DS 45: Transport: Spintronics, Spincalorics and Magnetotransport (jointly with HL, MA)

Time: Friday 9:30–11:30 Location: HSZ 03

DS 45.1 Fri 9:30 HSZ 03

Search for magneto-hydrodynamics in the delafossite metals $PdCoO_2$ and $PtCoO_2$ — •Nabhanila Nandi[1], Pallavi Kushwaha[1], Seunghyun Khim[1], Philip J.W. Moll[1], Burkhard Schmidt[1], Thomas Scaffidi[2], Markus König[1], and Andrew P. Mackenzie[1,3] — [1]Max Planck Institute for Chemical Physics of Solids, Nöthnitzer Straße 40, 01187 Dresden, Germany — [2]Department of Physics, University of California, Berkeley, California 94720, USA — [3]Scottish Universities Physics Alliance, School of Physics and Astronomy, University of St. Andrews, St. Andrews KY16 9SS, United Kingdom

Electrical resistance is conventionally determined by the momentum-relaxing scattering of electrons by the host solid and its excitations. Hydrodynamic fluid flow through channels, in contrast, is determined by geometrical factors, boundary scattering and the viscosity of the fluid, which is governed by momentum-conserving internal collisions. In almost all known materials, however, the signatures of viscosity in electron flow cannot be resolved, because the rate of momentum-relaxing collisions dominates that of the momentum-conserving ones that give the viscous term. In previously published work, we reported experimental evidence that there is a regime in restricted channels of the ultra-pure two-dimensional delafossite metal $PdCoO_2$ in which the resistance has a large viscous contribution. In this talk I will report on our current work in which we extend our experiments to magneto-hydrodynamics, discussing data both from $PdCoO_2$ and a second delafossite metal, $PtCoO_2$.

DS 45.2 Fri 9:45 HSZ 03

Fe_3O_4 thin films: controlling and manipulating an elusive quantum material — •xionghua liu, chun-fu chang, aurora diana rata, alexander christoph komarek, and liu hao tjeng — Max Planck Institute for Chemical Physics of Solids, Nöthnitzerstr. 40, 01187 Dresden, Germany

Fe_3O_4 (magnetite) is one of the most elusive quantum materials and at the same time one of the most studied transition metal oxide materials for thin film applications. The theoretically expected half-metallic behavior generates high expectations that it can be used in spintronic devices. Yet, despite the tremendous amount of work devoted to preparing thin films, the enigmatic first order metal-insulator transition and the hall mark of magnetite known as the Verwey transition, is in thin films extremely broad and occurs at substantially lower temperatures as compared to that in high quality bulk single crystals.

In this work, we investigate systematically the effect of oxygen stoichiometry, thickness, strain, and microstructure on the Verwey transition in epitaxial Fe_3O_4 thin films on a variety of substrates. We have been able to determine the factors that affect negatively the Verwey transition in thin films. We have succeeded in finding and making a particular class of substrates that allows the growth of magnetite thin films with the Verwey transition as sharp as in the bulk. Moreover, we are now able to tune the transition temperature and, using tensile strain, increase it to substantially higher values than in the bulk.

DS 45.3 Fri 10:00 HSZ 03

Spin-switching via quantum dot spin valves — •Niklas M. Gergs[1], Scott A. Bender[1], Rembert A. Duine[1,2], and Dirk Schuricht[1] — [1]Institute for Theoretical Physics, Utrecht University, Utrecht, The Netherlands — [2]Department of Applied Physics, Eindhoven University of Technology, Eindhoven, The Netherlands

We theoretically investigate a spin-valve transistor setup, ie, correlated transport through a quantum dot positioned between two spin-polarised nano magnets. This causes the dynamical generation of a magnetic field on the dot even in the absence of external fields [1].

Here we consider the back action of the quantum dot onto the attached nano magnets via exerted spin torques. This may be used to switch the nano magnets reliably from a parallel to an anti-parallel alignment and vice versa. All operations are done in the Coulomb-blockade regime of the quantum dot, so that the charge transport through the setup is strongly suppressed.

[1] M. Braun, J. König, J. Martinek, Phys. Rev. B 70, 195345 (2004)

DS 45.4 Fri 10:15 HSZ 03

Strong non-equilibrium effects in spin torque systems — •Tim Ludwig[1], Igor S. Burmistrov[2,3], Yuval Gefen[4], and Alexander Shnirman[1] — [1]Institut für Theorie der Kondensierten Materie, Karlsruhe Institute of Technology, D-76128 Karlsruhe, Germany — [2]L.D. Landau Institute for Theoretical Physics RAS, Kosygina street 2, 119334 Moscow, Russia — [3]Laboratory for Condensed Matter Physics, National Research University Higher School of Economics, 101000 Moscow, Russia — [4]Department of Condensed Matter Physics, Weizmann Institute of Science, 76100 Rehovot, Israel

We consider a problem of persistent magnetization precession in a single domain ferromagnetic nano particle under the driving by the spin-transfer torque [1]. We find that the adjustment of the electronic distribution function in the particle renders this state unstable. Instead, abrupt switching of the spin orientation is predicted upon increase of the spin-transfer torque current. On the technical level, we derive an effective action of the type of Ambegaokar-Eckern-Schön action for the coupled dynamics of magnetization (gauge group SU(2)) and voltage (gauge group U(1)).

