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| **I: NANOMAGNETISM**  
Chair: Susmita Saha, PSI Villigen |
| Spintronics with topologically charged structures – vortex sensors for speed wheel sensors to the potential of skyrmion storage  
*Dieter Süß, Universität Wien*  
Within the talk I will review our activity on spintronic applications which is done in close cooperation with the industrial partner Infineon AG. The advantage of topological charged vortex structure for sensor application for low noise speed sensors will be reported that will be commercialized by Infineon for ABS systems in cars in 2018. As a second example, we will review the potential of skyrmion based racetrack structures. We will report the effect of structural pinning sites in order to stabilize magnetic skyrmion position in order to store stable bits. The energy barrier for annihilation of skyrmion at the boundary will be compared with the energy barriers to overcome these pinning site. It is shown that skyrmions can be more effectively pinned than protected from annihilation via boundaries. |
| 17:30  | 802 |
| Achiral tilted domain walls in perpendicularly magnetized nanowires  
*Benedikt Boehm ¹, A. Bisig ¹, A. Bischof ¹, G. Stefanou ², B. J. Hickey ², Rolf Allenspach ¹*  
¹ IBM Research - Zurich, CH-8803 Rüschlikon  
² School of Physics and Astronomy, University of Leeds, Leeds LS2 9JT, UK  
Perpendicularly magnetized nanowires exhibit distinct domain wall types depending on the geometry. Wide wires contain Bloch walls, narrow wires Néel walls. Here, the transition region is investigated by direct imaging of the wall structure using high-resolution spin-polarized scanning electron microscopy. An achiral wall type is discovered whose in-plane magnetic moment angle is intermediate between the one of Bloch and Néel walls which is unpredicted by established theoretical models. With the help of micromagnetic simulations, we find that the transition via this intermediate wall should occur in any perpendicularly magnetized material provided the wire width is chosen accordingly. |
| 17:45  | 803 |
| The triangular-lattice, Ising antiferromagnet with dipolar interactions: tuning a classical spin liquid  
*Andrew Smerald, Frédéric Mila, EPFL*  
We study theoretically the triangular-lattice, Ising antiferromagnet with long-range dipolar interactions, inspired by its realisation in nano-magnet arrays. We show that a classical spin-liquid regime exists above a low-temperature ordered phase, and explore how the nature of the spin liquid can be altered by a small lattice deformation. Deforming the lattice also tunes the nature of the transition from first order to Kasteleyn, via an unusual tricritical point. We show that the behaviour can be naturally explained in terms of a set of interacting strings, and this leads to an analogy with 1D quantum systems of spinless fermions. |
| 18:00  | 804 |
| Angular Dependent Magnetization Dynamics of Quasicrystalline Nanomagnet Lattices  
*Vinayak S. Bhat ¹, Sho Watanabe ¹, Ioannis Stasinopoulos ², Dirk Grundler ¹*  
¹ EPFL, ² Technische Universität München  
Quasistatic studies on artificial quasicrystals reported exotic properties such as knee anomalies in the magnetic hysteresis. Spin wave resonances may help to further understand their exotic properties. We fabricated interconnected networks of nanobars (810 nm long, 130 nm wide) from 25 nm thick Permalloy and arranged them on Penrose P2, P3, and Ammann quasicrystal lattices. Performing angular dependent broadband spectroscopy in the GHz frequency regime we observed systematic and reproducible spin wave resonances in the switching regime. Combined... |
with micro-magnetic simulations and X-ray photoemission electron microscopy we discuss our experimental results in view of reprogrammable magnonic devices.

*Research supported by SNF (#163016) and DFG (TRR80-F7).

