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MA 29.7 Wed 16:45 HSZ 401

Ultrafast electrical control of the exchange interaction — •Johan H. Mentink and Martin Eckstein — Max Planck Research Department for Structural Dynamics, University of Hamburg-CFEL, 22607 Hamburg, Germany

Ultrafast magnetism is concerned with the dynamics of magnetic materials on a timescale of their intrinsic magnetic interactions [1]. The strongest of them is the exchange interaction, which determines the ordering of microscopic spins. In many situations the ultrafast dynamics of magnetization can conveniently be described using (quasi) equilibrium models in which only the (effective) temperature and the magnetization depend on time, leaving the exchange interaction essentially unchanged. Nevertheless, since the exchange interaction is determined by the interactions between the electrons, it can potentially be controlled with electric fields. In this contribution we demonstrate theoretically that ultrafast electrical control of the exchange interactions is indeed possible by studying the Hubbard model out of equilibrium in the regime relevant to Mott insulators and charge-transfer insulators. Furthermore, we show that such ultrafast modification of the exchange interaction can experimentally be detected by measuring the spin resonances that are excited by it.

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MA 29.8 Wed 17:00 HSZ 401

Microscopic electronic configurations during ultrafast magnetisation dynamics — Inka Locht[1], Igor Di Marco[1], Silvano Garnerone[2], Raghuveer Chimata[1], Anna Delin[1], Olle Eriksson[1], and •Marco Battiato[1,3] — [1]Department of Physics and Astronomy, Uppsala University, Uppsala, Sweden — [2]Institute for Quantum Computing, University of Waterloo, Waterloo, Canada — [3]Institute of Solid State Physics, Vienna University of Technology, Vienna, Austria

Recent experiments [1,2] have shown the new possibility of generating an increase of magnetisation in Fe upon direct injection of spin from a neighbouring layer. This reopens the unsolved question about the microscopical configuration after ultrafast magnetisation dynamics, requiring an answer that addresses both dynamics on equal footing.

We provide a model for the description of the electronic and magnetic configurations of ferromagnetic Fe undergoing both ultrafast decrease and increase of magnetization. The model is based on the assumption that after the the ultrafast magnetization change is complete the system has achieved a local thermodynamic equilibrium. With statistical arguments it is possible to show that the magnetic configurations in the case of reduced or increased magnetic moment are qualitatively different. The predicted magnetic configurations are then used to compute T-MOKE spectra at the 3p (M) absorption edges which are in excellent agreement with the existing experiments.

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MA 29.9 Wed 17:15 HSZ 401

Gilbert damping tensor within the breathing Fermi surface model: anisotropy and non-locality — •Danny Thonig[1,2] and Jürgen Henk[2] — [1]Max Planck Institute of Microstructure Physics, Halle, Germany — [2]Martin Luther University Halle-Wittenberg, Halle, Germany

An essential property of magnetic devices is the relaxation rate in magnetic switching which depends strongly on the damping in the magnetization dynamics. The latter enters the Landau-Lifshitz-Gilbert equation as Gilbert damping α and is commonly taken as a phenomenological parameter. Recent experiments predict, however, a complicated behavior of dissipation in low-dimensional systems, which is hardly to explain by a local scalar α. This mismatch calls for a theoretical understanding based on *ab initio* results.

We apply the breathing Fermi surface model [1] in the framework of a renormalized Green function tight-binding approach. Slater-Koster parameters were obtained by genetic-algorithm optimization with respect to first-principles results. Magnetic as well as structural disorder are treated by the coherent potential approximation. The results are non-local Gilbert tensors $\boldsymbol{\alpha}_{ij}$ which depend on the electron, spin and phonon temperatures as well as on the directions of the local magnetic moments.

Our approach is applied to the bulk and to surfaces of Stoner magnets. The non-local tensorial behavior of the damping leads to significant differences with respect to the conventional local scalar treatment.

