MA 15: Computational Magnetism II

Time: Monday 15:00–16:30 Location: HSZ 403

MA 15.1 Mon 15:00 HSZ 403

Magnetic topological semimetals — •Maia G. Vergniory[1,2], Niels B. M. Schröter[3], Iñigo Robredo[1,5], Sebastian Klemenz[4], Robert Kirby[4], Vladimir Strocov[3], Jonas Krieger[3], Tianlun Yu[3], Fernando de Juan[1,2], Aitor Bergara[1,5], Jeniffer Cano[6], Barry Bradlyn[7], Andreas Schnyder[8], and Leslie Schoop[4] — [1]Donostia International Physics Center, 20018 Donostia-San Sebastian, Spain — [2]IKERBASQUE, Basque Foundation for Science, 48013 Bilbao, Basque Country, Spain. — [3]Swiss Light Source, Paul Scherrer Institute, CH-5232 Villigen PSI, Switzerland — [4]Princeton University, Princeton NJ, USA — [5]Condensed Matter Physics Department, University of the Basque Country, Spain — [6]State University of New York at Stony Brook and Flatiron, USA — [7]University of Illinois at Urbana-Champaign, USA — [8]Max Planck Institute for Solid State Research, Stuttgart, Germany

Weyl fermions are expected to exhibit exotic physical properties such as the chiral anomaly, large negative magnetoresistance or Fermi arcs. Recently a new platform to realize these fermions has been introduced based on the appearance of a high-order nodal crossings at high symmetry points of certain space groups. In this talk will show we can also find these crossings in magnetic groups, such as the 3-fold and 6-fold magnetic degeneracies, which are topologically equivalent to spin-1 Weyl and Dirac fermions. We will conclude showing the experimental realization of some of these magnetic fermions in real materials. such as the non-symmoriphic CeSbTe or the topological properties of a metallic ferromagnetic pyrite.

MA 15.2 Mon 15:15 HSZ 403

Spin-polarized transport in anti-ferromagnetic RuO_2 — •Kyo-Hoon Ahn[1], Atsushi Hariki[1], Kwan-Woo Lee[2,3], and Jan Kuneš[1,4] — [1]Institute for Solid State Physics, TU Wien, 1040 Vienna, Austria — [2]Division of Display and Semiconductor Physics, Korea University, Sejong 30019, Korea — [3]Department of Applied Physics, Graduate School, Korea University, Sejong 30019, Korea — [4]Institute of Physics, Czech Academy of Sciences, Na Slovance 2, 182 21 Praha 8, Czechia

We will present the origin of antiferromagnetism (AFM) in RuO_2 using two approaches of static Hartree-Fock and density functional + dynamical mean-field theory. Since the ordering of two anti-parallel Ru sites does not change the translational symmetry, the AFM electronic structure is spin-polarized which is unique among commom antiferromagnets. In the Fermi surfaces the two spin channels are $\pi/2$-rotated to each other, classified as a spin-triplet d-wave Pomeranchuk instability. Comparing the energy difference of paramagnetic (PM) and AFM for the entire Brillouin zone (BZ), we found a hot spot at the point K2 on the PM Fermi surface, where nodal-lines meets the BZ edge as well as the Ru1 and Ru2 characters touch each other. By constructing a model Hamiltonian for the K2 point, we show that the nodal-lines close to the Fermi level are split by the applied staggered potential, and this is the origin of the AFM instability. [1] Ahn *et al.*, Phys. Rev. B **99**, 184432 (2019).

MA 15.3 Mon 15:30 HSZ 403

Optimal control of magnetization switching in nanowires — •Mohammad Badarneh[1], Grzegorz Kwiatkowski[1], and Pavel Bessarab[1,2,3] — [1]University of Iceland, Reykjavík, Iceland — [2]ITMO University, St. Petersburg, Russia — [3]Peter Grünberg Institute and Institute for Advanced Simulation, Forschungszentrum Jülich, Jülich, Germany

We explore theoretical limits for the energy-efficient control of switching phenomena in bistable magnetic nanowires. We calculate optimal control paths (OCPs) for the magnetization switching as functions of the switching time, damping and various parameters of the nanowires. Following an OCP involves concerted rotation of the magnetic moments in such a way that the system's internal modes are effectively used to aid magnetization switching. OCP calculations demonstrate that short nanowires reverse their magnetization via coherent rotation which can be induced by applying uniform external magnetic field with frequency defined by a collective in-phase precession of the magnetization. If the length of the wire exceeds a certain critical length, standing spin wave emerges during magnetization switching. Such spin wave assisted magnetization switching has recently attracted much attention as a promising technique to reduce the switching field for magnetic recording. Our results demonstrate that optimal switching mechanisms and corresponding control stimuli can be predicted from first principles, contributing to the development of low-power technologies.

