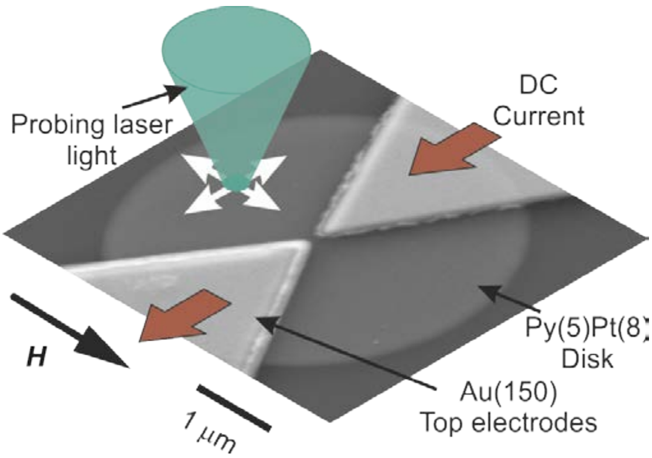
Magnetic dynamics driven by spin current

S. O. Demokritov
University of Muenster, Corrensstrasse 2-4, 48149 Muenster, Germany
E-mail: demokrit@wwu.de

The interplay between spin transport and magnetization, a collective property of the electrons, plays a central role in spin-based electronic devices. The effect of spin current on the magnetic configuration results from the modification of the dynamical properties of nanomagnets by the spin transfer torque (STT). In particular, STT changes the effective magnetic damping.

We use micro-focus Brillouin light scattering spectroscopy to study magnetic fluctuations in a Permalloy microdisc located on top of a Pt strip carrying an electric current. Magnetic dynamics in our nano-devices is driven by pure spin currents generated due to the spin Hall effect in the Pt electrode. We show that the fluctuations can be efficiently suppressed or enhanced by different directions of the electric current. Additionally, we find that the effect of spin current on magnetic fluctuations is strongly influenced by nonlinear magnon-magnon interactions, which prohibit auto-generation in this geometry [1].

Using a local injection of spin current by Pt into an extended Permalloy film we demonstrate that above a certain current threshold, our device enters a single-mode coherent auto-oscillation regime with the frequency of oscillation 5-10 GHz [2]. The corresponding strongly-localized dynamic mode with the diameter below 100 nanometers, has characteristics reminiscent of the nonlinear stationary spin-wave “bullet”[3]. Similar to conventional spin-torque nano-oscillators (STNO) the realized spin-Hall-effect nano-oscillator reperesents a tuneable microwave generator with a linewidth of about 10 MHz. Moreover, we show that it can be synchronized to the external microwave signal.



Layout of the test device.

[1] Demidov et al. *Phys. Rev. Lett*. **107**, 107204 (2011).

[2] Demidov et al. *Nature Materials* **11**, 1028 (2012).

[3] Slavin, A. & V. Tiberkevich, *Phys. Rev. Lett*. **95**, 237201 (2005).