MA 26: Micromagnetism / Computational Magnetics

Time: Wednesday 10:45–12:15 Location: H 0112

MA 26.1 Wed 10:45 H 0112

Multiscale simulation of micromagnetic singularities — •Christian Andreas[1,2], Attila Kákay[1], Ming Yan[1], and Riccardo Hertel[1,2] — [1]Peter Grünberg Institut, Electronic Properties, Forschungszentrum Jülich GmbH — [2]IPCMS, CNRS UMR 7504, Strasbourg, France

Several fundamental processes like bubble domain reversal and vortex core switching include the formation of Bloch points (BP) [1,2,3]. Such micromagnetic singularities pose limits to the validity of micromagnetic simulations and are usually treated within the realm of micromagnetism by using mesh refinement and extrapolations to zero-mesh size. The problem is the singularity of the exchange energy density for BPs. A more realistic description is obtained by employing a multiscale model, which removes this singularity. We present a multiscale approach combining our micromagnetic code TetraMag with a Heisenberg model. This allows us to treat the exchange energy around BPs atomistically, by taking into account 10^6 atoms. The multiscale code exploits the computational power of Graphical Processing Units, thereby allowing us to extend the dynamic calculation to several nanoseconds on the micrometer length scale. The results elucidate to which extent BPs can be treated reliably with standard micromagnetic simulations. It is shown that the intrinsic overestimation of the BP energy of the continuum approximation is generally not counterbalanced by discretization effects which systematically underestimate it. [1] Hertel, R. et al., Phys. Rev. Lett. 98, 117201 (2007) [2] Thiaville, A. et al., Phys. Rev. B 67, 094410 (2003) [3] Döring, W. J. Appl. Phys. 39, 1006 (1968)

MA 26.2 Wed 11:00 H 0112

Chiral skyrmions as a new objects for magnetic storage technologies — •Nikolai Kiselev[1,2], Rudolf Schäfer[1], Alex Bogdanov[1], and Ulrich K. Rössler[1] — [1]IFW Dresden, Germany — [2]PGI and IAS, Forschungszentrum Jülich, Germany

Chiral Skyrmions (CS) in magnetic materials are topologically non-trivial, intrinsically stable magnetization configurations with particle-like properties. CS can arise in bulk and nanolayers of magnetic metals with intrinsic [1] or surface/interface [2,3] induced Dzyaloshinskii-Moriya interaction. CS drastically differ from other axisymmetric patterns induced by external dipole-dipole forces (bubble domains in nanolayers [3] and magnetic vortices in magnetic nanodots). They are extremely stable in wide ranges of magnetic field, geometrical and materials parameters (layer thickness, uniaxial anisotropy, magnetization). Our theoretical findings allow us to conclude that CS hold promise for a new paradigm in data storage devices that can be based on stable multidimensional solitons in chiral soft magnetic media.

[1] A. N. Bogdanov, A. D. Yablonsky Sov. Phys. JETP 68, 101 (1989), [2] X. Z. Yu et al. Nature Mat. 465, 901 (2010), [3] S. Heinze et al. Nature Phys. 7, 713 (2011), [4] N.S. Kiselev et al. Phys. Rev. Lett. 107, 179701 (2011); J. Phys. D: Appl. Phys. 44, 392001 (2011).

MA 26.3 Wed 11:15 H 0112

FMR in one-dimensional assemblies of magnetite nanocrystals and anisotropy evolution during growth — •Michalis Charilaou[1], Michael Winklhofer[2], Inés García-Rubio[3], and Andreas U Gehring[1] — [1]Earth and Planetary Magnetism, Department of Earth Sciences, ETH Zurich, 8092 Zurich, Switzerland — [2]Department of Earth and Environmental Science, University of Munich, 80333 Munich, Germany — [3]Laboratory of Physical Chemistry, Department of Chemistry and Applied Biosciences, ETH Zurich, 8093 Zurich, Switzerland

We have simulated FMR spectra of dilute suspensions of linear magnetite chains oriented randomly in space by modeling the chain as a Stoner-Wohlfarth-type rotation ellipsoid whose long axis coincides with an easy [111] axis of the cubic magnetocrystalline anisotropy system. The validity of the model is examined by comparing the results to explicit calculations of the interactions among the particles in the chain. The single ellipsoid model reproduces the experimentally observed FMR traits of such chain assemblies and can be related to the explicit chain model by adjusting the contribution to the uniaxial anisotropy along the chain axis to account for the magnetostatic interactions. Moreover, we investigate the evolution of anisotropy in these systems by fitting FMR signals at different growth-stages of the nanoparticles.

