SYMS 2 Magnetic Switching II

Time: Monday 17:00–18:50 Room: HSZ 04

Invited Talk SYMS 2.1 Mon 17:00 HSZ 04

Spin-Hall effect in a two-dimensional electron system — •Peter Schwab[1], Michael Dzierzawa[1], Roberto Raimondi[2], and Cosimo Gorini[2] — [1]Universität Augsburg, Germany — [2]Università di Roma Tre, Italy

In a two-dimensional electron gas with spin-orbit coupling an electric field can generate spin currents and spin polarization. We study the problem using the method of quasiclassical Green's functions. In the clean limit we establish a connection between the spin-Hall conductivity and a Berry phase in momentum space. For disordered systems we calculate spin currents and spin accumulation numerically for a strip connected to a voltage source. Universal spin currents are found in the short-time dynamics, leading to a spin-Hall spin polarization near the edges of the strip.

Invited Talk SYMS 2.2 Mon 17:20 HSZ 04

Submicrometer ferromagnetic logic gates — •Russell Cowburn — Blackett Physics Laboratory, Imperial College London, Prince Consort Road, London SW7 2BW, UK

Spintronics, in which both the spin and charge of electrons are used for logic and memory operations, promises an alternative route to traditional semiconductor electronics. A complete logic architecture can be constructed that uses planar magnetic wires less than a micrometer in width. Logical NOT, logical AND, signal fan-out and signal cross-over elements each have a simple geometric design and can be integrated together into one circuit. An additional element for data-input allows information to be written to domain wall logic circuits. Working nanocircuits comprising all of these logic elements will be described, as well as a proposal for a new ultrahigh density data storage device based on domain walls circulating in 3-dimensional magnetic networks (Science 309, 1690, 2005).

Invited Talk SYMS 2.3 Mon 17:50 HSZ 04

Spin torque: wall dynamics in nanowires vs. switching in nanopillars — •Jacques Miltat and André Thiaville — Laboratoire de Physique des Solides, Univ. Paris-Sud and CNRS, ORSAY, France

Spin transfer induced switching in nanopillars may be viewed as an efficient process mainly due to the existence of a parametric pumping phase preceeding switching. Thus, a minute torque combined to the micromagnetic response of the nanoelement allows for switching at relatively low current densities. Spin pressure may also induce wall motion in ferromagnetic nanowires. Assuming current polarization adiabaticity and full transfer of angular momentum to the local magnetization, the usual spin torque term translates into $-\left(\vec{u}\cdot\vec{\nabla}\right)\vec{M}$, where $\vec{u}$ represents a velocity vector proportional to the current density and impinging electrons polarization. Unfortunately, according to the adiabatic theory, walls in nanowires, be it of the Transverse or Vortex type, are found to move only for current densities about one order of magnitude larger than experimental values. Also, wall structures are found to transform continuously during motion, a phenomenon directly linked to the so-called Walker velocity limit. A better agreement between theory and experiment may be achieved via the introduction of an additional torque term, the origin of which remains unclear at this stage. It is anticipated that theory and experiments might be best compared under pulsed current conditions, special attention being paid to the displacement of a depinned wall during the time necessary for a structure transition at a specified current density.

Invited Talk SYMS 2.4 Mon 18:20 HSZ 04

Interactions between domain walls and spin currents — •M. Klaeui[1], M. Laufenberg[1], D. Backes[1], P.-O. Jubert[2], R. Allenspach[2], A. Bischof[2], L. Vila[3], C. Vouille[3], G. Faini[3], and U. Ruediger[1] — [1]Fachbereich Physik, Universitaet Konstanz, D-78457 Konstanz — [2]IBM Research, Zurich Research Laboratory, CH-8803 Rueschlikon — [3]LPN - CNRS, Route de Nozay, F-91460 Marcoussis

A promising novel approach for switching magnetic nanostructures is current-induced domain wall propagation (CIDP) where due to a spin torque effect, electrons transfer angular momentum to a head-to-head domain wall and thereby push it in the direction of the electron flow without any externally applied fields. We use magnetoresistance measurements and spin polarized scanning electron microscopy to directly observe domain wall propagation in-situ in ferromagnetic nanostructures induced by current pulses [1]. We determine the propagation distances as a function of pulse height and pulse length as well as the critical current densities, where domain propagation sets in as a function of temperature. High resolution microscopy allows us to image the nanoscale spin structure of the walls after injection of currents and shows that the current modifies the spin structure dramatically [1]. Comparison to recent theoretical description [2] yields qualitative agreement on some aspects of domain wall transformation, whereas the theories do not reproduce the observed strong temperature dependence of the spin torque effect [2].

[1] M. Klaui et al., Phys. Rev. Lett. 94, 106601 (2005), Phys. Rev. Lett. 95, 26601 (2005); [2] A. Thiaville et al., Europhys. Lett. 69, 990 (2005); G. Tatara et al., Appl. Phys. Lett. 86, 252509 (2005);