TT 51: Transport: Nanoelectronics II - Spintronics and Magnetotransport (jointly with HL and MA)

Time: Friday 9:30–12:00 Location: BH 243

TT 51.1 Fri 9:30 BH 243

Adiabaticity mediated mesoscopic spin transport — •Tobias Dollinger, Henri Saarikoski, and Klaus Richter — Universität Regensburg, Germany

We examine mesoscopic transport in ballistic and diffusive waveguide geometries with Zeeman coupling by means of a numerical recursive Green's function algorithm and interprete the results using a semi-classical transport formalism. Our discussion is focused on analyzing magnetoconductance traces of two-dimensional systems with spatially nonuniform magnetic moment. We illustrate how controlling magnetic field textures within a sample allows for an efficient manipulation of spin transmission properties, which are determined by nonadiabatic transition probabilities.

TT 51.2 Fri 9:45 BH 243

Electronic transport through EuO spin filter tunnel junctions — •Nuttachai Jutong[1], Ivan Rungger[2], Stefano Sanvito[2], Udo Schwingenschlögl[3], and Ulrich Eckern[1] — [1]Institut für Physik, Universität Augsburg, 86135 Augsburg, Germany — [2]School of Physics and CRANN, Trinity College Dublin, Dublin, Ireland — [3]KAUST, PSE Division, Thuwal 23955-6900, Kingdom of Saudi Arabia

Spin filter tunnel junctions based on europium monoxide (EuO), a ferromagnetic semiconductor, are investigated by means of density functional theory. In particular, the spin transport of Cu/EuO/Cu junctions is investigated by using the self-consistent ab-initio electron transport code SMEAGOL. The dependence of the transmission coefficient on the interface spacing and on the EuO thickness is studied, and explained in terms of the density of states and the complex band structure of EuO. Our calculation indicates that EuO epitaxially grown on Cu can act as a perfect spin filter, with polarization close to 100%, which is related mainly to the Eu-4f states. The transmission coefficient is sensitive to the interface spacing, since this spacing determines the charge transfer between EuO and the Cu leads.

TT 51.3 Fri 10:00 BH 243

Spin transistor action from Onsager reciprocity and SU(2) gauge theory — Inanc Adagideli[1], •Vitalij Lutsker[2], Matthias Scheid[2], Philippe Jacquod[3], and Klaus Richter[2] — [1]Faculty of Engineering and Natural Sciences, Sabanci University, Istanbul, Turkey — [2]Institut für Theoretische Physik, Universität Regensburg, 93040 Regensburg, Germany — [3]Physics Department, University of Arizona, Tucson, USA

We construct a local gauge transformation to show how, in confined systems, a generic, weak non-homogeneous $SU(2)$ spin-orbit Hamiltonian reduces to two $U(1)$ Hamiltonians for spinless fermions at opposite magnetic fields, to leading order in the spin-orbit strength. Using an Onsager relation, we further show how the resulting spin conductance vanishes in a two-terminal setup, and how it is turned on by either weakly breaking time-reversal symmetry or opening additional transport terminals. We numerically check our theory for mesoscopic cavities as well as Aharonov-Bohm rings.

TT 51.4 Fri 10:15 BH 243

Magnetic impurities on Bi thin films — •Daniel Lükermann[1], Sergii Sologub[2], Christoph Tegenkamp[1], and Herbert Pfnür[1] — [1]Leibniz Universität Hannover, Institut für Festkörperphysik, Appelstr. 2, 30167 Hannover — [2]Institute of Physics, National Ac. of Sc. Ukraine, Nauky Av. 46, 03028 Kyiv, Ukraine

The semimetal bismuth has attracted a lot of interest because of its unique electronic properties such as a low carrier concentration and a large mobility. Furthermore, the surface states reveal a pronounced Rashba splitting and the conductivity can be well discriminated from bulk contributions if thin films are grown on Si(111) substrates, making surface related effects accessible even in macroscopic conductance measurements.

In order to elucidate the effect of spin-related scattering at impurities, magnetic and non-magnetic metals were adsorbed on thin films of epitaxially grown Bi(111) and investigated by means of conductance and magneto-conductance measurements. We observe a very strong reduction of conductance by roughly 30 % for adsorbate concentrations of less than 2% of a monolayer both for Bi- and Co-atoms, whereas Fe-atoms only show an effect of 15 %, ruling out the simple assumption of enhanced spin-flip-scattering of the spin-polarized carriers at magnetic impurities. An evaluation of magneto-conductance and Hall-effect data reveals that the charge transfer from the impurity atoms into the surface states of bismuth plays an important role and can not be neglected in interpreting the data.

TT 51.5 Fri 10:30 BH 243

Adiabatic pumping through an interacting quantum dot with spin-orbit coupling — •Stephan Rojek[1], Jürgen König[1], and Alexander Shnirman[2] — [1]Theoretische Physik, Universität Duisburg-Essen and CeNIDE, 47048 Duisburg, Germany — [2]Institut für Theorie der Kondensierten Materie and DFG-Center for Functional Nanostructures (CFN), Universität Karlsruhe, 76128 Karlsruhe, Germany

We study adiabatic pumping through a two-level quantum dot coupled to two normal metallic leads in the presence of spin-orbit coupling. The variation of the two energy levels of the dot periodically in time leads to finite charge and spin currents.

We calculate the pumped charge and spin using a diagrammatic real-time approach [1]. Going beyond the limit of noninteracting electrons on the quantum dot [2], we study the situation of strong Coulomb interaction. In both limits of noninteracting and strongly interacting electrons, spin-orbit coupling provides the possibility for pure spin current. We introduce an isospin to describe the level degree of freedom. This isospin feels an exchange field similar to the exchange field in a quantum-dot spin valve. The exchange field originates form the Coulomb interaction and its strength is sensitive to the symmetry in the tunneling matrix elements. New features concerning the pure spin pumping as well as the absolute pumped charge of the two-level quantum dot with spin-orbit coupling arises from the Coulomb interaction.