18:15 805 Direct investigation of microstructure and magnetism of individual cobalt nanoparticles

Tatiana M. Savchenko 1, Armand Béché 2, Martin Timm 1, David M. Bracher 1, G. Khadra 3, A. Tamion 3, F. Tournus 3, C. Albin 3, Veronique Dupuis 3, Johan Verbeeck 2, Frithjof Nolting 1, Armin Kleibert 1

1 Swiss Light Source, Paul Scherrer Institute, CH-5232 Villigen
2 Electron Microscopy for Material Science, University of Antwerp, Belgium
3 Institut Lumière Matière, UMR5306 Université Lyon 1-CNRS, FR-69622 Villeurbanne Cedex

Enhanced magnetism in 3d transition metal nanoparticles is of great interest for applications and for our fundamental understanding of nanomagnetism. However, despite considerable research efforts, the origin of anomalous magnetic properties in nanoparticles, such as enhanced magnetic anisotropy, are still poorly understood. Here, we combine X-ray photo-emission electron microscopy (X-PEEM) with high-angle annular dark-field scanning transmission electron microscopy (HAADF-STEM) in order to correlate magnetism and microstructure of individual nanoparticles. Our data suggest that the magnetism of cobalt nanoparticles is determined by competing shape, surface, and structural contributions. Further, we find that this competition can easily mask the commonly expected size dependence of nanoparticles magnetic properties such as magnetic energy barriers.

18:30 806 Antiferromagnetic order probed in individual goethite nanoparticles

David M. Bracher 1, Tatiana M. Savchenko 1, Marcus Wyss 2, Giorgia Olivieri 3, Matthew A. Brown 3, Frithjof Nolting 1, Martino Poggio 2, Armin Kleibert 1

1 Swiss Light Source, Paul Scherrer Institute, CH-5232 Villigen
2 Department of Physics, University of Basel, Klingelberstrasse 82, CH-4056 Basel
3 Lab. for Surface Science and Technology, Department of Materials ETH Zürich, CH-8093 Zürich

Antiferromagnetic materials play an important role in modern spintronics devices. While the properties of antiferromagnetic bulk materials are often well investigated, much less is known about their properties at the nanoscale. Here, we use X-ray photo-emission electron microscopy (X-PEEM) together with X-ray magnetic linear dichroism to study the magnetism of individual goethite nanoparticles. The X-PEEM data are combined with scanning electron microscopy to correlate the magnetic properties of the nanoparticles with their actual morphology. Our data indicate that goethite nanoparticles are antiferromagnetically ordered at room temperature, similar to the respective bulk, however, a preferred magnetization axis is not found.

18:45 807 Time- and spatially-resolved magnetization dynamics driven by spin-orbit torques

Manuel Baumgartner 1, Pietro Gambardella 1, Kevin Garello 2, Johannes Mendil 1, Can Onur Avci 1, Eva Grimaldi 1, Christoph Murer 1, Junxiao Feng 1, Mihai Gabureac 1, Christian Stamm 1, Yves Acremann 1, Simone Finizio 3, Sebastian Wintz 3, Jörg Raabe 3

1 ETH Zürich, 2 IMEC, 3 PSI

Current-induced spin-orbit torques (SOTs) represent one of the most effective ways to manipulate the magnetization in spintronic devices. The orthogonal torque-magnetization geometry and the large domain wall velocities inherent to materials with strong spin-orbit coupling make SOTs appealing for fast switching applications in nonvolatile memory and logic units. Here, we report the first direct observation of SOT-driven magnetization dynamics in Pt/Co/AlOx dots during current pulse injection. Time-resolved x-ray images with 25 nm spatial and 100 ps temporal resolution reveal that switching is achieved by fast nucleation of an inverted domain at the edge of the dot and propagation of a tilted domain wall across the dot.

