MA 28: Spin Dynamics and Transport: Domain Walls

Time: Tuesday 14:00–15:45 Location: HSZ 401

MA 28.1 Tue 14:00 HSZ 401

Inertia-Free Thermally Driven Domain-Wall Motion in Antiferromagnets — •Severin Selzer[1], Unai Atxitia[1], Ulrike Ritzmann[2], Denise Hinzke[1], and Ulrich Nowak[1] — [1]Universität Konstanz — [2]Johannes Gutenberg-Universität Mainz

Induced domain wall motion is the key to an efficient and fast control of magnetic nanostructures. Due to their complex spin structures leading to higher spin dynamics than in ferromagnets, antiferromagnets are promising candidates as materials for future devices.

Domain-wall motion in antiferromagnets triggered by thermally induced magnonic spin currents is studied theoretically. It is shown by numerical calculations based on a classical spin model that the wall moves towards the hotter regions, as in ferromagnets. However, for larger driving forces the so-called Walker breakdown - which usually speeds down the wall - is missing. This is due to the fact that the wall is not tilted during its motion. For the same reason antiferromagnetic walls have no inertia and, hence, no acceleration phase leading to higher effective mobility (Phys. Rev. Lett. 117, 107201).

MA 28.2 Tue 14:15 HSZ 401

Chiral domain walls in low dimensional Co heterostructures — •Jonathan Chico[1], Konstantinos Koumpouras[2], Lars Bergqvist[3,4], and Anders Bergman[2] — [1]Peter Grünberg Institut and Institute of Advanced Simulation, Forschungszentrum Jülich & JARA, D-52428, Jülich, Germany — [2]Department of Physics and Astronomy, Materials Theory Division, Uppsala University, Box 516, SE-75120 Uppsala, Sweden — [3]Department of Materials and Nano Physics, School of Information and Communication Technology, KTH Royal Institute of Technology, Electrum 229, SE-16440 Kista, Sweden — [4]SeRC (Swedish e-Science Research Center), KTH Royal Institute of Technology, SE-10044 Stockholm, Sweden

Recently relativistic effects in domain wall dynamics have come to the forefront in ultra thin magnetic layers in contact with heavy metals, where domain wall motion against the electron flow has been observed, phenomena which cannot be explained only by the volume spin transfer torque (STT)[1].

From the first principles point of view we investigate Co thin films in contact with substrates composed of 4d and 5d elements. The substrate is observed to play a major role in the magnetocrystalline anisotropy and the Dzyaloshinskii-Moriya interactions (DMI). Atomistic spin dynamics simulations making use of these parameters, showcase how the chiral nature of the domain walls present in these systems, in combination with the Spin Hall Effect, can describe the recent experimental findings.

[1] Kwang-Su Ryu et. al *Nature Nanotech.*, **8**, 527 (2013)

MA 28.3 Tue 14:30 HSZ 401

Efficient Current Induced Motion of Chiral Domain Walls — Robin Bläing[1], •Tianping Ma[1], Chirag Garg[1,2], Tom Lichtenberg[1], See-Hun Yang[2], Ilya Kostanovskiy[1], and Stuart Parkin[1,2] — [1]Max Planck Institut of Microstructure Physics, Halle, Germany — [2]IBM Almaden Research Center, San Jose, US

Novel three-dimensional memory devices based on magnetic domains in thin film ferromagnets have high potential to solve long-term memory storing problems. One example is the racetrack memory which is based on current-induced motion of the magnetic domains. The driving force is a spin current injected into the ferromagnetic layer from an underlayer via the spin Hall effect. In addition, the Dzyaloshinskii-Moriya interaction plays a major role in order to achieve an efficient motion. We study novel 2D materials to improve the spin Hall efficiency and Dzyaloshinskii-Moriya interaction. Furthermore, for commercial devices the threshold current to efficiently drive magnetic domain walls needs to be lowered and therefore temperature dependent measurements are performed to gain further understanding of this property.

MA 28.4 Tue 14:45 HSZ 401

Anticlockwise Néel domain walls in ultrathin Cobalt films on Pt(111) — Edna Corredor Vega, •Susanne Kuhrau, Fabian Kloodt, Robert Frömter, and Hans Peter Oepen — Institut für Angewandte Physik, Universität Hamburg, Jungiusstraße 11, 20355 Hamburg, Germany

Recently, the Co/Pt (111) system has attracted large interest because of the potential to stabilize isolated skyrmions at room temperature (RT) due to its large interfacial Dzyaloshinskii-Moriya Interaction (DMI). We present a comprehensive study on Co wedges epitaxially grown on Pt (111) at RT with thicknesses ranging between 0 to 7 ML. The magnetic microstructure is investigated via Scanning Electron Microscopy with Polarization Analysis (SEMPA) [1]. The SEMPA is designed to image the in-plane components of the magnetization. For the investigation the sample was slightly tilted to get access to the perpendicular component. On increase of Co thickness the domain size shrinks. In the thickness range studied all domain walls are of Néel type and show a fixed sense of rotation. For 7 ML the wall width is (10.8±1.3) nm. A lower limit estimate of the DMI vector D [2] reveals a value of $D > 1$ mJ/m^2 for 7 ML.