[1] T. Ludwig, I. S. Burmistrov, Y. Gefen, and A. Shnirman, arXiv:1610.09944 (2016)

DS 45.5 Fri 10:30 HSZ 03

Spin-charge coupled dynamics driven by a time-dependent magnetization — •Sebastian Tölle[1], Ulrich Eckern[1], and Cosimo Gorini[2] — [1]Institute of Physics, University of Augsburg, 86135 Augsburg, Germany — [2]Faculty of Physics, University of Regensburg, 93040 Regensburg, Germany

The spin-charge coupled dynamics in a thin, magnetized metallic system are investigated. The effective driving force acting on the charge carriers is generated by a dynamical magnetic texture, which can be induced, e.g., by a magnetic material in contact with a normal-metal system. We consider a general inversion-asymmetric substrate/normal-metal/magnet structure, which, by specifying the precise nature of each layer, can mimick various experimentally employed setups. Inversion symmetry breaking gives rise to an effective Rashba spin-orbit interaction. We derive general spin-charge kinetic equations which show that such spin-orbit interaction, together with anisotropic Elliott-Yafet spin relaxation, yields significant corrections to the magnetization-induced dynamics. To highlight their physical meaning, the spin pumping configuration of typical experimental setups is analyzed in detail. In the two-dimensional limit the build-up of a DC voltage is dominated by the spin galvanic (inverse Edelstein) effect. A measuring scheme that could isolate this contribution is discussed.

DS 45.6 Fri 10:45 HSZ 03

Emergent magnetic ordering in transition metal atomic contacts — •Martin Keller, Florian Strigl, Elke Scheer und Torsten Pietsch — Department of Physics, University of Konstanz, 78457 Konstanz, Germany

MD simulations and DFT calculations predict the development of local magnetic order at reduced dimensions in some paramagnetic transition metals (Pt, Pd, Ir), especially in atomic configurations [1,2,3]. This unusual property allows us to investigate the influence of the local magnetic properties on the conductance of atomic contacts without the effect of magnetic leads. Therefore atomic contacts of these metals are a model system to understand the origin of magnetoconductance and the role of spin-polarization of the conduction electrons. Herein we discuss recent results of Pt, Pd and Ir in the context of a microscopic model that successfully describes the observed magnetoconductance signature in these atomic contacts and chains [4]. Additionally, electronic transport spectroscopy is used to evaluate magnetic excitations in the electronic system of the contact, i.e. the presence of i) a zero-bias anomaly which is described by Kondo physics and ii) conductance fluctuations in the atomic contact, which indicate the formation of a magnetically ordered state. We will compare the three transition metals with respect to their different electronic structure and the role of spin-orbit coupling in the contacts.

[1] Phys. Rev. Lett. 92, 057201 (2004)
[2] Phys. Rev. B 78, 014423 (2008)
[3] Phys. Rev. B 81, 054433 (2010)
[4] Nature Comm. 6, 6172 (2015); Phys. Rev. B 94, 144431 (2016)

DS 45.7 Fri 11:00 HSZ 03

Electron transport through the helical systems: chiral magnetoresistance effect — •Volodymyr V. Maslyuk, Rafael Gutiérrez, and Gianaurelio Cuniberti — Institute for Material Science and Max Bergmann Center for Biomaterials, Dresden University of Technology, Hallwachstr. 3, 01069 Dresden, Germany

Recently, the chirality-induced spin selectivity (CISS) effect [1] has been discovered in which electron transport through systems with helical symmetry shows the different transmission for the electrons with different spin-polarizations. In this work, we show that CISS can be utilized in the new class of magnetic field sensors via novel chiral magnetoresistance effect (CMR) [2]. We present a theoretical investigation of the electron transport through the poly-GLY in helical form placed between one magnetic and one nonmagnetic leads by using the DFT and NEGF approach. We obtain that MR of the order 2

[1] Göhler B., Hamelbeck V., Markus T. Z., Kettner M., Hanne G. F., Vager Z., Naaman R., and Zacharias H., Science 331, 894 (2011)
[2] Kiran V., Mathew S.P., Cohen S.R., Delgado I.H., Lacour J., Naaman R., Adv. Mater. 28, 1957 (2016)

DS 45.8 Fri 11:15 HSZ 03

A Landauer-Büttiker approach for hyperfine mediated electronic transport in the integer quantum Hall regime — •Aniket Singha[1], M. Hamzah Fauzi[2], Yoshiro Hirayama[2], and Bhaskaran Muralidharan[1] — [1]Department of Electrical Engineering, IIT Bombay, Powai, Mumbai-400076, India — [2]Graduate School of Science, Tohoku University, Aoba-ku, Sendai-980-8578, Japan

The interplay of spin-polarized electronic edge states with the dynamics of host nuclei in quantum Hall systems presents rich and non-trivial transport physics. Here, we develop a Landauer-Büttiker approach to understand various experimental features observed in integer quantum Hall set ups featuring quantum point contacts. Such approach entails a phenomenological description of spin resolved inter-edge scattering induced via hyperfine assisted electron-nuclear spin flip-flop processes along with a self consistent simulation framework between the nuclear spin dynamics and edge state electronic transport in order to gain insights into the nuclear polarization effects on electronic transport vice-versa. In particular, we show that the hysteresis noted experimentally in the conductance-voltage trace as well as in the resistively detected NMR lineshape results from a lack of quasi-equilibrium between electronic transport and nuclear polarization evolution. In addition, we present circuit models to further facilitate a clear understanding of the electronic transport processes occurring near the quantum point contact.