19:00 Transfer to Dinner

19:30 Conference Dinner
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| 11:15 | 811 | Using quantitative Magnetic Force Microscopy to assess average and local values of Dzyaloshinskii-Moriya interaction | Hans J. Hug \(^1,2\), Marcos Penedo \(^1\), Mirko Bacani \(^1\), Johannes Schwenk \(^1\), Xue Zhao \(^1\), A. O. Mandru \(^1\), Miguel A. Marioni \(^1\)  
\(^1\) EMPA, \(^2\) Uni Basel                                                                 |

Magnetic Force Microscopy (MFM) is a versatile tool to map the stray field emanating from a sample surface with high spatial resolution and sensitivity, and in applied magnetic fields up to several Teslas. The technical aspects of MFM will be reviewed and examples of high current interest such systems exhibiting interfacial Dzyaloshinskii-Moriya interaction (DMI) will be discussed. The average Dzyaloshinskii-Moriya (DM) interaction \(D\), and the exchange stiffness \(A\) can be extracted from MFM data of the domain structure obtained after different demagnetization procedures. Local values of \(D\), \(K_u\), and \(A\) can be obtained from fitting model skyrmion magnetization structures to MFM data. We find that the local values of \(D\) are substantially larger than the average value, indicating that in our system, the skyrmions are strongly pinned. Apart from the domains and skyrmions MFM can also detect small field variations arising from a local variation of the areal magnetic moment density that can be attributed to a corresponding variation of the Co layer thickness. High-resolution and quantitative MFM is thus a powerful experimental method to assess local magnetic sample properties relevant for the development of future skyrmionic devices.

| 11:45 | 812 | Creating Skyrmions with Electric Fields: Experiment and Theory                          | Alex Kruchkov \(^1\), Jonathan White \(^2\), Ivica Zivkovic \(^1\), Henrik Rønnow \(^1\)  
\(^1\) EPFL, \(^2\) PSI                                                                 |

Skyrmions are topologically protected spin whirls envisaged as promising information carriers. In this talk, we report both writing and erasing skyrmions with moderate electric fields in \(\text{Cu}_2\text{OSeO}_3\). Using neutron scattering, we demonstrate that the skyrmion pocket either expands or shrinks significantly depending on the direction of electric fields, allowing us to write or erase the skyrmion phase in bulk. The effect is addressed theoretically by using the framework of fluctuation-induced phase transitions and the first order perturbation theory in electric fields. As the electric field is almost not heating the insulating \(\text{Cu}_2\text{OSeO}_3\) samples, our study provides further perspectives for dissipation-free electrical control of skyrmions in insulators.

| 12:00 | 813 | Probe magnetism in an ultrafast transmission electron microscope: skyrmion creation by optical pulses in FeGe | Gabriele Berruto \(^1\), Ivan Madan \(^1\), Yoshie Murooka \(^1\), Raymond Lamb \(^2\), Ping Huang \(^1\), Henrik Rønnow \(^1\), Damien McGrouther \(^2\), Fabrizio Carbone \(^1\)  
\(^1\) EPFL, \(^2\) University of Glasgow                                                                 |

Magnetic skyrmions are topologically non-trivial nano-scale spin textures having raised great interest not only for their unique physical behaviors, but also for the potential applications in spintronics. In thin crystals of helical magnets, the skyrmion phase coexists with the topologically trivial helical and field-polarized phases over large portions of the phase diagram. Here we use an ultrafast TEM in Lorentz-Fresnel imaging mode to report the creation of skyrmions by a single optical pulse in a 50 nm-thick crystal of the helical magnet FeGe. We show that it is possible to create stable skyrmions in a wide region of the phase diagram. Possible mechanisms responsible for skyrmion formation will be discussed.
Nanoscale magnetic ratchets based on shape anisotropy

Jizhai Cui, Cheng-Yen Liang, Greg Carman, Chris Lynch, Scott Keller
Department of Mechanical and Aerospace Engineering, University of California, Los Angeles

Controlling magnetization using piezoelectric strain offers unprecedented power efficiency for next-generation spintronic devices. However, strain is a uniaxial effect and, unlike directional magnetic field or spin-polarized current, cannot induce a full 180° reorientation of the magnetization vector when acting alone. We have engineered novel “peanut” and “cat-eye” shaped nanomagnets on piezoelectric substrates that undergo repeated deterministic 180° magnetization rotations in response to individual strain pulses by breaking the uniaxial symmetry using shape anisotropy. This behavior can be likened to a magnetic ratchet, advancing magnetization clockwise with each piezostrain trigger. The results were validated in micromagnetics simulations. This work provides a simple and effective design for developing future spintronic applications.

