MA 34: Spintronics (joint session MA/TT)

Time: Wednesday 15:00–17:00 Location: EB 202

MA 34.1 Wed 15:00 EB 202

Spin Hall Magnetoresistance in uniaxial antiferromagnet/Pt heterostructures — •Richard Schlitz[1,2], Tobias Kosub[3], Andy Thomas[4], Kornelius Nielsch[4,5], Denys Makarov[3], and Sebastian T.B. Goennenwein[1,2] — [1]Institut für Festkörper- und Materialphysik, TU Dresden, 01062 Dresden, Germany — [2]Center for Transport and Devices of Emergent Materials, TU Dresden, 01062 Dresden, Germany — [3]Helmholtz-Zentrum Dresden-Rossendorf e.V., Institute of Ion Beam Physics and Materials Research, 01328 Dresden, Germany — [4]Leibniz Institute for Solid State and Materials Research Dresden (IFW Dresden), Institute for Metallic Materials, 01069 Dresden, Germany — [5]TU Dresden, Institute of Materials Science, 01062 Dresden, Germany

Antiferromagnets recently attracted a lot of interest as candidate materials for spintronic applications. In this study, we investigate the spin Hall magnetoresistance (SMR) in uniaxial antiferromagnet (AFM)/Pt bilayers. Our results suggest that experiments close to the Neel temperature of the AFM layer allow to study the magnetic phase diagram of the AFM. By rotating the magnetic field in three orthogonal rotation planes, we establish the 3D fingerprint of the SMR also in AFM/Pt heterostructures, giving further insights into the impact of anisotropy and domain pattern. Finally, we propose an extension of the monodomainization model put forward recently in conjunction with measurements on NiO/Pt heterostructures [1] which provides an alternative explanation on the origin of the negative SMR signature.

[1] J. Fischer *et al.*, arxiv:1709.04158 (2017)

MA 34.2 Wed 15:15 EB 202

Current induced Nèel vector manipulation in Mn_2Au and associated giant anisotropic magnetoresistance — •Bodnar Stanislav[1], Šmejkal Libor[1,2,3], Gomonay Olena[1], Sinova Jairo[1], Sapozhnik Alexey[1], Elmers Hans-Joachim[1], Kläui Mathias[1], Filianina Mariia[1], and Jourdan Martin[1] — [1]Mainz University, Staudinger Weg 7, 55128 Mainz, Germany — [2]Institute of Physics, Academy of Sciences of the Czech Republic, Cukrovarnicka 10, 162 00 Praha 6, Czech Republic — [3]Faculty of Mathematics and Physics, Charles University, Department of Condensed Matter Physics, Ke Karlovu 5, 12116 Praha 2, Czech Republic

Antiferromagnetic materials could be used as active elements in spintronics. This requires the ability to switch and read-out the Néel vector state. In our work we demonstrate for Mn_2Au, a good conductor with a high ordering temperature suitable for applications, reproducible switching of the Nèel vector using current pulse generated bulk spin-orbit torques and read-out by magnetoresistance measurements. Reversible and consistent changes of the longitudinal resistance and planar Hall voltage of star-patterned epitaxial $Mn_2Au(001)$ thin films were generated by pulse current densities of 10^7 A/cm^2 . The symmetry of the torques agrees with theoretical predictions and a large read-out magnetoresistance effect of more than 6 % is reproduced by ab initio transport calculations.

MA 34.3 Wed 15:30 EB 202

Granularity Effects in Antiferromagnetic Spintronics Devices — •Tobias Kosub[1], Patrick Appel[2], Brendan Shields[2], Patrick Maletinsky[2], René Hübner[1], Jürgen Lindner[1], Jürgen Fassbender[1], and Denys Makarov[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf e.V., Institute of Ion Beam Physics and Materials Research, Dresden, Germany — [2]University of Basel, Basel, Switzerland

Antiferromagnetic thin film systems have recently become an important focus in spintronics as all-electrical writing and reading mechanisms were discovered [1-3]. The early device prototypes have clearly shown that the extrinsic effects of film strain, granularity and non-zero magnetization are decisive factors in actual performance. Such thin film effects do not merely bring about small alterations to the expected behavior, but can indeed make or break functionality.