MA 26.4 Wed 11:30 H 0112

Temperature dependence of normal modes of ferrimagnets — •Frank Schlickeiser[1], Unai Atxitia[2], Soenke Wienholdt[1], Denise Hinzke[1], Oksana Chubykalo-Fesenko[2], and Ulrich Nowak[1] — [1]University of Konstanz, Germany — [2]Institute of material science Madrid, Spain

Recently, opto magnetic writing using a circularly polarised laser pulse in the 40 femtosecond range was successfully demonstrated [1-3]. It is assumed that the magnetisation switching is forced by a combination of a heat pulse and a magnetic field created due to the inverse Faraday effect. However, so far this effect has only been found for a special class of materials as the ferrimagnet GdFeCo. The reason for this restriction is not fully understood yet and therefore of great interest. We investigate the dynamics of a ferrimagnet by means of computer simulations as well as analytically, where the behaviour of the precession frequency as well as the effective damping parameter of the ferromagnetic and exchange mode is investigated. Both approaches coincide well for different strengths of an external magnetic field as well as for different strengths of an uni axial anisotropy. Our results, representing a generalisation and improvement of former approximated solutions (e.g.[4]), therefore build a basis for a better theoretical comparison to recent experiments[5]. [1] C.D.Stanciu et al., Phys. Rev. Lett.**99**, 047601 (2007), [2] A.V. Kimel, C. D. et al., Nature **435**, 655 (2010), [3] K.Vahaplar et al., Phys. Rev. Lett. **103**, 117201 (2009), [4] R.Wangsness, Phys. Rev. B **93**, 68 (1954), [5] C.D.Stanciu et al., Phys. Rev. B **73** , 220402 (2006).

MA 26.5 Wed 11:45 H 0112

Temperature-dependent Heisenberg exchange coupling constants from linking electronic-structure calculations and Monte Carlo simulations — •Danny Böttcher[1,2], Arthur Ernst[1], and Jürgen Henk[1,2] — [1]Max Planck Institute of Microstructure Physics, Halle, Germany — [2]Martin Luther University Halle-Wittenberg, Halle, Germany

In various theoretical approximations Heisenberg exchange coupling constants J_{ij} are calculated for zero temperature and, therefore, provide e.g. too small a critical temperature T_C in comparison to the experimental value. In contrast, J_{ij} computed within the disordered local moments (DLM) formalism (i. e. for a paramagnetic sample), overestimate T_C. This mismatch leads to the idea of temperature-dependent exchange parameters.

We propose a method to calculate the temperature dependence of J_{ij} [1]. Within the DLM formalism, the magnetization and the J_{ij} are computed from first principles for any concentration c of the magnetic constituents. The exchange coupling constants are then used in Monte Carlo (MC) simulations to compute the temperature dependence of the magnetization for the given c. By comparing the magnetization from DLM calculations and from MC simulations we obtain a mapping of temperature versus concentration and eventually temperature-dependent J_{ij}. The approach which is applied to bulk Fe and Co can for example improve critical exponents.

[1] D. Böttcher, A. Ernst, and J. Henk, J. Magn. Magn. Mat. **324** (2012) 610.

MA 26.6 Wed 12:00 H 0112

Magnetic Force Microscopy on single crystalline Fe70Pd30 ferromagnetic shape memory films — •Anja Graumann[1], Yanhong Ma[1], Alexander Malwin Jakob[1,2], Frank Frost[1], and Stefan Georg Mayr[1,2] — [1]Leibniz-Institut für Oberflächenmodifizierung e.V., Permoserstr. 15, 04318 Leipzig, Germany — [2]Translationszentrum für Regenerative Medizin und Fakultät für Physik und Geowissenschaften, Universität Leipzig, 04318 Leipzig, Germany

Fe70Pd30 ferromagnetic shape memory thin films of 500 nm thickness grown on MgO (100) single crystal substrates at approximately 900 °C show a twin-related relief at the sample surface imaged by scanning electron and atomic force microscopy. Using X-ray diffraction measurements with Cu Kα radiation the existance of a martensitic face centered tetragonal phase at room temperature - a necessary condition for the shape memory effect - could be confirmed. To characterize micromagnetic properties, magnetic force microscopy has been performed. Central focus lies on correlations between magnetic and structural properties of the film. The measurements are interpreted with the help of micromagnetic simulations, which reveal a complex magnetic structure governed by shape and crystallographic anisotropies. This work is funded by the German Research Foundation.