MA 20: Micromagnetism / Computational Magnetics

Time: Wednesday 17:00–18:15 Location: H22

MA 20.1 Wed 17:00 H22

Transmission and reflection of spin waves in the presence of Néel walls. — •Sebastian Macke and Dagmar Goll — Max-Planck-Institut für Metallforschung, Heisenbergstr. 3, 70569 Stuttgart

Within the framework of the continuum theory of micromagnetism the interaction of spin waves with domain walls is presented.

For a thin stripe a coupled differential equation system based on the linearization of the Landau-Lifshitz-Gilbert equation is derived including exchange interaction, crystal anisotropy and demagnetization field. The ground state of the stripe is a homogeneous magnetization state on both sides of the stripe separated by a Néel-type domain wall. On one side of the stripe monochromatic spin waves with well-defined frequency and orientation are excited. Then the reflected and transmitted fractions of the spin wave are analyzed. For wavelengths larger than the wall width we observe a reflection of the waves while for smaller wavelengths the spin waves transmit by 100%. The phase of the spin wave can shift on a wide range. A resonance effect inside the domain wall can occur for special wave vectors. It will be shown that especially the demagnetizing field plays a fundamental role. The accuracy of the method is tested for special cases using micromagnetic finite element simulations. Different materials are analyzed dependent on the thickness of the stripe and the direction of the spin wave.

MA 20.2 Wed 17:15 H22

Domain wall motion damped by the emission of spin waves — •Robert Wieser, Elena Y. Vedmedenko, and Roland Wiesendanger — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Jungiusstrasse 11, D-20355 Hamburg, Germany

The domain wall motion of field driven transverse domain walls in biaxial ferromagnets is investigated by solving the Landau-Lifshitz-Gilbert equation. It is demonstrated that with increasing easy plane or hard axis anisotropy D_h different types of domain wall motion occur: The different scenarios correspond to different velocity equations. In the limit of absent hard axis anisotropy ($D_h/J = 0$) a precessional domain wall motion can be found, while for $D_h/J \neq 0$ a steady domain wall motion interrupted by a Walker breakdown at high fields prevails. In the limit of huge anisotropies ($D_h/J \gg 0$) a domain wall motion damped by emission of spin waves occurs. The emitted spin waves have been analyzed with aid of a spatial and a temporal Fourier transformation to give the corresponding energy dispersion. Furthermore, the connection between magnetic systems and the theory of solitons is discussed.

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MA 20.3 Wed 17:30 H22

Magnetic friction - from thin films to slabs — •Martin P. Magiera[1], Dietrich E. Wolf[1], and Ulrich Nowak[2] — [1]Faculty of Physics and CeNIDE, University of Duisburg-Essen, 47048 Duisburg, Germany — [2]Department of Physics, University of Konstanz, 78457 Konstanz, Germany

Energy dissipation in magnetically interacting systems attract increasing interest recently (e.g. [1]). We study the magnetic contribution to friction force by atomistic computer simulations [2]: A substrate is modeled in the framework of the anisotropic Heisenberg model. Parallel to the substrate a dipole is moved with constant velocity, affecting the substrate spins by dipolar interaction. We integrate the stochastic Landau-Lifshitz-Gilbert equation for each substrate spin. Friction force can be calculated from the energy dissipation rate.

For T=0, friction can be understood by virtue of a macrospin model; it is "viscous" and proportional to the damping constant α [2]. Depending on substrate thickness, tip strength and scanning velocity, we observe a transition between two states, which directly changes the strength of magnetic friction by one order of magnitude. At T>0, the strict α-proportionality breaks down, and inverts above T_0. For this regime we present an intriguing consistence of an algebraic temperature-decay of friction with the critical decay of the susceptibility above T_c.

[1] D. Kadau, A. Hucht and D.E. Wolf, PRL **101**, 137205 (2008)
[2] M.P.Magiera, L. Brendel, D.E. Wolf and U. Nowak, EPL **87**, 26002 (2009)

MA 20.4 Wed 17:45 H22

Effect of the Anisotropy Distribution on the Coercive Field and Switching Field Distribution of Bit Patterned Media — •Philipp Krone[1], Denys Makarov[1], Thomas Schrefl[2], and Manfred Albrecht[1] — [1]Chemnitz University of Technology, Institute of Physics, D-09107 Chemnitz, Germany — [2]St. Pölten University of Applied Sciences, A-3100 St. Pölten, Austria

Bit patterned media (BPM) is a promising concept for future magnetic storage devices providing ultra-high recording densities beyond 1 Tbit/inch^2. The concept of BPM implies the formation of an ordered two dimensional array of magnetic nanostructures with an out-of-plane magnetic anisotropy, where an individual nanostructure will store a single bit of information. A systematic study on the magnetization reversal in square arrays of magnetic nanostructures will be presented. To account for the unavoidable inhomogeneities of the magnetic properties, a distribution of magnetic anisotropy values was taken into account. We show that the variation in magnetic anisotropy and the influence of magnetic dipole-dipole interaction between the individual bits with separation distance is crucial for the performance of bit patterned media concerning in particular the switching field distribution [1]. Interestingly, a narrowing of the switching field distribution was found with the angle between the direction of the external magnetic field and easy axis of magnetization, which is an important aspect for the usability of bit patterned media with tilted anisotropy at ultra-high storage densities beyond 1 Tbit/inch^2.

[1] Krone et al., J. Appl. Phys. 106 (10), 103913 (2009)

MA 20.5 Wed 18:00 H22

Micromagnetic study of field-driven domain wall dynamics in Permalloy nanotubes — •Christian Andreas, Ming Yan, Attila Kákay, and Riccardo Hertel — Institut für Festkörperforschung, Elektronische Eigenschaften, Forschungszentrum Jülich GmbH

At sufficiently large propagation velocity, magnetic domain walls (DWs) in thin strips reach the Walker limit[1], a dynamic micromagnetic instability characterized by complex domain wall transformations and a drastic reduction of the DW speed. Using our hybrid FEM/BEM micromagnetic code, we found that DWs in nanotubes are much more stable against such transformations than DWs in thin strips. We studied in detail the field-driven motion of vortex DWs[2] in Permalloy nanotubes with outer diameter of 60 nm and various inner diameters. In the case of nanotubes, the breakdown process involves the nucleation of a vortex-antivortex pair, while in thin strips a single (anti-)vortex is nucleated at the lateral boundary. These differences are due to topological reasons and also lead to different values of the critical field, since the threshold for pair creation is higher than for the nucleation of a single (anti-)vortex. In conclusion we find that DWs in nanotubes can propagate much faster than in thin strips. The possibility to fabricate such magnetic nanotubes[3] should allow for the experimental verification of the predicted fast DW motion.

[1] N. L. Schryer and L. R. Walker, J. Appl. Phys. **45**, 5406 (1974)
[2] R. Hertel et al., J. Magn. Magn. Mater. **278** 291 (2004)
[3] K. Nielsch et al., J. Appl. Phys. **98** 034318 (2005)