MA 44: Spin Torque and Spin Excitations II

Time: Thursday 15:00–16:30 Location: HSZ 403

MA 44.1 Thu 15:00 HSZ 403

First-principles determination of spin-orbit torques within relativistic KKR — Diemo Ködderitzsch, Marten Seemann, Sergiy Mankovskyy, and •Hubert Ebert — Universität München, Dept. Chemie, Butenandtstraße 5-13, D-81377 München, Germany

The prediction and experimental observation of torques acting on the magnetization due to an applied electric field induced by spin-orbit interaction and broken inversion symmetry has recently attracted a lot of interest.[1,2] Employing a recent Kubo-Bastin-like formulation for the determination of spin-orbit torques [3] we here present a fully relativistic implementation within the KKR first-principles electronic structure method. The matrix elements for the torkance-current correlation functions are calculated in a similar manner as those occurring in transverse transport and the Gilbert damping.[4,5] A symmetry analysis of the occurring torque terms is given. Applications to disordered systems will illustrate the approach.

[1] Manchon, Zhang, PRB **78**, 212405 (2008); [2] Gambardella, Miron, Phil. Trans. R. Soc **369**, 3175 (2013); [3] Freimuth, Blügel, Mokrousov, arXiv: 1305:4873v1 (2013); [4] Lowitzer, Ködderitzsch, Ebert, PRL **105**, 266604 (2010); [5] Ebert, Mankovsky, Ködderitzsch, PRL **107**, 066603 (2011)

MA 44.2 Thu 15:15 HSZ 403

Linear and nonlinear stationary ac response of the magnetization of nanomagnets in the presence of thermal agitation and spin-transfer torques — D.J. Byrne[1], •W.T. Coffey[2], Y.P. Kalmykov[3], and S.V. Titov[4] — [1]School of Physics, University College Dublin, Belfield, Dublin 4, Ireland — [2]Department of Electronic and Electrical Engineering, Trinity College, Dublin 2, Ireland — [3]Université de Perpignan Via Domitia, Laboratoire de Mathématiques et Physique, F-66860, Perpignan, France — [4]Kotelnikov Institute of Radio Engineering and Electronics of the RAS, Russia

Thermal fluctuations of nanomagnets driven by spin-polarized currents are treated via the Landau-Lifshitz-Gilbert equation generalized to include both the random thermal noise field and the Slonczewski spin-transfer torque term. The statistical moment method [Y. P. Kalmykov et al., Spin-torque effects in thermally assisted magnetization reversal: Method of statistical moments, Phys. Rev. B 88 (2013) 144406] for the study of out-of-equilibrium time independent observables of the generic nanopillar model of a spin-torque transfer (STT) device subjected to thermal fluctuations is extended to the stationary time dependent observables arising from applied a.c. field. The virtue of our solutions is that they hold for the most comprehensive formulation of the generic nanopillar model, i.e., for arbitrary directions of the external field and spin polarization and for arbitrary free energy density, yielding the STT switching characteristics under conditions otherwise inaccessible. Both the dynamic magnetic susceptibility and dynamic hysteresis are determined for an a.c. field of arbitrary strength.

MA 44.3 Thu 15:30 HSZ 403

Magnons in ultrathin ferromagnetic films with a large perpendicular magnetic anisotropy — •Huajun Qin[1], Khalil Zakeri Lori[1], Arthur Ernst[1], Tzu-Hung Chuang[1], Ying-Jiun Chen[1], Yang Meng[1], and Jürgen Kirschner[1,2] — [1]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle, Germany — [2]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, 06120 Halle, Germany

Ultrathin films with a large perpendicular magnetic anisotropy are of great fundamental as well as technological interest. We present the first experimental observation of high energy magnon excitations in a set of tetragonally distorted ultrathin FeCo films with a large perpendicular magnetic anisotropy. We use spin polarized electron energy loss spectroscopy to excite and probe the magnetic excitations. In this experiment, the polarization vector of the incoming beam is perpendicular to the film magnetization. The magnon dispersion relation and lifetime are probed along the $\bar{\Gamma}$–$\bar{\mathrm{X}}$ direction of the surface Brillouin zone. The magnons possess energies up to 160 meV and lifetimes in the range of a few tens of femtoseconds down to sixteen femtoseconds at the zone boundary. Combined with the first-principles calculations, we show that in addition to the tetragonal distortion, which is the origin of the large perpendicular magnetic anisotropy, the interfacial electronic hybridization also has an impact on the properties of magnons [1].

[1] H.J. Qin, Kh. Zakeri, A. Ernst, T.-H. Chuang, Y.-J. Chen, Y. Meng, and J. Kirschner, PRB **88**, 020404 (R) (2013).

