MA 15: Spintronics and Magnetic Semiconductors (jointly with HL)

Time: Tuesday 9:30–12:00 Location: H3

MA 15.1 Tue 9:30 H3

Low versus high energy excitations in the Skyrmion lattice system Cu_2OSeO_3 — •Dirk Wulferding[1], Peter Lemmens[1], Vladimir Gnezdilov[2], Yurii Pashkevich[3], Christian Pfleiderer[4], and Helmuth Berger[5] — [1]IPKM, TU-BS, Braunschweig — [2]ILTPE, Kharkov, Ukraine — [3]DonFTI, Donetsk, Ukraine — [4]Physikdepartment, TU München — [5]EPFL, Lausanne, Switzerland

Cu_2OSeO_3, a ferromagnetic insulator with a skyrmion lattice phase previously known from intermetallics, shows low as well as high energy excitations that strongly depend on small applied magnetic fields. In particular, the low energy anomalies are discussed in relation to the Skyrmion lattice. Work supported by DFG, B-IGSM and NTH School for Contacts in Nanosystems.

MA 15.2 Tue 9:45 H3

Electron Dynamics in a Ferrocene-Based Mixed-Valence Compound — •Nicolas Yeche[1], Lucas Mäde[1], Alexander Hildebrandt[2], Ulrike Pfaff[2], Simon Liebing[3], Marco Günther[1], Heinrich Lang[2], Jens Kortus[3], and Hans-Henning Klauss[1] — [1]TU Dresden, Dresden, Germany — [2]TU Chemnitz, Chemnitz, Germany — [3]TU Freiberg, Freiberg, Germany

Mixed-valence compounds are metal-organic molecules in which the metal centres, a priori identical, are in different oxidation states. These compounds usually stabilize through a strong electron delocalization between the various metallic atoms. Thanks to Mössbauer spectroscopy measurements, we followed the charge dynamics in the monocationic form of 2,5-Diferrocenyl,1-Phenyl-1H-Pyrrole. There, two a priori symmetrical ferrocene moieties contain one Fe(III) and one Fe(II).

We present results obtained from the solid state as well as in dispersed molecules in a tetrahydrofurane glass. From the fluctuation of the electric field gradient (EFG) at the iron nuclei sites we follow the charge fluctuation rate from room temperature down to 4.2K. Results on the average EFG are then compared with DFT calculations.

MA 15.3 Tue 10:00 H3

Flux quantization in spintronic devices — •Wei Chen, Peter Horsch, and Dirk Manske — Max Planck Institute for Solid State Research, Stuttgart

We show that electric flux vector, defined as the cross product of electric field and trajectory, manifests quantization in various spintronic devices in the same sense as quantization of magnetic flux in a SQUID. This quantization is related to many fascinating phenomena such as field-adjustable spin Josephson effect, the current-voltage characteristics of spin-FET, and persistent spin current in a metallic ring. In the case where the quantization is purely due to Aharanov-Casher effect, the flux quantum is determined only by fundamental constants.

MA 15.4 Tue 10:15 H3

Three-magnon splitting process and efficiency of spin pumping in YIG/Pt bilayer — •Oleksandr Dzyapko[1], Vladislav Demidov[1], Hidekazu Kurebayashi[2], and Sergej Demokritov[1] — [1]Institute for Applied Physics, University of Münster, Münster, Germany — [2]Cavendish Laboratory, University of Cambridge, Cambridge, UK

Spin pumping is a process of generation of electron spin current from magnetic dynamics (spin-wave spin current). Recently, it has been shown that in YIG/Pt bilayers a process of three magnon splitting, influencing magnetic dynamics in the ferromagnet can enhance the efficiency of spin current generation in to adjacent metallic layer [1]. However, in the similar experiment performed by another group, the authors claim to observe the enhancement of a spin current in a YIG/Pt-system with a thin YIG-layer, for which the tree-magnon splitting is forbidden [2]. In order to clarify the role of the three magnon splitting process we performed a set of experiments in YIG/Pt bilayers with YIG-film of different thicknesses. The existing theory predicts that the frequency range in which the three magnon splitting process is allowed shrinks with decreasing film thickness. In agreement with the theory, the enhanced efficiency of spin current generation was observed at those frequencies, where the three magnon splitting processes is allowed, clearly demonstrating a close correlation between these two effects.