Magnetolectric coupling between ultrathin Fe films and Pb (Mg_{1/3}Nb_{2/3})O_3_{[(1-x)[PbTiO_3]_x]} x = 0.32 (001) (PMN-PT)

Sridhar Reddy Avula Venkata, Cinthia Piamonteze, Swiss Light Source, Paul Scherrer Institut

We study ultra-thin films of Fe magneto-electrically coupled with a ferroelectric substrate PMN-PT (001). We have grown ultra-thin wedge of Fe with thickness varying from 1 ML to 5 ML on PMN-PT (001) under ultra-high vacuum conditions. We employed x-ray magnetic circular dichroism (XMCD) technique at the Fe L_{3,2}-edges. The results for the Fe wedge (1-5 ML) shows that the thinner part (1 ML) is paramagnetic while the thicker part (5 ML) is ferromagnetic. Furthermore, we measured a change in the remanent spin magnetic moment for 5 ML of Fe upon switching the ferroelectric polarization of PMN-PT (001).

Electric field control of magnetism through field effects in perpendicularly magnetized multilayers

Jaianth Vijayakumar 1, Tatiana M. Savchenko 1, Micheal Horisberger 2, Frithjof Nolting 1, Carlos A. F. Vaz 1
1 Swiss Light Source, Paul Scherrer Institut, 5232 Villigen PSI
2 Neutron Optics and Scientific Computing Group, Paul Scherrer Institut, 5232 Villigen

Charge-mediated control of magnetism has been found in many systems. Here we present an approach to controlling magnetism through field effects using a silicon nitride membrane as gate dielectric. A Pt/Co/Pt tri-layer structure is grown on a high resistance silicon nitride membrane and an electric field is applied out-of-plane. Magnetic characterization is performed with Magneto-optic Kerr effect (MOKE) and Photoemission electron microscopy (PEEM). We find that the electric field modifies the magnetic anisotropy and induces nucleation of new magnetic domains. We find that the charge modulation at the interface reduces the energy barrier for domain wall nucleation by 10%, explaining such an effect.

Tuning Ferromagnetism at Room Temperature by Visible Light

Bálint Náfrádi 1, Péter Szirmai 1, Masimo Spina 1, Andrea Pisoni 1, Xavier Mettan 1, Norbert Nemes 2, László Forró 1, Endre Horvath 1
1 Laboratory of Physics of Complex Matter, EPFL
2 Laboratorio de Heteroestructuras con aplicación en Spintronica, Unidad Asociada Consejo Superior de Investigaciones Científicas/Universidad Complutense Madrid, ES-28049 Madrid

Most of the digital information today is encoded in the magnetization of ferromagnetic domains. Writing a bit is usually achieved by rotating domains, which relies on magnetic fields. An alternative approach is to change the magnetic state directly by changing the interaction between spins. Correlated oxides are ideal materials for this because the effect of small external control parameter is amplified by the electronic correlations. Here, we present a radically new method for reversible, light-induced tuning of ferromagnetism at room temperature using a CH_3NH_3PbI_3/La_{0.7}Sr_{0.3}MnO_3 heterostructure. We demonstrate that photo-induced charge carriers from the CH_3NH_3PbI_3 photovoltaic perovskite efficiently dope the La_{0.7}Sr_{0.3}MnO_3 thin film and melt the ferromagnetism.
13:15 818 Spin Hall effect measured by magneto-optical Kerr microscopy

Christian Stamm 1, Christoph Murer 1, Marco Berritta 2, Junxiao Feng 1, Mihai Gabureac 1,
Peter Oppeneer 2, Pietro Gambardella 1
1 Department of Materials, ETH Zürich
2 Department of Physics and Astronomy, Uppsala University

The spin Hall effect in a current-carrying wire leads to the accumulation of spins at the outer edges of the wire. We detect this spin imbalance by magneto-optical Kerr microscopy and find that the Kerr rotation for Pt and W has opposite sign, as expected from the respective spin Hall angles. The measured spin accumulation scales linearly with the applied current density. In thickness-dependent measurements as well as in ab-initio calculations we find a spin diffusion length in Pt of 9 ± 2 nm, significantly larger compared to a Pt film that is in contact with a magnetic layer.

