MA 54: Magnetic textures: Transport and dynamics III

Time: Friday 9:30–12:30 Location: H37

MA 54.1 Fri 9:30 H37

Development of a Miniature Polarisation Analysis Device — •Ran Tang[1], Henrik Gabold[1], Robert Georgii[2], and Peter Böni[1] — [1]James-Franck-Str. 1, Physik-Department E21, TU München, 85748 Garching, Germany — [2]Lichtenbergstr. 1, MLZ, 85748 Garching, Germany

Spherical neutron polarimetry (SNP) has been systematically developed and applied over the last decades since the cryogenic polarisation analysis device (CryoPAD) presented by Tasset et al. in 1989. This technique allows to determine all the nine components in the polarisation matrix at once and therefore to solve the Blume-Maleyev equations. The biggest advantage of SNP over conventional polarisation analysis methods is the ability to separate nuclear and magnetic contributions in the scattering processes even with finite nuclear-magnetic interference terms. Hence the magnetic properties, e.g. magnetoelectricity, non-collinear magnetic structures, different types of magnetic domains in antiferromagnetic structures, and commensurate and incommensurate structures, can be finely determined. Inspired by the CryoPAD, the Mu-metal Polarisation Analysis Device (MuPAD) presented by Janoschek et al., and the following Mini MuPAD, introduced by Haslbeck and Kindervater et al., with a more compact form, we want to report on the currently being developed cylindrical Mini PAD. In comparison to the existing Mini MuPAD, the precession coils are bent into cylindrical shape around the sample, and the scattering angles are hence no longer restricted to be smaller than 10°. Furthermore, thanks to its size, it is simple to handle and can be combined with a cryostat.

MA 54.2 Fri 9:45 H37

Pressure induced modification of the anomalous Hall effect — Rafael Gonzales[1,2], •Bertrand Dupé[2], and Jairo Sinova[2] — [1]Universidad del Norte, Barranquilla, Colombia — [2]Johannes Gutenberg Universität of Mainz, Mainz, Germany

The Anomalous Hall Effect (AHE) consists of the presence of a transverse voltage when an electrical current is applied on a ferromagnetic material [1]. The anomalous Hall conductivity (AHC) is proportional to the saturation magnetization in the Kaplus Luttinger theory [2] and to the spin orbit coupling in the Berry phase theory [3]. Here, we studied the dependence of the AHC of pressure in 3d transitions metals by mean of Density function theory. We interpolated the band structure by means of Wannier functions. By using the Berry phase theory, we show that the in the AHC is in general not proportional to the magnetization and the spin orbit coupling. [1] N. Nagaosa et al., Rev. Mod. Phys. 82, 1539 (2010). [2] R. Kaplus et al., Phys. Rev. 95, 1154 (1954). [3] M. V. Berry, Proc. R. Soc. London 392, 45 (1984).

MA 54.3 Fri 10:00 H37

Composition dependent exchange interactions and Gilbert damping in (Mn,Fe)Ge B20 alloys — •S. Mankovsky and H. Ebert — Dept. Chemistry, LMU Munich, D-81377 Munich, Germany

First-principles investigations of the magnetic properties of various materials with B20 crystal structure have been performed for different composition and structure parameters. The calculations are based on the fully relativistic multiple scattering Korringa-Kohn-Rostoker (KKR) formalism. A particular issue of these investigations is the Gilbert damping (GD) parameter and its strong dependence on the conditions of sample preparation as it was demonstrated experimentally for the FeGe compound [1]. Therefore, detailed investigations on the temperature and composition dependence of the GD have been performed for pure FeGe and MnGe compounds as well as for (Mn,Fe)Ge alloys. This study shows in particular an increase of the GD by an order of magnitude when going from MnGe to FeGe. The impact of the structure parameters and different types of defects (e.g. vacancies and antisite defects) was investigated to understand the dependence on sample preparation conditions. In addition, the exchange parameters, both isotropic and Dzyaloshinskii-Moriya interactions (DMI), have been calculated accounting simultaneously for thermal lattice vibrations and spin fluctuations, vacancies and antisite defects. From this we find in particular a significant increase of the DMI, namely diagonal $D^{\alpha\alpha}$ elements, in the pure MnGe limit. All results are compared with available experimental data as far as possible.

[1] Phys. Rev. B 95, 134416 (2017)

MA 54.4 Fri 10:15 H37

Topological Hall effect in thin films of $Mn_{1.5}PtSn$ — •Peter Swekis[1,2], Anastasios Markou[1], Dominik Kriegner[1], Jacob Gayles[1], Richard Schlitz[2,3], Walter Schnelle[1], Sebastian T. B. Goennenwein[2,3], and Claudia Felser[1] — [1]Max-Planck Institute for Chemical Physics of Solids, 01187 Dresden, Germany — [2]Institut für Festkörper- und Materialphysik, Technische Universität Dresden, 01062 Dresden, Germany — [3]Center for Transport and Devices of Emergent Materials, Technische Universität Dresden, 01062 Dresden, Germany

Spin chirality in metallic materials with non-coplanar magnetic order can give rise to a Berry phase induced topological Hall effect. Here, we report the observation of the topological Hall effect in high-quality films of $Mn_{1.5}PtSn$ below a spin reorientation transition temperature. We find, that the maximum topological Hall resistivity is of comparable magnitude as the anomalous Hall resistivity, with their relation depending on the spin reorientation. Further, we underline the robustness of the topological Hall effect in $Mn_{2-x}PtSn$ by extracting the effect for multiple stoichiometries (x = 0.5, 0.25, 0.1).