1.H. Kurebayashi, et al., Nature Mater. 10, 660 (2011).
2.V. Castel, et al., Phys. Rev. B 86, 134419 (2012).

MA 15.5 Tue 10:30 H3

Optimization of spin pumping in YIG/Pt structures — •Matthias Benjamin Jungfleisch, Viktor Lauer, Roland Neb, Andrii V. Chumak, and Burkard Hillebrands — Fachbereich Physik and Landesforschungszentrum OPTIMAS, Technische Universität Kaiserslautern, D-67663 Kaiserslautern, Germany

Spin pumping in yttrium iron garnet (YIG)/platinum (Pt) structures is an interface effect and, thus, it is of crucial importance to investigate the influence of surface processing of the ferromagnetic YIG layer before the Pt deposition.

Here, we present for the first time, systematic studies on the YIG/Pt interface, which improve the spin pumping efficiency. The spin currents generated by spin pumping in the Pt layer are detected by the inverse spin Hall effect (ISHE). Three sets of YIG/Pt samples with different YIG thicknesses and constant Pt thickness of 10 nm were investigated. Spin pumping was driven by the ferromagnetic resonance excited by an external microwave signal. We measure the FMR spectra using a conventional microwave technique, as well as the ISHE induced voltage, allowing us to calculate the spin pumping efficiency defined as the ratio of the detected ISHE charge current to the absorbed microwave power. We succeeded in improving the spin pumping efficiency by a factor of more than 150.

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MA 15.6 Tue 10:45 H3

Physical, chemical and structural characterization of the antiferromagnetic semiconductor LiMnAs. — •Andreea Beleanu, Guido Kreiner, Walter Schnelle, Gerhard H. Fecher, and Claudia Felser — Max Planck Institute for Chemical Physics of Solids, Dresden, Germany.

The compound LiMnAs is a promising candidate for spintronic applications due to its antiferromagnetic and semiconducting behavior. Polycrystalline LiMnAs was obtained as single-phase material from stoichiometric amounts of high purity elements. The compound was characterized by powder x-ray diffraction, metallographic examinations, chemical and thermal analysis and by measurements of magnetic and transport properties. LiMnAs crystallizes in the tetragonal space group $P4/nmm$ with an antiferromagnetic order. It undergoes a phase transition to a cubic phase at 600°C. DC resistivity measurements indicate a semiconducting behavior. Using the Arrhenius plot two sections of activated conduction with a small band gap E_g of 0.21 eV indicating doped levels at low temperatures and a larger E_g of 0.57 eV at high temperatures were determined.

MA 15.7 Tue 11:00 H3

Creep/recovery and $1/f^\alpha$ noise signatures of resistively switching manganites — •Jon-Olaf Krisponeit, Christin Kalkert, Bernd Damascke, Vasily Moshnyaga, and Konrad Samwer — I. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Perovskite manganites show various interesting resistance effects, such as a metal-insulator transition driven by temperature as well as magnetic fields (colossal magnetoresistance). They also belong to a wide class of oxides which exhibit electrically induced resistive switching. Despite extensive efforts, the underlying mechanism of the switching effect, which possesses a high potential for applications, is still far from being understood.

We report the results on the dynamics of resistive switching on $La_{0.8}Ae_{0.2}MnO_3$ (Ae = Ca, Sr thin film samples. By means of conductive atomic force microscopy (C-AFM) we studied the time evolution of nanoscaled metallic domains. Creep/recovery features show up in pulse-train experiments and current map sequences. Moreover, the current $I(t)$ exhibits $1/f^\alpha$ noise signatures during the switching process. Such behavior is characteristic for various avalanche-type physical processes, like, for instance, the Barkhausen effect and martensitic transitions. Therefore, our results indicate the resistive switching effect to belong to this class of phenomena, and the dynamics to be

governed by pinning and depinning of structural domain walls.

Financial support by DFG via SFB 602 and the Leibniz Program is acknowledged.