13:30 819 Time-resolved X-ray detected ferromagnetic resonance with spatial resolution using scanning X-ray microscopy

Taddäus Schaffers 1, Verena Ney 1, Katharina Ollefs 2, Ralf Meckenstock 2, Detlef Spoddig 2,
Hendrik Ohldag 3, Andreas Ney 1
1 Division of Solid State Physics, Johannes Kepler University, Altenberger Str. 69, AT-4040 Linz
2 Experimental Physics, University of Duisburg-Essen, Lotharstr. 1, DE-47057 Duisburg
3 Stanford Synchrotron Radiation Laboratory, SLAC National Accelerator Laboratory, Menlo Park, CA 94025, USA

Recently we have combined a scanning transmission x-ray microscopy (STXM) setup with a novel microwave synchronization scheme for studying high frequency magnetization dynamics in the GHz regime [1] enabling spatially resolved ferromagnetic resonance (FMR) studies on magnetic micro- and nanostructures. Compared to other spatially resolved FMR detection schemes [2] the STXM-FMR setup features element-selectivity as well as high temporal and spatial resolution down to 18 ps and 35 nm [1]. We will briefly present the STXM-FMR detection [1] and first results for coupled magnetic structures (Co stripe coupled to Py dot).


13:45 END

ID
MAGNETISM AND SPINTRONICS POSTER

831 cancelled

832 Superlattice of single atom magnets

Stefano Rusponi 1, Romana Baltic 1, Marina Pivetta 1, Fabio Donati 1, Christian Wäckerlin 1,
Aparajita Singha 1, Jan Dreiser 2, Harald Brune 1
1 EPFL/IPHYS, 2 PSI/SLS