[1] J. Splettstoesser *et al.*, Phys. Rev. B **74**, 085305 (2006).
[2] V. Brosco *et al.*, Phys. Rev. B **82**, 041309(R) (2010).

15 min. break.

TT 51.6 Fri 11:00 BH 243

Anomalous Hall conductivity in Ni and its alloys — •D. Ködderitzsch, K. Chadova, J. Minar, and H. Ebert — Universität München, Department Chemie, Butenandtstraße 5-13, D-81377 München, Germany

The anomalous Hall conductivity (AHC) in Ni as discussed on the basis of the intrinsic contribution shows a strong overestimation of the AHC [1]. Recent studies using the LSDA+U approximation seem to remedy this problem [2]. However, still missing is taking into account the temperature dependence of the AHC which has recently been re-investigated [3] and changes the picture.

Using our recently implemented [4] first-principles approach to describe transverse transport based on the Kubo-formalism in the Kubo-Středa formulation we study the anomalous Hall conductivity (AHC) in Ni. To take into account the effect of correlations we extended our method to employ the LSDA+U, as well as the LSDA+DMFT to go beyond the LSDA approximation to DFT. Furthermore, we study the influence of finite temperatures on the AHC by using an alloy-analogy for a quasistatic representation of the thermal displacements of the atoms. In addition, we performed calculations for dilute impurities in the Ni host.

[1] Nagaosa *et al.* Rev. Mod. Phys. **82**, 1539 (2010) and references therein
[2] Weischenberg *et al.* PRL **107**, 106601 (2011); Fuh and Guo PRB **84**, 144427 (2011)
[3] Xiao, Jin
[4] Lowitzer, Gradhand, Fedorov, Mertig, Ködderitzsch, Ebert, PRL **105**, 266604 (2010) and PRL **106**, 056601 (2011)

TT 51.7 Fri 11:15 BH 243

Investigation of magnetic point contacts irradiated by microwave and THz radiation — •Stefan Egle, Torsten Pietsch, and Elke Scheer — Department of Physics, University of Konstanz

The growing field of spintronics became one of the most intensively studied topics in modern solid-state physics. The possibility not only exploiting the charge of an electron, but also its spin (or magnetic moment), offers the possibility to explore various interesting effects. In this talk, we investigate magnetic point contacts and heterostructures, where a ferromagnet (F) acts as a spin polarizer, injecting hot electrons into a non-magnetic metal (N) or a diluted ferromagnet (f). Thereby, an external magnetic field in case of N is used to generate a Zeeman-splitting between spin-up and spin-down electrons. In case of F/f-contacts, this energy splitting ΔE is given by the exchange energy of f. These energies correspond to electromagnetic frequencies in the GHz (N) and THz regime (f). The highly non-equilibrium spin-population of F is then used to create a spin inversion in N or f, leading to a spin-flip photon emission. By matching the resonant condition hν=ΔE and using an external source in the microwave and THz range, theory predicts an induced spin lasing effect in N/f. Presently, we investigate the influence of the external irradiation on the electronic resistance via transport spectroscopy. In particular, we will present our measurements on the magnetotransport properties, studying the complex interplay between the crucial parameters, namely magnetization, current density and geometry of the point contacts. The results illustrate that a successful spin-population inversion can be detected.

TT 51.8 Fri 11:30 BH 243

Gate dependent TMR-effect in a SWCNT-based spin valve device with exchange biased ferromagnetic contacts — Andreas Prüfling, •Daniel Steininger, Maurice Ziola, Matthias Sperl, Andreas K. Hüttel, and Christoph Strunk — Universität Regensburg, Germany

We report on magneto-transport measurements on a single wall carbon nanotube based spin valve device with Permalloy ($Ni_{81}Fe_{19}$) and $Ni_{81}Fe_{19}/Fe_{50}Mn_{50}$ bilayer contacts. Sputtered thin films and EBL-patterned strip-arrays of these materials were characterized by means of vibrating sample- and SQUID magnetometry and optimized by varying both layer thickness ratios, and material grain size via the sputtering power. Utilizing the magnetic exchange bias effect in these ferromagnet/anti-ferromagnet bilayer systems, the difference in cooercive fields of our contacts is sufficently large to achieve controllable independent switching of two contacts by an external magnetic field. Magneto-transport measurements performed in the Coulomb blockade- and Kondo regime of a SWCNT quantum dot device show systematic gate dependence of the tunneling magnetoresistance (TMR) when the gate voltage is scanned through several Coulomb diamonds.

TT 51.9 Fri 11:45 BH 243

Rotating skyrmion lattices by spin torques and field gradients — •Karin Everschor[1], Markus Garst[1], Benedikt Binz[1], Christian Pfleiderer[2], and Achim Rosch[1] — [1]Institute for Theoretical Physics, University of Cologne, Germany — [2]Physics-Department E21, Technical University Munich, Germany

Chiral magnets like MnSi form lattices of skyrmions, i.e. magnetic whirls, which react sensitively to small electric currents. The interplay of these currents and thermal gradients can induce either a rotation of the magnetic pattern by a finite angle or – for higher current densities or larger gradients – a steady rotation defined by a constant angular velocity. We develop a theory of rotational forces induced by gradients in magnetic field or temperature. Reactive forces (Magnus and Lorentz forces) arise from Berry phases while several mechanisms affect the dynamics of magnets by damping. We use the Landau Lifshitz Gilbert equation extended by extra damping terms in combination with a phenomenological treatment of pinning forces to develop a theory of the relevant rotational torques.