MA 15.8 Tue 11:15 H3

Magnetic control of channel conductance in Metal Semiconductor Field Effect Transistors with magnetic ZnO channel — •Tim Kaspar[1], Danilo Bürger[1,2], Ilona Skorupa[1], Artur Erbe[1], Daniel Grimm[2,3], Oliver G. Schmidt[2,3], Manfred Helm[1], and Heidemarie Schmidt[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, P.O. Box 510119, 01314 Dresden, Germany — [2]TU Chemnitz, Reichenhainer Str. 39, 09111 Chemnitz, Germany — [3]IFW Dresden, Helmholtzstraße 20, 01069 Dresden, Germany

We focus on the development of ZnO based devices, e.g. Schottky diodes with a magnetic ZnO depletion region [1]. Our work is motivated by the observation of s-d exchange interaction in magnetic ZnO below 50 K. For ZnO:Co we have shown that the magnetoresistance depends on the magnetic ion concentration, the free electron concentration and temperature [2]. Here we focus on the control of conductance in Metal Semiconductor Field Effect Transistors (MESFETs)with diluted magnetic ZnO channels by applied external electrical and magnetic fields. Co-doped magnetic ZnO channel layers with a Co concentration of 5 at% have been deposited by pulsed laser deposition. Ag/Au gate and Ti/Au source and drain contacts have been structured by optical lithography. The characteristics of the MESFETs with magnetic channel in external perpendicular magnetic fields up to 1.8 T are presented.

[1] Qingyu Xu, H. S.et al., Jpn. J. Appl. Phys.49, 043002(2010)
[2] Qingyu Xu, H. S.et al., Phys. Rev. B.76, 134417(2007)

MA 15.9 Tue 11:30 H3

Tuning the ultrafast magnetic dynamics in Gd-Doped EuO — •A. Schroer[1], M. Matsubara[2], A. Schmehl[3], J. Mannhart[4], A. Melville[5], D. G. Schlom[5], M. Trujillo Martinez[1], M. Fiebig[2], and J. Kroha[1] — [1]Universität Bonn — [2]ETH Zürich — [3]Universität Augsburg — [4]MPI-FF Stuttgart — [5]Cornell University

EuO is a dense ferromagnetic semiconductor with a Curie temperature of T_C = 69 K. Upon Gd-doping, $Eu_{1-x}Gd_xO$ undergoes a simultaneous ferromagnetic and insulator-metal transition, with a resistivity drop of several orders of magnitude, making it an interesting material or spintronics applications. The magnetic coupling J_{eff} between the Eu 4f moments is mediated by a virtual magnetic exciton (Eu 4f-5d mixing), enhancing the wave function overlap of the magnetic Eu orbitals. We show by pump-probe experiments that pumping electrons resonantly into the Eu 5d conduction band in pure EuO leads to an ultrafast increase of the ferromagnetic coupling J_{eff}, and that this coupling can be tuned from a further increase to a decrease by Gd doping. For this pump-induced non-equilibrium situation we calculate the RKKY-like, conduction electron induced magnetic coupling. We find that the magnetic interaction is in general oscillatory and decays spatially with a power law, like the equilibrium RKKY interaction, but the power law exponent is changed. The tuning of the pump-induced change of J_{eff} by Gd-doping is explained by a subtle interplay of correlation-induced shift of spectral weight and of a pump-induced redistribution of the conduction electron occupation.

MA 15.10 Tue 11:45 H3

Magnetism in geometrically frustrated $HgCr_2Se_4$ — •Michael Wagner[1], Sarah Dunsiger[1], Vladimir Tsurkan[2], Alois Loidl[2], and Christian Pfleiderer[1] — [1]Physik Department E21, Technische Universität München, 85748 Garching, Germany — [2]Institut für Physik, Universität Augsburg, 86135 Augsburg, Germany

Geometrically frustrated spin systems on a pyroclore lattice are prone to competing antiferromagnetic and ferromagnetic interactions. Under hydrostatic pressure the relative strength of the various magnetic interactions may be changed driving phase transitions of the ground state. We studied the chromium spinel $HgCr_2Se_4$, a ferromagnetic semiconductor with $T_c \approx 106$ K. We have measured the magnetization under pressure with a bespoke Cu:Be piston cylinder cell. Our measurements were carried out on a single crystal prepared by chemical transport reaction. As a function of temperature the magnetization vanishes at the curie temperature T_c which decreases as a function of pressure consistent with literature [1]. Furthermore we find some indications of critical behaviour.

[1] V. Srivastava. Journal of Applied Physics, 40:3, 1969