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MA 29.10 Wed 17:30 HSZ 401

Supermagnonic Bloch point propagation in cylindrical nanowires — •Christian Andreas[1,2], Attila Kákay[1], and Riccardo Hertel[2] — [1]Peter Grünberg Institut (PGI-6), Forschungszentrum Jülich GmbH, D-52428 Jülich, Germany — [2]Institut de Physique et Chimie des Matériaux de Strasbourg, Université de Strasbourg, CNRS UMR 7504, Strasbourg, France

Bloch points (BPs) [1,2] are micromagnetic singularities that can play a decisive role in magnetic switching processes. The archetypal example is a soft-magnetic cylinder [3], where a BP resides in the center of a vortex domain wall (VDW). Micromagnetic theory is not capable to treat BPs and their dynamics correctly, as they represent topological defects and singularities. We used our multiscale-multimodel code [4] that combines an atomistic Heisenberg model with a finite element micromagnetic algorithm to trace Bloch points and to study the dynamics of VDWs driven by an external magnetic field. The results show that, owing to the high stability of VDWs, the combination of BP and VDW can smoothly propagate at supermagnonic velocities above 1000 m/s when it is driven by fields of only a few mT. We further find a limiting BP/VDW propagation velocity that remains unchanged for a broad range of magnetic field values; a feature that could be advantageous for domain-wall based magnetic storage or logic devices.

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[4] C. Andreas, A. Kákay, R. Hertel, arXiv:1311.1617 [cond-mat] (2013)

MA 29.11 Wed 17:45 HSZ 401

Energy dissipation of moved magnetic vortices — •Martin Magiera — Fakultät für Physik, Universität Duisburg-Essen

A two-dimensional easy-plane ferromagnetic substrate, interacting with a dipolar tip which is magnetized perpendicularly with respect to the easy plane is studied numerically by solving the Landau-Lifshitz Gilbert equation. The dipolar tip stabilizes a vortex structure which is dragged through the system and dissipates energy [EPL **100**, 27004 (2012)]. Based on Thiele's equation, an analytical expression for the energy dissipation for the limiting case of a vanishing scanning velocity as well as its validity are discussed [EPL **103**, 57004 (2013)]. A magnetic friction number is defined which represents a general criterion for the validity of Thiele's equation and quantifies the degree of nonlinearity in the response of a driven spin configuration.

MA 29.12 Wed 18:00 HSZ 401

ON THE KRAMERS VERY LOW DAMPING ESCAPE RATE FOR POINT PARTICLES AND CLASSICAL SPINS — •William T. Coffey[1], William J. Dowling[2], Yuri P. Kalmykov[3], and Serguey V. Titov[4] — [1]Department of Electronic and Electrical Engineering, Trinity College, Dublin 2, Ireland — [2]Department of Electronic and Electrical Engineering, Trinity College, Dublin 2, Ireland — [3]University of Perpignan, Perpignan, France — [4]Kotelnikov Institute of Radio Engineering and Electronics, RAS, Russia

The seminal Kramers result for the very low dissipation (VLD) escape rate of point particles from a potential well is rigorously derived by writing following Stratonovich, the Langevin equation (LE) in energy (slow) and configuration (fast) variables which now contain a multiplicative noise term. The corresponding Fokker-Planck equation (FPE) in configuration-energy space may then be written via the Kramers-Moyal expansion merely by calculating the drift and diffusion coefficients from the LE given the Stratonovich interpretation. The configuration-energy LE method may be transparently generalized following transformations given very recently by Dunn et al. [T. Dunn et al., in Fluctuating Nonlinear Oscillators, Ed. by M.I. Dykman, Oxford University Press, Oxford, 2012], to the stochastic motion of classical spins executing Stoner-Wohlfarth orbits in nonaxially symmetric anisotropy-Zeeman potentials which is governed by the Landau-Lifshitz-Gilbert equation yielding an exact expression for the VLD mean first passage time whence the Kramers VLD rate for spins.