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MA 15.4 Mon 15:45 HSZ 403

Magnetically controlled shapes of flexible ferromagnetic ribbons — •Kostiantyn V. Yershov[1,2], Volodymyr P. Kravchuk[2,3], Denis D. Sheka[4], and Jeroen van den Brink[1] — [1]Leibniz Institute for Solid State and Materials Research, Dresden, Germany — [2]Bogolyubov Institute for Theoretical Physics, Kyiv, Ukraine — [3]Karlsruhe Institute of Technology, Karlsruhe, Germany — [4]Taras Shevchenko National University of Kyiv, Ukraine

We consider flexible one- and two-dimensional ferromagnets with coupled magnetic and mechanical subsystems. The coupling between the magnetic and mechanical subsystems is driven by uniaxial anisotropy with the easy-axis normal or tangential to the magnetic film/ring and by the Dzyaloshinskii–Moriya interaction (DMI). We show that magnetic subsystem can determine the equilibrium shape of the ferromagnet. For elastic rings depending on the magnetic and elastic parameters and the size of the system one can obtain two different states: the onion state with the quasi-uniform magnetization and the vortex state with the magnetization oriented tangentially to the wire. We also show that the presence of DMI, results in a spontaneous deformation of a flexible magnetic ribbon. The final state of the ribbon is characterizing by the geometrical chirality whose sign is determined by the sign of the DMI constant. Depending on the mechanical, magnetic, and geometric parameters of the system one can obtain two different states: twisted-state with a straight central line and DNA-like state with a helix-shaped central line.

MA 15.5 Mon 16:00 HSZ 403

Meron/antimeron magnetic majority gates. — •Nikolaos Ntallis[1], Anders Bergman[1], Danny Thonig[3], Erik Sjöqvist[1], Anna Delin[2], Olle Eriksson[1,3], and Manuel Pereiro[1] — [1]Department of Physics and Astronomy, Uppsala University, Uppsala 751 20, Sweden — [2]Department of Applied Physics, School of Engineering Sciences, KTH Royal Institute of Technology, Electrum 229, SE-16440 Kista, Sweden — [3]Orebro University, SE-701 82, Orebro, Sweden

The development of electronic devices is undergoing the bottleneck of the performance and power consuming with continuous miniaturization. Spin based logic devices, which use the spin degree of freedom, have attracted a lot of research interest due to their potential in low-power operation, non-volatility and possibility to enable new computing applications. In this work, we present a model for a magnetic majority gate in which bits are assigned to merons/antimerons. We employ atomistic spin dynamics simulations via the UppASD package on nanostructures with symmetry of a kagome lattice. The merons can propagate along the edge of the material with negligible energy dissipation due to the presence of chiral edge modes. We demonstrate how different input modes can result into a single topological excitation in the output signal.

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MA 15.6 Mon 16:15 HSZ 403

Engineering relaxation pathways for plasmon-assisted nanomagnetic computation — •Naëmi Leo, Matteo Menniti, and Paolo Vavassori — CIC nanoGUNE, Donostia – San Sebastián, Spain

Nanomagnetic logic, which uses arrays of magnetostatically-coupled single-domain nanomagnets for computation, is a low-power alternative to current charge-based semiconductor devices. At the heart of the computation process lies the thermal relaxation from a magnetic-field-set moment configuration towards a low-energy state of the interacting ensemble. The computational functionality of such circuits is determined by the single-spin-flip connectivity of magnetic states, and the temperature-dependent rates for moment orientations, that regulate which relaxation pathways the system will explore.

Here we discuss recent developments to manipulate the relaxation kinetics of nanomagnetic circuits: As the spatial arrangement of the nanomagnets determines the configuration energies, pathways of different character – monotonic and intermittent – can be realised, which lend themselves to the implementation of deterministic and probabilistic computation, respectively. To allow for the kinetic control of relaxation pathways, plasmon-assisted photoheating of hybrid gold-magnet nanostructures allows for fast, spatially-, and sublattice-selective heating schemes within time scales as short as a few tens of picoseconds.