Regular arrays of single atom magnets represent model systems for information storage at the ultimate length scales. Individual rare-earth atoms on decoupling layers have recently received great attention for showing extraordinary magnetic stability; however, they still lack spatial order. Here we report a self-assembled superlattice of individual and noninteracting Dy atoms on graphene grown on Ir(111), with magnetic hysteresis up to 5.6 T and spin lifetime of 1000 seconds at 2.5 K. The observed magnetic stability of Dy atoms is a consequence of the low intrinsic electron and phonon densities of graphene and the six-fold symmetry of the Dy adsorption site [R. Baltic et al., Nano Lett. (2016), DOI: 10.1021/acs.nanolett.6b03543].
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<td>833</td>
<td>Additive Manufacturing of Polymer Bonded Rare-Earth Magnets for a Predefined External Field</td>
<td>Christian Huber¹, Claas Abert¹, Florian Bruckner¹, Martin Groenefeld², Julian Teliban², Dieter Süss¹</td>
<td>Recently it was shown that an end-user 3D printer can be used to print polymer bonded rare-earth magnets with a complex shape. The focus here is to manufacture polymer bonded NdFeB magnets for producing a tailored external field in a specific region outside the magnet. To determine the desired magnetization or shape of the printed magnet we developed an inverse stray field method and a topology optimization algorithm based on finite elements that allows us to deduce the magnetization and the shape of the magnet, respectively. With this simulation framework magnets are designed and printed.</td>
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<td>834</td>
<td>Anomaly in electric transport behavior across Verwey transition in spintronic Fe₃O₄ oxide thin films</td>
<td>Murtaza Bohra, Mahindra Ecole Centrale, Hyderabad, 500043, Telangana, India</td>
<td>Nanocrystalline Fe₃O₄ thin films were grown by adopting two different reduction approaches: (1) vacuum annealing, (2) wet H₂ annealing. While vacuum annealed films show Verwey transition with lower resistivity compared to the bulk Fe₃O₄, the same are not observed in electric transport properties of wet H₂ annealed films. However, this transition was clearly seen in the temperature dependence of magnetizations of both sets of Fe₃O₄ thin films. This seems to indicate that the both electric transport and magnetization are independent processes; it’s just coincidence to happen at same place of Verwey transition at 120 K. Different electric transport properties in both reductions treated Fe₃O₄ films will be discussed.</td>
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<td>835</td>
<td>Magnetic properties and morphology of cobalt-cobalt oxide core-shell structured nanoparticles</td>
<td>Jaianth Vijayakumar¹, Tatiana M. Savchenko¹, Armand Béché², Johan Verbeeck², Frithjof Nolting¹, Carlos A. F. Vaz¹, Armin Kleibert¹</td>
<td>We report the formation and magnetic properties of metallic cobalt-core and oxide shell structured nanoparticles upon oxidation of Co nanoparticles with molecular oxygen under ultra-high vacuum conditions. The presence of a core-shell structure was confirmed with HR-STEM while x-ray photoemission electron microscopy shows that the core remained metallic and magnetic at low oxygen dosage, with CoO as the oxide shell. At higher oxygen dosages CoO and Co₃O₄ form the oxide shell and the core loses its magnetic contrast. These results show that the presence of high magnetic anisotropy in Co nanoparticles does not arise from a surface anisotropy contribution.</td>
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<td>836</td>
<td>Magneto-optical detection of the spin Hall effect in Pt and W thin films</td>
<td>Christoph Murer¹, Christian Stamm¹, Marco Berritta², Junxiao Feng¹, Mihai Gabureac¹, Peter Oppeneer², Pietro Gambardella¹</td>
<td>A charge current flowing through a nonmagnetic conductor induces a spin current perpendicular to both the current direction and the spin polarization due to the spin Hall effect (SHE). Due to the nature of the SHE, most spin accumulation detection methods rely on the utilization of adjacent ferromagnets [1]. We report here the first direct measurement of the current-induced interfacial spin accumulation due to the SHE in Pt and W thin films by magneto-optical scanning Kerr microscopy. Our measurements, combined with first principle electronic structure calculations of the SHE and magneto-optic response of Pt and W, yield quantitative estimates of the spin Hall angle and spin diffusion length in nonmagnetic conductors.</td>
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Spin wave scattering by a magnetic defect in a magnonic crystal detected by Brillouin light scattering microscopy

Korbinian Baumgaertl, Sho Watanabe, Dirk Grundler, EPFL

Magnonic crystals (MCs) allow for tailoring the dispersion relation of spin waves (SWs) in nanopatterned ferromagnets. Local defects in MCs are expected to add further functionality. We prepared 1D MCs consisting of bistable magnetic stripes separated by sub-100 nm air gaps. By adjusting the magnetic history, we programmed ordered magnetic states with single stripes of opposed magnetization. We studied the influence of these defects on propagating SWs via broadband microwave spectroscopy and phase-resolved focused Brillouin light scattering microscopy. Depending on a bias magnetic field, we observed SW attenuation and phase shift caused by the magnetic defects.

We thank for funding by SNSF via grant 163016.

Broadband spin-wave spectroscopy performed on single crystals of the insulating chiral magnet Cu$_2$OSeO$_3$

Ping Che 1, Ioannis Stasinopoulos 2, Andreas Bauer 2, Johannes Waizner 3, Helmuth Berger 1, Markus Garst 4, Christian Pfleiderer 2, Dirk Grundler 1

1 EPFL, 2 Physik Department E51, Technische Universität München
3 Institut für Theoretische Physik, Universität zu Köln
4 Institut für Theoretische Physik, Technische Universität Dresden

The chiral ferrimagnet Cu$_2$OSeO$_3$ hosts topologically protected spin textures known as magnetic skyrmions. It has been shown to provide novel functionality in microwave technology due to e.g. dichroism. We conducted broadband spin-wave spectroscopy on different single crystals of Cu$_2$OSeO$_3$ with magnetic fields applied in different orientations. In the field-polarized phase at 5 K we observe numerous sharp resonances that we attribute to discretized spin waves in the mm-long crystals. Their observation substantiates a very low damping parameter which is key for microwave applications.

