MA 7: Magnetic Relaxation and Gilbert Damping

Time: Monday 11:00–12:00 Location: H43

MA 7.1 Mon 11:00 H43

Strong photon-magnon-coupling between superconducting niobium lumped-element-resonators and micron sized magnets — •Philipp Geyer[1], Philip Trempler[1], Karl Heimrich[1], and Georg Schmidt[1,2] — [1]1Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, Von-Danckelmann-Platz 3, 06120 Halle (Saale), Germany — [2]2Interdisziplinäres Zentrum für Materialwissenschaften, Martin-Luther-Universität Halle-Wittenberg, Nanotechnikum Weinberg, 06120 Halle (Saale), Germany

Since quantum computing plays a more and more important role in information technology hybrid quantum magnonics emerge as a promising research field. Here, the coupling between different quantum states like microwave photons and magnons at cryonic temperatures is in focus [1]. We investigate the coupling between superconducting niobium Lumped-Element-Resonators and thin micron-sized magnetic structures. Therefore, we use the magnetic material permalloy and yttrium-iron-garnet (YIG). Permalloy was structured by optical lithography and grown by argon-ion sputtering at room-temperature. YIG was grown as free standing structure [2] or commercial LPE film and further processed and placed on the cavity by focused-ion-beam technique. We detect strong coupling as avoided crossing in the transmission related S-Parameter measured by a vector-network-analyzer. For validation of our experimental results, we perform electromagnetic simulations with CST Studio Suite and micromagnetic simulations with MuMax3. [1] H. Huebl et.Al. Phys. Rev. Lett. 111, 127003 (2013) [2] P. Trempler et. Al. Appl. Phys. Lett. 117, 232401 (2020) 401 (2020)

MA 7.2 Mon 11:15 H43

Magnetization dynamics affected by phonon pumping — •Richard Schlitz[1], Luise Siegl[2], Takuma Sato[3], Weichao Yu[4], Gerrit E. W. Bauer[3], Hans Huebl[5], and Sebastian T. B. Goennenwein[2] — [1]Department of Materials, ETH Zürich, 8093 Zürich, Switzerland — [2]Department of Physics, University of Konstanz, 78457 Konstanz, Germany — [3]Tohoku University, Sendai 980-8577, Japan — [4]State Key Laboratory of Surface Physics and Institute for Nanoelectronic Devices and Quantum Computing, Fudan University, Shanghai 200433, China — [5]Walther-Meißner-Institute, Bayerische Akademie der Wissenschaften, 85748 Garching, Germany

Coupling magnetic and acoustic excitations enables novel functionalities for magnonic devices. We explore broadband ferromagnetic resonance (FMR) in a $Y_3Fe_5O_{12}$ film on a $Gd_3Ga_5O_{12}$ substrate. At low frequencies, the Kittel mode hybridizes with standing ultrasound waves that form across the layer stack resulting in a characteristic modification of the magnetic susceptibility. At higher frequencies, the individual phonon resonance overlap, leading to a permanent emission of phonons and thus an enhanced relaxation of the FMR. The broadband frequency dependence of the magnetoelastic coupling and thus the phonon pumping follows theoretical predictions. We additionally find substantial magnon-phonon coupling of a perpendicular standing spin wave mode. This evidences the importance of the mode overlap between the acoustic and magnetic modes and thus paves the way to tailoring the magnetoelastic mode coupling.

[1] R. Schlitz et al., arxiv:2202.03331 (2022)

MA 7.3 Mon 11:30 H43

Gilbert damping in the real-space KKR method — Balázs Nagyfalusi[1], László Szunyogh[2], and •Krisztián Palotás[1,2] — [1]Wigner Research Center for Physics, Budapest, Hungary — [2]Institute of Physics, Budapest University of Technology and Economics, Budapest, Hungary

The ab-initio determination of Gilbert damping parameters is an important issue for accurate atomistic spin dynamics calculations. Going beyond presently available methods of calculating the Gilbert damping scalar parameter in bulk materials, we implemented the torque-torque correlation formula [1] into the real-space Korringa-Kohn-Rostoker (KKR) method [2] using the Budapest SKKR code to be able to treat chemically inhomogeneous systems. This enables the ab-initio determination of spatially resolved on-site and non-local Gilbert damping tensors [3] in atomic nanostructures. After performing extensive tests for metallic bulk materials to identify the relevant parameter settings of the calculations, we show some examples of inhomogeneous Gilbert damping results in various metallic atomic (nano-)structures.

[1] H. Ebert et al., Phys. Rev. Lett. 107, 066603 (2011). [2] B. Lazarovits et al., Phys. Rev. B 65, 104441 (2002). [3] D. Thonig et al., Phys. Rev. Mater. 2, 013801 (2019).

MA 7.4 Mon 11:45 H43

Bath-induced spin inertia — Mario A. Gaspar Quarenta[1], •Tim Ludwig[1], Huaiyang Yuan[1], and Rembert A. Duine[1,2] — [1]Institute for Theoretical Physics, Utrecht University, Princetonplein 5, 3584 CC Utrecht, The Netherlands — [2]Department of Applied Physics, Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindhoven, The Netherlands

In spintronics, magnetization dynamics is often described by the Landau-Lifshitz-Gilbert equation, where Gilbert damping is included phenomenologically to account for dissipation. In microscopic models, dissipation can be described by coupling the magnetization to a bath that can absorb energy and angular momentum. Gilbert damping is then obtained if one assumes the bath to be Ohmic; that is, if one assumes the bath spectral density to be linear in frequency. Real baths, however, can be Ohmic only at low frequencies and, as we will argue, the baths' high-frequency modes induce magnetization inertia. Explicitly, we show for a macrospin coupled linearly to a bath of harmonic oscillators (Caldeira-Leggett model) that the low-frequency bath modes (if Ohmic) lead to Gilbert damping while the high-frequency bath modes universally lead to macrospin inertia. We expect our results to give new insights into recent experiments on magnetization nutation. But our results might prove to be relevant in general, as they indicate that a Gilbert-damping term should always be accompanied by a term accounting for bath-induced spin inertia.