DC CURRENT CONTROLLED THREE MAGNON SCATTERING PROCESS IN SPIN-TORQUE NANO-OSCILLATORS

H. Schultheiss[1], A. Laraoui[1], F. Ciubotaru[1], M. Manfrini[2], M. van Kampen[2], L. Lagae[2], A. N. Slavin[3], B. Leven[1], B. Hillebrands[1]
[1] *Fachbereich Physik and Forschungsschwerpunkt MINAS, TU Kaiserslautern, Kaiserslautern, Germany*
[2] *IMEC, Leuven, Belgium*
[3] *Oakland University, Rochester, MI, USA*

The discovery of the spin torque effect [1,2], by which a spin-polarized direct current can induce a stable precession of the free layer of a magnetic spin valve element [3], has enabled a novel type of oscillator, which can serve as a current-controlled, frequency agile microwave source with applications in integrated electronics and telecommunications devices. Studying the magnetization dynamics of such spin torque oscillators are of large interest for the fundamental understanding of the interaction between a spin polarized current and a magnetic thin film.

Here we report the Brillouin light scattering microscopy investigations of spin waves radiation from a single point contact (with 80 nm in diameter) into an extended Py free layer of one spin-valve structure under the influence of an applied ac and dc current. The magnetic resonance frequencies of the free layer (near to the point contact) are determined for different externally applied magnetic fields. Strong nonlinear effects are observed and discussed within the framework of three-magnon-scattering. The spin-wave radiation patterns are investigated with a spatial resolution of 250 nm for several ac frequencies and applied magnetic fields.

For getting more information about the effect of dc current on these nonlinear processes we studied the power dependency of the emitted spin waves as a function of the applied microwave power and the dc current. Intriguing is the linear shift of the power threshold for these nonlinear processes when a dc current is applied. Depending on the dc current direction the threshold and efficiency of the three-magnon-scattering can be strongly enhanced or reduced. This can be understood as a clear control of the internal damping due to three magnon scattering processes by a dc current (spin torque effect).

Support by the DFG within the SPP 1133 and by the EC-MRTN SPINSWITCH (MRTN-CT-2006-035327) is acknowledged.

[1] J.C. Slonczewski, JMMM **159**, L1– L7 (1996)
[2] L. Berger, Phys. Rev. B **54**, 9353–9358 (1996)
[3] W.H. Rippard *et al,* Phys. Rev. Lett. **92**, 027201 (2004)