MA 44.4 Thu 15:45 HSZ 403

Magnetic excitations in ultrathin Co films on Ir(100) — •Ying-Jiun Chen[1], Khalil Zakeri[1], Arthur Ernst[1,3], Huajun Qin[1], Tzu-Hung Chuang[1], Yang Meng[1], and Jürgen Kirschner[1,2] — [1]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle, Germany — [2]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, 06120 Halle, Germany — [3]Wilhelm Ostwald Institut für Physikalische und Theoretische Chemie, Universität Leipzig, Linnéstrasse 2, 04103 Leipzig, Germany

We report on the experimental results of high-energy magnetic excitations in an ultrathin face-centered tetragonal (fct) Co film with a thickness of 2.8 monolayer (ML) grown on the (5×1) reconstructed Ir(100) surface. The magnon dispersion relation is measured along the main symmetry axes of the sureface Brillouin zone *i.e.* $\bar{\Gamma}$-$\bar{\mathrm{X}}$ and $\bar{\Gamma}$-$\bar{\mathrm{M}}$ directions. The excitation energy increases as the wave-vector increases and reaches a value of about 260 meV at the $\bar{\mathrm{X}}$-point and 310 meV at the $\bar{\mathrm{M}}$-point. By comparing the results to the ones of a 3 ML Co film grown on Cu(100), and also to the results of theoretical calculations, we discuss how the lattice strain and Co_{3d}-Ir_{5d} hybridizations of the electronic states influence the magnon dispersion relation.

MA 44.5 Thu 16:00 HSZ 403

Spin Excitations in Individual Fe4 Molecular Magnets — •Jacob Burgess[1,2], Luigi Malavolti[3], Valeria Lanzilotto[3], Matteo Mannini[3], Shichao Yan[1,2], Deung-Jang Choi[1,2], Steffen Rolf-Pissarczyk[1,2], Andrea Cornia[4], Roberta Sessoli[3], and Sebastian Loth[1,2] — [1]Max Planck Institute for the Structure and Dynamics of Matter, Hamburg — [2]Max Planck Institute for Solid State Research, Stuttgart — [3]Department of Chemistry, University of Florence & INSTM, Italy — [4]Department of Chemical and Geological Sciences, University of Modena and Reggio Emilia & INSTM, Italy

Single molecule magnets (SMMs) are in general large and fragile molecules. This constitutes a significant challenge in incorporating them into spintronics applications, and also to the investigation of the molecules via scanning tunneling microscopy (STM). The Fe4 molecule [1] stands out as an unusually robust SMM that can withstand thermal evaporation as well as a wide range of possible functionalizations.

Here we present the first STM investigations of individual Fe4 molecules thermally evaporated onto a single layer Cu2N on a Cu (100) crystal. Magnetic excitations at meV energies can be detected by inelastic electron tunneling spectroscopy. Comparison to the excitation spectrum computed from a Spin Hamiltonian accounting for all spins individually allows extraction of anisotropy and exchange parameters for isolated molecules. This experiment indicates the surface has a minimal effect on the magnetic anisotropy of Fe4 molecules.

[1] M. Mannini et al., Nature 468, 417 (2010).

MA 44.6 Thu 16:15 HSZ 403

Novel spin excitations in the quasi-1D Haldane chain $SrNi_2V_2O_8$ under magnetic field — •Anup K. Bera[1], Bella Lake[1], Nazmul Islam[1], Bastian Klemke[1], Joseph M. Law[2], Astrid Schneidewind[3], Jitae Park[3], and Elisa Wheeler[4] — [1]Helmholtz-Zentrum Berlin, Berlin, Germany — [2]Helmholtz-Zentrum Dresden Rossendorf, Dresden, Germany — [3]Forschungs-Neutronenquelle Heinz Maier-Leibnitz, Garching, Germany — [4]Institut Laue-Langevin, Grenoble, France

Spin-1 Heisenberg antiferromagnetic chains (Haldane chains) demonstrate novel behaviors where quantum fluctuations destroy long-range order (LRO) even at T = 0. They have spin singlet ground state and gapped magnon (S=1) excitations. Applied magnetic fields suppress zero-point fluctuations, and restore a gapless spectrum. The result is a quantum phase transition at a critical field H_c, to a magnetized state. The presence of anisotropy and interchain interactions lead to more complex behavior and a richer phase diagram.

Spin excitations have been investigated experimentally on the model compound $SrNi_2V_2O_8$ having substantial interchain interactions and single-ion anisotropy. Field-induced 3D magnetic ordering has been found with two critical fields (12 T for $H \perp c$ and 20.8 T $H \parallel c$ at 4.2 K, respectively). For $H \perp c$, neutron scattering reveal (i) a unique field dependence of the gapped triplet excitations at $H < H_c$, (ii) gapless excitations at H_c, and (iii) the reappearance of gapped excitations at $H > H_c$. The dispersion at $H = H_c$ is gapless and linear, in contrast to the gapped and quadratic dispersions at both $H > H_c$ and $H < H_c$.