Support by DFG TRR80, DFG FOR960, ERC Advanced Grant 291079 (TOPFIT) and SNSF Sinergia Network NanoSkyrmions CRSII5 171003 is acknowledged.

Spin transport properties of ferromagnetic nanotubes

Maria Carmen Giordano, Korbinian Baumgaertl, Gözde Tütüncüoğlu, Anna Fontcuberta i Morral, Dirk Grundler
EPFL, 1015 Lausanne

The core-free magnetic configuration of ferromagnetic nanotubes leads to a controllable and fast reversal process and makes them promising candidates for high-density data storage, magnetic sensors, and logic device elements. We explore the magnetic configurations of different individual ferromagnetic nanotubes that we deposited on semiconductor nanowires of GaAs. Nanotubes prepared from permalloy or CeFeB have diameters ranging from 130 to 200 nm and a length in the range of 5 - 20 micrometers. We perform measurements on the magnetoresistance and anomalous Nernst effect.

The research is funded by the DFG via GR1640/5-2.

Spin wave excitations in ferromagnetic antidot lattices with penrose tilings

Sho Watanabe, Vinayak S. Bhat, Korbinian Baumgaertl, Dirk Grundler, EPFL

Interconnected nanomagnets periodically arranged in one and two dimensions, called magnonic crystals, have been shown to provide tailored band structures for spin waves. The same has been found for antidot lattices. Aperiodic tilings and so-called artificial quasicrystals are far less explored. We fabricated nanopatterned holes in CoFeB thin films that were arranged in a Penrose tiling. Using broadband spin wave spectroscopy, we studied the absorption of microwaves and the propagation of spin waves. We observed characteristic sets of resonances in both the absorption and transmission experiments. We interpret the results in terms of dispersive eigenmodes of the quasicrystalline nanohole lattices.

This work was supported by SNF via grant number 163016.
Skyrmion Confinement in Magnonic Antidot Lattices

Susmita Saha 1,2, Anna Kinga Suszka 1,2, Jörg Raabe 2, Laura J. Heyderman 1,2, Sebastian Wintz 2, Simone Finizio 2

1 ETH Zürich, 2 Paul Scherrer Institut

Magnonic crystals are a novel type of artificial crystals formed by the periodic arrangement of magnetic nanostructures and magnetic skyrmions [1] are topologically stable spin textures, generally stabilized by Dzyaloshinskii-Moriya interactions [2]. Key challenges regarding the skyrmion lattice are to stabilize and confine them. The aim of the present work is to stabilize and confine the magnetic skyrmions by patterning a nanometer size antidot lattice in high perpendicular magnetic anisotropy films. The observations are very important for future magnon spintronic devices based on skyrmion lattices.


Photoemission Electron Microscopy Studies of Dynamics in Dipolar-Coupled Arrays of Nanomagnets

Hanu Arava, Peter Derlet, Jaianth Vijayakumar, Armin Kleibert, Laura Heyderman, Paul Scherrer Institute

One of our primary areas of research is artificial spin ice, which consists of specific arrangements of nanomagnets that display analogous behavior to their real crystal counterparts such as the rare-earth Pyrochlore compounds. We have earlier investigated static/quasi-static responses of well-known structures, such as artificial square and kagome spin ices, and our current efforts are on probing for magnetization dynamics. Frustration, when combined with topological defects, leads to dynamics that are geometry specific. We investigate the temperature dependent response of the nanomagnet arrays using Photoemission Electron Microscopy.

