MA 48: PhD Student Symposium: "Spintronics on the Way to modern Storage Technology II", Organization: "Univ. Mainz team"

Time: Thursday 13:00–15:00 Location: BH 243

Invited Talk MA 48.1 Thu 13:00 BH 243
Ultrafast manipulation of magnetic order — •Theo Rasing — Radboud University Nijmegen

The interaction of sub-picosecond laser pulses with magnetically ordered materials has developed into an extremely exciting research topic in modern magnetism and spintronics. From the discovery of sub-picosecond demagnetization to the recent demonstration of magnetization reversal by a single 40 femtosecond laser pulse, the manipulation of spins by ultra short laser pulses has become a fundamentally challenging topic with a potentially high impact for future spintronics, data storage and manipulation and quantum computation. In addition, when the time-scale of the perturbation approaches the characteristic time of the exchange interaction (~10-100 fs), the soin dynamics enters a novel, highly non-equilibrium, regime where the exchange interaction might even become time dependent. Using ultrashort excitations, we may be able to manipulate the exchange interaction itself. Such studies require the excitation and probing of the spin and angular momentum contributions to the magnetic order at timescales of 10fs and below, a challenge to be met by future fs X-ray FEL*s.

References A.V.Kimel, et al, Nature 435 (2005), 655-657 C.D.Stanciu, et al, Phys.Rev.Lett.99, 047601 (2007) A.V.Kimel, et al, Nature Physics 10, 727-731 (2009) K.Vahaplar, et al, Phys.Rev.Lett.103, 117201 (2009) A.Kirilyuk, et al, Rev. Mod. Phys. 82, 2731-2784 (2010) I.Radu et al, Nature 472, 205 (2011)

Topical Talk MA 48.2 Thu 13:30 BH 243
Spin-transfer processes: Magnetic coupling, spin-transfer torque, and pure spin currents — •Daniel E. Bürgler — Peter Grünberg Institute, Electronic Properties (PGI-6) and Jülich-Aachen Research Alliance, Fundamentals of Future Information Technology (JARA-FIT), Forschungszentrum Jülich, D-52425 Jülich, Germany

Modern magnetic storage technology relies on manipulating and detecting magnetization states of nanometer-sized ferromagnetic (FM) entities. Spin-transfer processes in FM/non-FM/FM structures give rise to spintronic concepts featuring such functionalities. Equilibrium spin-transfer without net spin or charge transport is the origin of (anti)ferromagnetic interlayer coupling, which played a key role for the discovery of giant magnetoresistance. A spin-polarized current, i.e. flow spin momentum and charge, exerts a torque on the magnetization when entering a FM material by transferring spin angular momentum from the current to the magnetization. These spin-transfer torques give rise to current-driven magnetization dynamics with unprecedented properties like magnetization reversal without applying an external field or the excitation of persistent large-angle magnetization precessions with frequencies in the GHz range, which are the basis for spin-transfer nano-oscillators. Pure spin currents, finally, transport spin momentum without net motion of charge. This situation results for instance from spin accumulation in a non-magnetic metal. Non-local transport measurements in lateral spin valve exploit spin accumulation to generate and detect pure spin currents. Devices based on pure spin currents potentially operate with significantly reduced dissipation.

MA 48.3 Thu 14:00 BH 243
Improved reliability of magnetic field programmable gate arrays through the use of memristive tunnel junctions — •Jana Münchenberger, Patryk Krzysteczko, Günter Reiss, and Andy Thomas — Bielefeld University, Thin Films and Physics of Nanostructures, 33615 Bielefeld

Since the recent, successful implementation of the long-hypothesized memristor, its use in neuronal computing and in the reproduction of biological neural networks has gained increasing attention. In addition to the development of these new applications, the growing number of devices with memristive properties is promising to improve already established technologies. We use the recently reported memristance in magnesium-oxide-based magnetic tunnel junctions (MTJs) to improve the error tolerance in magnetic random access memory and magnetic field programmable logic. The MTJs have a thin barrier of 1.3 nm and were structured by e-beam lithography and ion beam etching. They show a tunnel-magnetoresistance (TMR) ratio of 100% and a memristive effect of about 6%. Using this effect, we can show that it is possible to tailor the resistance of the MTJs and thus compensate for resistance fluctuations that occur as a result of the fabrication process. Furthermore, the MTJs maintain stable resistances and do not need to be periodically refreshed.

MA 48.4 Thu 14:15 BH 243
Manipulation of Skyrmions created by opto-magnetic switching — •Stefan Gerlach, Denise Hinzke, and Ulrich Nowak — University of Konstanz, 78457 Konstanz, Germany

Magnetic bubbles are spots of opposite magnetization and can be observed in ferromagnetic thin films and nanoelements with high perpendicular anisotropy[1]. Their dynamics is determined by a topological number called the Skyrmion number which relates them to the well-known and similiar Skyrmions[2].

Opto-magnetic switching is known to reverse the magnetization of small spots in thin films within picoseconds[3]. We use Landau-Lifshitz-Bloch (LLB)-based simulations which allow for the linear reversal mechanism[4] combined with a two temperature model to describe the opto-magnetic switching. We will show how bubble domains can be created and discuss their dynamics when manipulated with external magnetic fields.

[1] C. Moutafis, et al., Phys. Rev. B 79, 224429 (2009)
[2] N. S. Kiselev et al., J. Phys. D: Appl. Phys. 44, 392001 (2011)
[3] K. Vahaplar et al., Phys. Rev. Lett. 103, 117201 (2009)
[4] N. Kazantseva et al., Phys. Rev. B 77, 184428 (2008)

Topical Talk MA 48.5 Thu 14:30 BH 243
Magnetoelastic Magnetization Control and Magnetization Dynamics at Low Temperatures — •Hans Huebl[1], Andreas Brandlmaier[1], Christoph Zollitsch[1], Johannes Lotze[1], Mathias Weiler[1], Fredrik Hocke[1], Georg Woltersdorf[2], Ruldof Gross[1], and Sebastian T.B. Goennenwein[1] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Physik-Department, Universität Regensburg, Regensburg, Germany

In magnetic storage applications magnetization direction manipulation and magnetization switching speed are two key parameters. While magnetization orientation is usually controlled by means of Oersted fields, magnetization control via elastic strain fields represents an alternative approach. Here, we implement such a "spin-mechanics" concept in a hybrid structure consisting of a ferromagnetic thin-film deposited onto a piezoelectric actuator. The combination of piezoelectric and magnetoelastic effects allows to change the magnetization orientation by up to 90° solely via the voltage applied to the actuator. In a second set of experiments, we investigate magnetization damping, which directly relates to the magnetization switching speed. We discuss broadband ferromagnetic resonance as a tool to investigate magnetization damping as a function of temperature between 300 K and 50 mK, and address the impact of photon-magnon coupling.

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