MA 16: Spin Dynamics: Magnetic relaxation and Gilbert Damping

Time: Monday 17:30–18:45 Location: HSZ 401

MA 16.1 Mon 17:30 HSZ 401

Room Temperature Spin Pumping into Cobalt Doped Zinc Oxide Evidenced by Multifrequency FMR — •Martin Buchner, Taddäus Schaffers, Bastian Henne, Verena Ney, and Andreas Ney — Johannes Kepler Universität, Linz, Austria

A precessing magnetization in a ferromagnet returns to its equilibrium position due to Gilbert damping. This damping can be increased by spin pumping, an angular momentum transfer to an adjacent non ferromagnetic layer [1]. By performing ferromagnetic resonance (FMR) measurements increased damping will result in a broadening of the linewidth. In classical, resonator-based FMR setups there is no possibility to distinguish between increased damping due to spin pumping and inhomogeneous broadening effects. This can only be achieved when measuring a frequency dependent linewidth. In this contribution we use a setup which replaces the resonator by a coaxial cable that is short-circuited at the sample side [2]. The magnetic field is induced into the sample via a microwave near field affect. In a two layer system consisting of permalloy and highly Co doped ZnO [3] film, both resonance position and the linewidth of the FMR lines, change. In the measured frequency range a 75 % increased damping parameter is found.

[1] Y. Tserkovnyak et al. Phys. Rev. Lett. 88, 117601 (2002).
[2] F. M. Römer et al. Appl. Phys. Lett. 100, 092402 (2012).
[3] B. Henne et al. Sci. Rep. 5, 16863 (2015).

MA 16.2 Mon 17:45 HSZ 401

Lifetime of terahertz magnons in ultrathin ferromagnets: Temperature effects — Huajun Qin[1], •Khalil Zakeri Lori[2,1], Arthur Ernst[1], and Juergen Kirschner[1] — [1]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle, Germany — [2]Heisenberg Spin-dynamics Group, Physikalisches Institut, Karlsruhe Institute of Technology, Wolfgang-Gaede-Str. 1, D-76131 Karlsruhe, Germany

Utilizing spin-polarized high resolution electron energy loss spectroscopy we investigate the temperature dependence of high-energy (terahertz) magnons, excited in an ultrathin ferromagnet. Both the energy and lifetime of terahertz magnons are measured as a function of temperature and across the magnetic transition temperature T_C. Similar to the magnons' energy, their lifetime decreases with temperature. The observed temperature-induced damping of terahertz magnons is discussed in terms of multi-magnon scattering mechanism. Our results indicate that the damping resulted from this mechanism can be comparable to the intrinsic Landau damping of the system. We demonstrate that although at T_C terahertz magnons are affected by different damping mechanisms, they still behave as well-defined collective excitations. We argue that the effects associated with the collective properties of terahertz magnons should eventually sustain at T_C and even beyond that.

MA 16.3 Mon 18:00 HSZ 401

Thermal emergence of laser induced spin dynamics for a Ni_4 cluster — •Stefan Sold[1], Wolfgang Hübner[1,3], Bhaskar Kamble[2], Georgios Lefkidis[1], and Jamal Berakdar[3] — [1]University of Kaiserslautern and Research Center OPTIMAS, Kaiserslautern, Germany — [2]Asia Pacific Center for Theoretical Physics, Pohang, Korea — [3]Martin-Luther-Universität Halle-Wittenberg, Halle, Germany

Using *ab initio* quantum chemistry we study the interplay of thermally-induced and laser-induced dynamics on the highly correlated magnetic Ni_4 cluster. We find that due to this interplay new cooperative dynamics emerges, which is a result of the combination of the quantum coherences introduced to the system by the laser pulse and the electronic relaxation due to the bath: A bath temperature of $10 < T < 300$ can help induce a spin flip, in cases the laser alone cannot.

Technically we propagate the density matrix of the system within the Markovian approximation, where the Lindblad superoperator describes the coupling to the bath [1]. By isolating the various electronic and spin relaxation channels we identify two different time regimes, both for the spins and for the charges [2], which we further analyze. We thus derive and discuss all phenomenological relaxation constants. Our quantum-thermodynamics findings on this prototypic system pave the way toward possible molecular spin-caloritronic applications.

[1] G. Schaller and T. Brandes, Phys. Rev. A **78**, 022106 (2008)
[2] G. P. Zhang, W. Hübner, G. Lefkidis, Y. Bai, and T. F. George, Nature Phys. **5**, 499 (2009)

MA 16.4 Mon 18:15 HSZ 401

Relaxation of a classical spin coupled to a strongly correlated electron system — •Mohammad Sayad, Roman Rausch, and Michael Potthoff — I. Institut für Theoretische Physik, Universität Hamburg

Electron correlations are expected to have qualitatively new effects on the spin dynamics. Up to now, this has been studied only indirectly by computing the effect of the Coulomb interaction on the Gilbert damping. Here, we investigate correlation effects beyond an LLG-type approach. To this end, we consider a prototypical model with a classical spin which is anti-ferromagnetically exchange coupled to a Hubbard system and study the spin dynamics as a function of the local Coulomb interaction U. To address this quantum-classical hybrid problem, we propose a combination of a non-Markovian linear-response theory for the spin dynamics with time-dependent density-matrix renormalization group for the correlated electron system. In the metallic phase at quarter filling, we find two different channels for energy and spin dissipation, namely dissipation via correlated hopping and via excitations of local magnetic moments. For strong U, these become active on largely different time scales. While the overwhelming contribution to the Gilbert damping is due to magnetic excitations in the strong-U limit, the magnetic contribution is much smaller in general and even vanishes for infinite U as it is never activated. At half-filling and strong U, electron correlations lead to an incomplete spin relaxation on intermediate time scales. This represents a novel effect in a quantum-classical hybrid model which is similar to prethermalization.

MA 16.5 Mon 18:30 HSZ 401

Spin-lattice Relaxation of NV-Centers in Diamond — •Johannes Gugler and Peter Mohn — Center for Computational Materials Science TU Vienna

Nitrogen-Vacancy centers in Diamond exhibit a very long electronic spin-relaxation time T1. Thus, they are a promising candidate for solid-state qubit implementation. The temperature dependence of T1 at the mK-temperature scale was not understood up to now. We performed DFT-calculations to obtain the structural, electronic and phononic properties of the NV-center in Diamond to investigate on the spin-lattice relaxation rate. Using the numerically obtained wavefunctions we calculate the electron-phonon transition matrix element of first order time dependent perturbation theory. Taking into account spin-orbit coupling and the electronic screening of the electron-ion potential we obtain the right temperature dependence and order of magnitude for the experimentally found relaxation times.