in the Mn3Sn nanowire structures.

MA 18.2 Tue 14:15 H19

Understanding the role of spin non-conserving on magnon excitation — •Hebatalla Elnaggar — Sorbonne University, Paris, France

Conventional wisdom suggests that one photon that carries one unit of angular momentum (1h) can change the spin angular momentum of a magnetic site with one unit (*M* = *1h) at most following the selection rules. This implies that a two-photon process such as 2*3* resonant inelastic X-ray scattering (RIXS) can change the spin angular momentum of a magnetic system with a maximum of two units (*M* = * 2h). Herein we describe a triple-magnon excitation in *-Fe2O3 and various perovskite thin films, which contradicts this conventional wisdom that only 1- and 2-magnon excitations are possible in a resonant inelastic X-ray scattering experiment [1].

We observe an excitation at exactly three times the magnon energy, along with additional excitations at four and five times the magnon energy, suggesting quadruple and quintuple magnons as well. Guided by theoretical calculations, we reveal how a two-photon scattering process can create exotic higher-rank magnons due to spin non-conserving interactions.

References: 1- H. Elnaggar, et. al., Magnetic excitations beyond the single- and double-magnons, Nat. Commun. 14, 2749 (2023).

MA 18.3 Tue 14:30 H19

Domain wall patterns in granular Cr_2O_3 thin films — •Igor Veremchuk[1], Oleksandr V. Pylypovskyi[1], Peter Rickhaus[2], Natascha Hedrich[3], Artem V. Tomilo[1], Tobias Kosub[1], Kai Wagner[3], Brendan Shields[3], Gediminas Seniutinas[2], Vicent Borras[2], Paul Lehmann[3], Liza Žaper[2], Paulina J. Prusik[1], Pavlo Makushko[1], René Hübner[1], Jüren Fassbender[1], Denis D. Sheka[4], Patrick Maletinsky[3], and Denys Makarov[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf e.V.,01328 Dresden, Germany — [2]Qnami AG, CH-4132 Muttenz, Switzerland — [3]University of Basel, Basel CH-4056, Switzerland — [4]Taras Shevchenko National University of Kyiv, 01601 Kyiv, Ukraine

Cr_2O_3 provides possibility to control its magnetic order parameter by an external electric field rendering it a prospective material for spintronic applications. We developed a material model for granular thin Cr_2O_3 films. The coupling between the grains influences the equilibrium domain pattern due to pinning of antiferromagnetic domain walls at the grain boundaries. By the characterization of the experimentally measured domain patterns via fractal dimension, we determine the inter-grain exchange coupling [1]. In contrast to extended films, finite-size samples can be set into a single-domain state even via a zero-field cooling procedure. Such a sample should be small enough for the propagation of thermally driven domain walls through the energy landscape formed by grain boundaries [2].

[1] O. V. Pylypovskyi et al., Phys. Rev. Appl. 20, 014020 (2023).
[2] P. Rickhaus, O. V. Pylypovskyi et al., Nano Lett. 24, 13172 (2024).

MA 18.4 Tue 14:45 H19

Domain walls properties and spin-flop transition in Cr_2O_3 — •Paulina J. Prusik[1,2], Igor Veremchuk[1], Florin Radu[3], Andrey N. Anisimov[1], Pavlo Makushko[1], Georgy V. Astakhov[1], Sophie F. Weber[4], René Hübner[1], Nicola A. Spaldin[4], Kirill D. Belashchenko[5], Jürgen Fassbender[1,2], Denys Makarov[1], and Oleksandr V. Pylypovskyi[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf e.V. — [2]Dresden University of Technology, 01062 Dresden, Germany — [3]Helmholtz-Zentrum Berlin für Materialien und Energie, 14109 Berlin, Germany — [4]ETH Zürich, 8093 Zürich, Switzerland — [5]University of Nebraska-Lincoln, Lincoln, NE 68588, USA

A room-temperature magnetoelectric uniaxial antiferromagnet Cr_2O_3 is a prospective material for spintronics and fundamental research [1,2]. We derive a σ-model for Cr_2O_3 and show the presence of a symmetry-breaking term relevant for non-collinear magnetic textures. It couples the magnetic field with a gradient of the Néel vector. Analyzing quantum magnetometry images of antiferromagnetic domain walls, we can properly describe the material parameters of Cr_2O_3. Furthermore, this term results in lowering of the spin-flop field for thin films of Cr_2O_3 by a factor of two comparing with single crystals. This finding is confirmed by X-ray magnetic linear dichroism measurements.

[1] J. Han et al., Nat. Mater. 22 (2023) 684; He et al, Nat. El. (2024) [2] P. Makushko et al., Nat. Comm. 13, 6745 (2022); O.V. Pylypovskyi et al., Phys. Rev. Let. 132, 226702 (2024); S.F. Weber et al., Phys. Rev. Lett. 130, 146701 (2023)

MA 18.5 Tue 15:00 H19

Current pulse driven switching mechanisms in antiferromagnetic Mn_2Au — •Jonathan Blässer[1], Sonka Reimers[1], Yuran Niu[2], Evangelos Golias[2], Francesco Maccherozzi[3], Miriam Fischer[1], Guzmán Orero Gámez[1], Mathias Kläui[1], and Martin Jourdan[1] — [1]Johannes Gutenberg-Universität, Mainz, Germany — [2]MAX IV Laboratory, Lund, Sweden — [3]Diamond Light Source, Chilton, Didcot, Oxfordshire, UK

In antiferromagnetic spintronics, reorientation of the staggered magnetization driven by current pulses can originate from different mechanisms. Investigating Mn_2Au, for longer pulses [Rei23] the thermal contribution is dominant. However, for pulses in the nanosecond range Néel spin-orbit torque switching is demonstrated.

[Rei23] S.Reimers et al., Nat Commun. 14, 1861 (2023)

MA 18.6 Tue 15:15 H19

Amplifying the antiferromagnetic spin Seebeck effect through topological magnons — Feodor Svetlanov Konomaev and •Kjetil Magne Dørheim Hals — Department of Engineering Sciences, University of Agder, 4879 Grimstad, Norway

Topological magnons emerge as topologically protected spin wave states at the edges of magnets. Here, we theoretically explore how these surface states can be harnessed to amplify the spin Seebeck effect (SSE) in antiferromagnets (AFMs) interfaced with normal metals (NMs). Based on a microscopic model of a kagome AFM, we demonstrate that broken mirror symmetry, combined with the Dzyaloshinskii-Moriya interaction (DMI), drives the system into a topological phase hosting spin-polarized magnons at the boundaries. Notably, linear response calculations reveal that in AFM/NM heterostructures, the topological magnons exhibit strong coupling to the metals charge carriers, resulting in a substantial enhancement of the SSE. The relative contribution of the topological magnons is found to be 4-5 times greater than that of the trivial magnon bands. Moreover, our results show that this enhancement is highly sensitive to the strength of the DMI.