[1] R. Frömter, et al., Rev. Sci. Instrum. 82, 033704, (2011).
[2] A. Thiaville, et al. Europhys. Lett. 100, 57002 (2012).

MA 28.5 Tue 15:00 HSZ 401

Domain width model for perpendicularly magnetized systems including DMI — •Thomas N.G. Meier, Matthias Kronseder, and Christian H. Back — Institut für experimentelle und angewandte Physik, Universität Regensburg, Deutschland

In ultrathin ferromagnetic films with perpendicular anisotropy a spin-reorientation transition from out-of-plane to in-plane orientation of the magnetization vector may occur. The competition of exchange and anisotropy energy on the one hand and the dipole interaction on the other hand leads to the formation of stripe domain patterns in the vicinity of the spin reorientation transition. Recently a strong Dzyaloshinskii-Moriya interaction (DMI) was found in various perpendicularly magnetized multilayer systems due to symmetry breaking at interfaces. The dependence of the stripe domain width on the DMI is theoretically and experimentally investigated. A domain spacing model applicable in the normal stripe domain phase is developed describing the dependence of the stripe domain width on the magnetic properties of the sample. We present a new approach to determine the magnitude of the DMI-constant by fitting the stripe domain width as a function of the effective perpendicular anisotropy on wedge-shaped samples with the model. By applying this method to the domain pattern of several ultrathin multilayer samples based on Ni/Fe/Cu(001) imaged by TP-MCD-PEEM the magnitude of the DMI of the FeNi- and NiFe-interfaces is determined. Furthermore we show that the DMI in Ni/Fe/Cu(001) can be considerably enhanced by adding an overlayer of platinum to the sample stack.

MA 28.6 Tue 15:15 HSZ 401

Current-driven periodic domain wall creation in ferromagnetic nanowires — •Matthias Sitte[1], Karin Everschor-Sitte[1], Thierry Valet[1], Davi R. Rodrigues[2], Jairo Sinova[1,3], and Artem Abanov[2] — [1]Institute of Physics, Johannes Gutenberg-Universität, 55128 Mainz, Germany — [2]Department of Physics & Astronomy, Texas A&M University, College Station, Texas 77843-4242, USA — [3]Institute of Physics, Academy of Sciences of the Czech Republic, Cukrovarnicka 10, 162 53 Praha 6, Czech Republic

We predict the electrical generation and injection of domain walls into a ferromagnetic nanowire without the need of an assisting magnetic field. Our analytical and numerical results show that above a critical current j_c domain walls are injected into the nanowire with a period $T \sim (j - j_c)^{-1/2}$. Importantly, domain walls can be produced periodically even in a simple exchange ferromagnet with uniaxial anisotropy, without requiring any standard “twisting” interaction such as Dzyaloshinskii-Moriya or dipole-dipole interactions. We show analytically that this process and the period exponents are universal and do not depend on the peculiarities of the microscopic Hamiltonian. Finally we give a specific proposal for an experimental realization.

MA 28.7 Tue 15:30 HSZ 401

Magnetism and Transport in Hybrid Magnetic Nanowires — •Sergej Andreev, Roman Hartmann, and Torsten Pietsch — Universität Konstanz, Deutschland

Ensembles of magnetic nanowires are the core-elements of various applications in nonvolatile memories, microwave devices and communication technologies as well as humidity- and gas sensors. Moreover, due to their small diameter in the range of few to tens of nanometers, these systems are highly interesting in magnonics and spin-(transfer) electronics, where high spin-current are required. Here we show how well-defined ensembles of hybrid, magnetic nanowires with diameters of few tens of nm, composed of multilayers of ferromagnetic Ni, NiCu, Co and other non-magnetic metals can be grown in microstructured arrays and integrated in high-frequency microwave electronic devices. The collective static and dynamic magnetic properties of the nanowire arrays are evaluated via SQUID magnetometry and FMR /EPR measurements. Additionally we will outline the potential of these devices in microwave- and THz emitters as well as spin-transfer driven magnetic oscillators.