Controlled aggregation of magnetic nanocrystals in Fe-doped GaN

Andrea Navarro-Quezada 1, Thibaut Devillers 1, Tian Li 1, Maciej Sawicki 2, Tomasz Dietl 2, Alberta Bonanni 1

1 Johannes Kepler Universität Linz, 2 Polish Academy of Sciences

The control over the aggregation of magnetic ions in a non-magnetic semiconductor matrix constitutes a new way to realize semiconductor/ferromagnetic nanocomposites with yet unexplored but striking functionalities. In this work we show that it is possible to obtain a controlled and well-defined arrangement of single-phase magnetic Fe-rich nanocrystals embedded in a GaN matrix [1]. We observe a phase-separation occurring already above 0.4% of iron ions, leading to the formation of Fe-rich nanocrystals with particular stoichiometry and magnetic properties. The significance of these results is discussed in view of prospects for spintronic devices.


Magneto-mechanical metamaterial

Paolo Testa 1,2, Jizhai Cui 1, Robert Style 2, Peter M. Derlet 1, Eric Dufresne 2, Laura Heyderman 1,2

1 Paul Scherrer Institute, 2 ETH Zürich

Artificially designed arrays of nanostructures with a microstructure at sub-micrometer length scales can exhibit unique functionality, especially when built from a combination of different classes of materials. We present an overview of a novel magneto-mechanical metamaterial, where the coupling between nanoscale magnets embedded in a soft polymer matrix is exploited to control its mechanical properties. In addition, we elaborate on the possible applications unlocked by this new system. Different approaches to the realization of such a material using lithography, 3D laser lithography and nanoparticle dispersions are expanded upon. Finally, we present the most recent results involving fabrication and characterization of magneto-mechanical properties of our proposed metamaterial.
845  **Monte Carlo Renormalization Group study of dipolar coupled XY spins**

* Dominik Schildknecht 1, Laura Heyderman 1,2, Peter Derlet 1
  1 Paul Scherrer Institute, 2 ETH Zürich

In contrast to well-known models such as the Heisenberg model, which just incorporate the notion of the nearest neighbour, the anisotropic dipolar interaction directly depends on the geometry of the lattice and therefore its symmetries. These symmetries should be reflected by the properties of a possible phase transition in that system. To study these effects we employ the Monte Carlo Renormalization Group technique since this method can provide precise estimates of the critical exponents. We will show our latest results for the 2D XY dipolar interacting square lattice and other related systems.

846  **Magnetic correlations in artificial 2D XY spin systems**

* Naëmi Leo 1, Stefan Holenstein 1, Dominik Schildknecht 1, Oles Sendetskyi 1, Peter Derlet 1, Hubertus Luetkens 1, Stephen Lee 2, Laura Heyderman 1,3
  1 Paul Scherrer Institute, 2 St. Andrews University, St. Andrews, Scotland, 3 ETH Zürich

Correlations in low-dimensional magnetic systems result in interesting properties, especially if continuous spin degrees of freedom are involved. Here we observe the magnetic correlations of dipolar-coupled artificial XY moments (circular nanomagnets) on a square lattice as a function of temperature using low-energy muon-spin relaxation. For strong interactions between the nanomagnets, we observe the onset of slow collective dynamics below a tunable critical temperature. In contrast, the dynamics in weakly-interacting systems is described by the blocking of individual nanomagnets which happens at considerably lower temperatures.

847  **Reconfigurable Magnetic Logic Combined with Nonvolatile Memory Writing**

* Zhaochu Luo, ETH Zürich & Paul Scherrer Institut

Benefiting from the extra dimension of spin, magnetic logic has attractive features of reconfigurable logic operation and built-in non-volatile memory, which is promising for bridging the gap between memory and processor. Here, we proposed a new magnetic logic combining anomalous Hall effect and negative differential resistance phenomenon. In magnetic logic, four basic Boolean logic operations can be programmed by a magnetic bit at room temperature with a high output ratio (> 1,000 %). In the same clock cycle, benefiting from the built-in spin Hall effect, logic results can be directly written into magnetic bits using an all-electric method.