MA 54.5 Fri 10:30 H37

Transport effects in magnetic textures of non-Abelian frustrated antiferromagnets — •Patrick M. Buhl[1], Frank Freimuth[1], Stefan Blügel[1], and Yuriy Mokrousov[1,2] — [1]Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich and JARA, 52425 Jülich, Germany — [2]Institute of Physics, Johannes Gutenberg-University Mainz, 55128 Mainz, Germany

The topological Hall effect as the main transport signature of skyrmion textures has proven to be a key phenomenon for skyrmion detection and device design utilizing skyrmions. Interpretation of experimental measurements requires theoretical predictions that can be obtained in the adiabatic limit through semiclassical equations of motion in combination with the Boltzmann formalism. A conceptually similar method was employed recently to estimate the non-Abelian topological spin Hall effect of skyrmion lattices in collinear antiferromagnets [1].

Here, we consider an extension of the non-Abelian wave-packet dynamics to magnetic textures made of frustrated antiferromagnets, with particular focus on the impact of local non-collinearity on traversing electrons. Based on model calculations, we investigate the impact of the modified non-Abelian electron dynamics on the transport properties of various frustrated imprinted textures of different topological character, and provide possible material candidates where the novel type of non-Abelian dynamics could be observed. This work is supported by SFB 1238 of the DFG.

[1] P.M. Buhl, et al., PSS RRL 11, 1700007 (2017)

MA 54.6 Fri 10:45 H37

Magnetic excitations of the ferrimagnetic spin spiral in FeP — •Dmytro S. Inosov[1], Yuliia V. Tymoshenko[1], Yevhen A. Onykiienko[1], Alistair S. Cameron[1], Alexandr S. Sukhanov[1,5], Igor V. Morozov[2,3], Saicharan Aswartham[3], and Helen C. Walker[4] — [1]TU Dresden, Germany — [2]Moscow State University, Russia — [3]IFW Dresden, Germany — [4]ISIS Neutron and Muon Source, Didcot, UK — [5]MPI CPfS, Dresden, Germany

Iron phosphide (FeP) is a very unusual itinerant helimagnet, in which the spin spiral derives from a ferrimagnetic arrangement of spins ("double helix" structure). There are two magnetic sublattices with different sizes of the magnetic moment, which are twisted into a helical spiral propagating along the orthorhombic c axis. As a consequence, two nonequivalent pairs of incommensurate magnetic Bragg peaks with associated helimagnon modes form near the allowed and forbidden structural Bragg peaks (101) and (110), respectively. We present the first measurements of spin-wave excitations by inelastic neutron scattering and discuss the hierarchy and possible origin of magnetic interactions.

MA 54.7 Fri 11:00 H37

Characterizing breathing modes of magnetic (anti-)skyrmions with the Hamiltonian formalism — •B. F. McKeever[1], D. R. Rodrigues[1], D. Pinna[1], Ar. Abanov[2], Jairo Sinova[1,3], and K. Everschor-Sitte[1] — [1]Johannes Gutenberg University Mainz, Germany — [2]Texas A&M University, College Station,

USA — [3]Institute of Physics ASCR, Prague, Czech Republic

We derive an effective Hamiltonian system describing the low energy dynamics of circular magnetic skyrmions and antiskyrmions using collective coordinates [1]. An effective energy landscape reveals two qualitatively different types of breathing behavior. For small energy perturbations we reproduce the well-known small breathing mode excitations, where the magnetic moments of the skyrmion oscillate around their equilibrium solution. At higher energies we find a rotational breathing behavior, transforming Neel to Bloch skyrmions and vice versa. For a damped system we observe the transition from the continuously rotating and breathing skyrmion into the oscillatory one. We analyze the characteristic frequencies of both types, as well as their amplitudes and energy dissipation rates. For rotational (oscillatory) breathing modes we predict on average a linear (exponential) decay in energy. This stark difference in dissipative behavior should be observable in the frequency spectrum of excited (anti-)skyrmions.

[1] B. F. McKeever et al., arXiv:1811.09949

15 min. break

MA 54.8 Fri 11:30 H37

On rate theory for continuous multidimensional magnetic systems — •Grzegorz Kwiatkowski[1,2] and Pavel F. Bessarab[1,3] — [1]University of Iceland, Reykjavík, Iceland — [2]Immanuel Kant Baltic Federal University, Kaliningrad, Russia — [3]ITMO University, St. Petersburg, Russia

The search for optimal magnetic memory bits combining high stability and energy-efficient writability is a key problem in the field of future information technologies. In this respect, designing samples characterized by low attempt frequency appears to be particularly promising. Here we demonstrate that internal degrees of freedom have a crucial impact on thermal stability of magnetic systems. Due to the effect of the internal modes, even monodomain particles which reverse their magnetization by strictly uniform rotation can have much lower attempt frequency compared to the values predicted by the rate theory due to Néel and Brown [1,2]. Our results also demonstrate the need for revision of classical rate theories for 2D- and 3D-systems due to inherent divergent behaviour. We propose a generalization of the rate theories for continuum systems in line with ideas of Debye [3] and present illustrative examples. Our results are particularly important for describing the thermal stability of magnetic skyrmions which are praised to be the information-carrying bits in next-generation data storage and logic devices.

