Centre de Nanosciences & de Nanotechnologies

Seminar

Tuesday September 24th 2019 - 11h 00

Amphitheater of C2N

"Magnetization Dynamics in Nanostructures and Thin Films"

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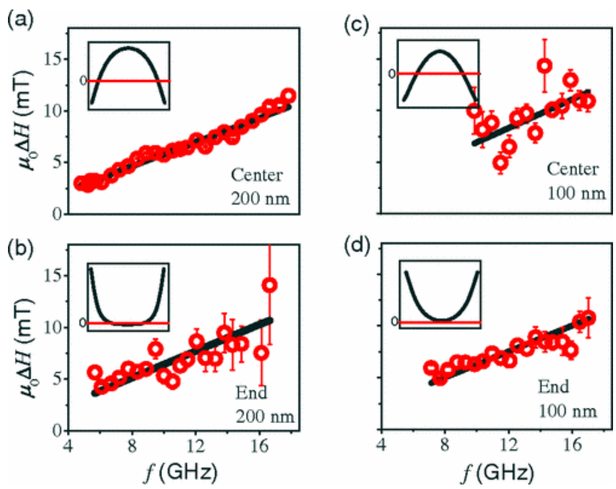
In the first part of my talk I will discuss the outstanding question in the broad field of spin dynamics with ferromagnets whether the damping of gyromagnetic precession is in actuality subject to finite size effects at the nanometer length scale. We demonstrate that the effective damping in nanomagnets depends strongly on the excited spin-wave mode and on the size of the nanomagnet. The damping constant a is a critical parameter for spintronics devices, e.g., spin-torque-transfer magnetic random-access memory (STT-MRAM). Optical measurements of the magnetization dynamics are particularly challenging when the diffraction-limited laser spot is much larger than the size of the nanomagnet. We developed a novel heterodyne magneto-optical microwave microscope (H-MOMM) to measure ferromagnetic resonance in individual, well-separated nanomagnets by use of heterodyne detection of magneto-optical signals at microwave frequencies. The experimental results are in good agreement with calculations based on the theory of dissipative transverse spin-currents internal to a conductive magnetic film, where the spin-currents are proportional to the spatial curvature of the excited mode [1], [2].



In the second part I will demonstrate how the Dzyaloshinskii-Moriya Interaction (DMI) can be directly determined from the frequency of propagating spin-waves. The DMI has recently attracted great interest as it is the origin of many chiral phenomena including chiral domain-walls and skyrmions. We quantified the DMI induced frequency-shift with Brillouin-Light-Scattering spectroscopy (BLS). I will present DMI measurements on several different multilayer systems. We demonstrated in a series of $Ni_{80}Fe_{20}$/Pt samples for a range of $Ni_{80}Fe_{20}$ thicknesses that the DMI is proportional to the Heisenberg exchange which has been predicted earlier by Fert [3] and Moriya [4] for metallic oxides and magnetic spin-glasses [5]. In a second study we studied the influence of an oxide layer on the DMI in Cu/CoFe and Pt/CoFe samples. We found that an oxide layer increases the DMI [6]. Finally, I will show results for a series of CoFeB/Cu(x)/Pt system, where we find that the DMI and the proximity magnetization in Pt are correlated.

[1] H.T. Nembach, J.M. Shaw, C.T. Boone and T.J. Silva, Physical Review Letters, 110, 117201 (2013), Highlight in Nature Nanotechnology 8, 227 (2013)

Hans T. Nembach is a Senior Research Associate at JILA, University of Colorado and Research Associate at the National Institute of Standards and Technology (NIST) in Boulder, Colorado. He received his PhD in physics from the Technical University Kaiserslautern, Germany in 2006, where he worked in the group of Prof. Burkhard Hillebrands. He began work at NIST in 2006 under the auspices of a DAAD postdoctoral fellowship. In 2015 he received the NIST Physical Measurement Laboratory Distinguished Associate Award. His research interests are magnetization dynamics in thin films, multilayers and magnetic nanostructures.

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