In this context, we demonstrate two new complementary methods to study the impact of granularity on the magnetism of antiferromagnetic thin films. We show extremely sensitive Zero-Offset Hall measurements of the non-zero magnetization as well as Nitrogen Vacancy Magnetic Microscopy of the domain patterns for Cr_2O_3 thin films.

We can track the magnetic ordering in both real and statistical space and we derive important quantities such as pinning and the intergranular exchange.

[1] T. Kosub et al., *Nature Commun.* **8**, 13985 (2017).
[2] T. Kosub et al., *Phys. Rev. Lett.* **115**, 097201 (2015).
[3] P. Wadley et al., *Science* **351**, 587 (2016).

MA 34.4 Wed 15:45 EB 202

Defect induced magnetism — A framework for all-semiconductor spintronics — •Lukas Botsch[1], Israel Lorite[1], Yogesh Kumar[1], Pablo Esquinazi[1], Tom Michalsky[1], Joachim Zajadacz[2], and Klaus Zimmer[2] — [1]Felix-Bloch-Institute for Solid State Physics, Leipzig University, Germany — [2]Leibniz-Institut für Oberflächenmodifizierung e. V., Leipzig, Germany

Combining the so-called defect induced magnetism (DIM) phenomenon — inducing magnetic order in nominally non-magnetic materials through defects — with acceptor/donor doping in semiconducting materials opens a whole new degree of engineering freedom to design spintronic devices. The DIM phenomenon is known to exist in a variety of materials such as different oxides, nitrides and carbon based materials. We demonstrate the versatility of this framework by showing its application in an all-semiconductor spin-filter device, prepared at the surface of a ZnO microwire by low energy ion implantation. This device is based on a spin-blockade effect that arises at the interface between highly doped magnetic and lightly doped non-magnetic regions at the surface of the wire. The device can be tuned to operate in a large range of temperatures and shows strong spin filtering.

MA 34.5 Wed 16:00 EB 202

p-type co-doping effect in III-Mn-V dilute ferromagnetic semiconductors — •Chi Xu[1,2], Ye Yuan[1,2], Mao Wang[1,2], Roman Böttger[1], Manfred Helm[1,2], and Shengqiang Zhou[1] — [1]Helmholtz-Zentrum Dresden Rossendorf, Institute of Ion Beam Physics and Materials Research, Bautzner Landstrasse 400, D-01328 Dresden, Germany — [2]Technische Universität Dresden, D-01062 Dresden, Germany

III-Mn-V based diluted magnetic semiconductors offer an opportunity to explore various aspects of carrier transport in the presence of cooperative phenomena. In this work, we demonstrate the efficiency of an alternative approach to control the carrier state through involving one magnetic impurity Mn and one electrically active dopant Zn. Mn-doped and Zn co-doped Ga-V films have been prepared by combining ion implantation and pulsed laser melting, followed by a systematic investigation on the magnetic and transport properties of (Ga,Mn)P by varying Mn concentration as well as by Zn co-doping. Changes of electrical, magnetic and magneto-transport behavior of the investigated Ga-Mn-V films were observed after co-doping with Zn. The changes are caused by interstitial Mn atoms which are transferred from substitutional sites or formation of Mn-Zn dimers.