[1] L. Néel, Ann. Geophys. **5**, 99 (1949).
[2] W. F. Brown, Phys. Rev. **130**, 1677 (1963).
[3] P. Debye, Ann. Phys. **344**, 14 (1912).

MA 54.9 Fri 11:45 H37

Characterization of MnGe thin films and nanostructures — •David Schroeter[1], Nico Steinki[1], Thomas Kimmel[1], Alexander Fernández Scarioni[2], Hans Werner Schumacher[2], Stefan Süllow[1], and Dirk Menzel[1] — [1]Institut für Physik der Kondensierten Materie, TU Braunschweig, Germany — [2]Physikalisch-Technische Bundesanstalt, Braunschweig, Germany

In the recent years thin films of the B20 compound like MnSi and MnGe became subject of great interest, since the magnetic properties of bulk material are modified due to the dimensional reduction and the uniaxial anisotropy with a proposed stabilized skyrmionic phase [1,2]. Additionally, bulk material MnGe is known for its short periodicity of the magnetic spin structure of roughly 3 nm [2], making MnGe thin films an ideal candidate for the investigation of thin films exhibiting high-skyrmion density.

In this situation, we have set out to investigate the (magneto-)resistivity, Hall effect and magnetization in MnGe thin films and nanostructures. We have analyzed the electronic transport properties in Hall geometries of various sizes to determine the intrinsic behavior and potential finite size effects. We compare the thin film and nanostructure data to experiments performed on nanostructured MnSi thin films and discuss our results in terms of the structural and morphologic characterization of the samples.

[1] A. B. Butenko et al., Phys. Rev. B 82, 052403 (2010). [2] N. Kanazawa et al., Phys Rev. Lett. 106, 156603 (2011).

MA 54.10 Fri 12:00 H37

Dynamics of confined magnetic skyrmions under application of an oscillatory magnetic field — •Sakineh Abdizadeh Kalan[1,2], Jahanfar Abouie[1], and Khalil Zakeri Lori[2] — [1]Institute for Advanced Studies in Basic Sciences(IASBS), Zanjan 45137-66731, Iran — [2]Heisenberg Spin-dynamics Group, Physikalisches Institut, Karlsruhe Institute of Technology, Wolfgang-Gaede-Str. 1, D-76131 Karlsruhe, Germany

We report a detailed micromagnetic study of the dynamics of a magnetic skyrmion confined in a 120-nm-diameter disk of 0.6 nm thickness, using the Object Oriented Micromagnetic Framework (OOMMF). We observe that the dynamics depends on the frequency as well as the amplitude of the applied magnetic field, as expected. Our results indicate that there is a threshold field amplitude above which the dynamics becomes more complex. In the second step, the gyroscopic motion of field-driven skyrmion is investigated by analytical calculations. We use the Thiele equation for massive skyrmions in the presence of a magnetic field. The time dependent trajectory of skyrmion core is analytically calculated for different magnetic fields and different field geometries. Comparing the results of micromagnetic simulations to those of the analytical calculations, we discuss the details of the observed complex skyrmion dynamics.

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MA 54.11 Fri 12:15 H37

Damping of spin wave modes in magnetic skyrmions — •Levente Rózsa, Julian Hagemeister, Elena Y. Vedmedenko, and Roland Wiesendanger — University of Hamburg, Hamburg, Germany

Magnetic skyrmions are localized noncollinear spin configurations, which have attracted significant research attention lately in the field of magnonics due to their spin wave excitation modes connected to the magnetic structure [1]. Understanding the damping mechanisms determining the lifetimes of the magnons is required for future technological applications.

Here the connection between noncollinear spin configurations and the effective damping parameters of spin waves is investigated, which are shown to be mode-dependent and enhanced compared to the Gilbert damping α [2]. It is demonstrated how these effective damping parameters can be calculated based on the elliptic polarization of the modes in the limit of vanishing α, and how excitations may become overdamped for larger α values. The results are illustrated for the example of isolated $k\pi$ skyrmions, cylindrically symmetric spin configurations where the out-of-plane spin component rotates by $k\pi$ between the center and the collinear background. The role of effective damping parameters is discussed close to the instabilities of the skyrmions at low and high field values [3].

[1] M. Garst et al., J. Phys. D: Appl. Phys. **50**, 293002 (2017).
[2] L. Rózsa et al., Phys. Rev. B **98**, 100404(R) (2018).
[3] L. Rózsa et al., arXiv:1810.06471 (2018).