MA 34.6 Wed 16:15 EB 202

Dynamics of Mn Local Moments in Metallic and Semiconducting Pnictides — M. A. Surmach[1], P. Y. Portnichenko[1], Z. Deng[2,3], C. Q. Lin[2,4,5], J. K. Glasbrenner[6], I. I. Mazin[6], D. L. Sun[7], Y. Liu[7], C. T. Lin[7], A. Ivanov[8], J. T. Park[9], J. A. Rodriguez-Rivera[10,11], and •D. S. Inosov[1] — [1]TU Dresden, Germany — [2]Inst. of Physics, Beijing — [3]Center for High Pressure Sci. & Technol., Beijing — [4]Univ. of Chinese Academy of Sciences, Beijing — [5]Collab. Innov. Center of Quantum Matter, Beijing — [6]Naval Research Lab., Washington, USA — [7]MPI-FKF, Stuttgart, Germany — [8]ILL, Grenoble, France — [9]MLZ, Garching, Germany — [10]Univ. of Maryland, USA — [11]NIST Center for Neutron Research, USA

We have investigated the effects of Mn doping in two materials isostructural to 122-type iron-based superconductors by neutron spectroscopy. First, we discuss the excitation spectrum of Mn-substituted $BaFe_2As_2$, where local magnetic clusters pinned to the impurity sites lead to an emergence of (π, π) magnetic excitations. We discuss their 3D character and the origin of the spin gap. The 2nd class of materials derives from the isostructural semiconductor $BaZn_2As_2$, giving rise to a dilute magnetic semiconductor upon Mn substitution. Hole doping by K provides an opportunity to tune the carrier concentration and the amount of magnetic moments independently. The resulting compound, $(Ba_{1-x}K_x)(Zn_{1-y}Mn_y)_2As_2$, is a ferromagnet with the maximal Curie temperature of 230 K. It offers a versatility of chemically tailored properties, as the hole doping is decoupled from spin injection and occurs in a different crystallographic layer.

MA 34.7 Wed 16:30 EB 202

Quasiclassical theory of the Rashba-Edelstein magnetoresistance — •Sebastian Tölle[1], Michael Dzierzawa[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

In a recent experiment, a magnetoresistance originating from Rashba spin-orbit coupling in a metallic heterostructure has been observed [1]. We consider a 3D Rashba metal with mass anisotropy [2] attached to a ferromagnetic insulator and employ the quasiclassical approach to derive a set of coupled spin-diffusion equations. Due to the spin transfer torque, the current-induced spin polarization (Edelstein effect) acquires a characteristic dependence on the polarization direction of the ferromagnet which manifests itself as a signature in the magnetoresistance. Our theoretical results reproduce several qualitative features of the experiments. In particular, the Elliott-Yafet spin relaxation plays a major role in explaining the temperature dependence of the observed signature.

[1] H. Nakayama et al., Phys. Rev. Lett. 117, 116602 (2016); H. Nakayama et al., Appl. Phys. Lett. 110, 222406 (2017).
[2] V. Brosco and C. Grimaldi, Phys. Rev. B 95, 195164 (2017).

MA 34.8 Wed 16:45 EB 202

Geometric phase switching in spin interferometry — •Henri Saarikoski[1], Andres Reynoso[2], Diego Frustaglia[3], Jose-Pablo Baltanás[3], Makoto Kohda[4], and Junsaku Nitta[4] — [1]RIKEN Center for Emergent Matter Science, Wako, Saitama 351-0198, Japan — [2]Instituto Balseiro and Centro Atómico Bariloche, 8400 Bariloche, Argentina — [3]Departamento de Física Aplicada II, Universidad de Sevilla, E-41012 Sevilla, Spain — [4]Department of Materials Science, Tohoku University, Sendai 980-8579, Japan

The geometric (Berry) phase acquired by an electron in a cyclic evolution depends on the topology of the driving fields. An oscillating field in the adiabatic limit does not result in a Berry phase in contrast to a rotating field that gives a Berry phase of π. We consider here theoretically topological geometric phase switching in quasi-two-dimensional mesoscopic ring systems where the geometric phase is of nonadiabatic (Aharonov-Anandan) type of geometric phase. The driving field results from interplay between Bychov-Rashba and Dresselhaus [001] spin-orbit fields and an in-plane magnetic field. We find that the geometric phase switching is imprinted both in the resistance as well as in anisotropy oscillations of the ring. We compare results with experiments in circular and polygonal ring systems.