MA 60: Spin Structures and Magnetic Phase Transitions

Time: Thursday 17:30–19:15 Location: HSZ 103

MA 60.1 Thu 17:30 HSZ 103

Imaging the ferromagnetic phase transition in magnetic microstructures with PEEM — •Oliver Sandig[1], Julia Herrero-Albillos[1], Nils Nüsse[1], Florian Kronast[1], Florian M. Römer[2], and Michael Farle[2] — [1]Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin — [2]Universität Duisburg-Essen, Duisburg

A fundamental question in ferromagnetic systems with reduced dimensions is, whether magnetic properties vary laterally at the edges of the sample, at defects or at steps due to the underlying substrate. Due to changes in the local fluctuation rate of the magnetic moments, the Curie Temperature (T_C) is a good quantity to detect such variations. Those changes of T_C and the involved length scales are of increasing interest for the stability of data storage and spintronic applications. We used x-ray photoelectron emission microscopy to image local variations of T_C in micro-structured Fe films. We grew well defined magnetic structures of different shape and size by in-situ Fe evaporation on pre-patterned Si substrates. Different areas on our sample were magnetically decoupled from each other due to the sample topography. To image local variations of T_C we used a special sample holder. It allows measuring the local AC susceptibility (χ_{ac}) as a function of temperature with a spatial resolution better than 100nm and temperature stability of 0.2K [1]. In our presentation we compare T_C of different magnetic structures to that of a continuous reference film which allows us to identify the onset of finite size effects in our sample.

MA 60.2 Thu 17:45 HSZ 103

Magnetic ordering and spin dynamics in the Swedenborgite $CaBaCo_2Fe_2O_7$ — •Johannes Reim[1], Werner Schweika[1], Erik Rosén[1], Martin Valldor[2], and Enrico Faulhaber[3] — [1]IFF-4, Forschungszentrum Jülich GmbH — [2]II. Phys. Institut, Universität zu Köln — [3]FRM II, Garching

The Swedenborgites [1] represent a new type of highly frustrated magnets with antiferro-magnetically coupled spins on staggered kagome layers. Geometrical frustration suppresses long-range magnetic order to evolve in many compounds that we have studied so far by polarised neutron diffraction on powder samples. However, a few chemical compositions do enter a Néel state at lower temperatures [2], for example $CaBaCo_2Fe_2O_7$.

By using neutron single crystal diffraction and diffuse neutron scattering we observed magnetic long-range order below 160 K exhibiting a $\sqrt{3} \times \sqrt{3}$ superstructure and a weak anisotropy as evidenced by polarisation analysis. Modelling a Heisenberg nearest neighbour Hamiltonian for different in- and out-of-plane coupling constants with Monte Carlo simulations we determine the phase diagram in dependence on these coupling constants. Neutron measurements of the spin dispersion exhibits unusually broad excitations indicating strongly damped spin vectors.

[1] M. Valldor, M. Andersson, Solid State Sciences 4 (2002) 923-931; [2] M. Valldor, Y. Sanders, W. Schweika, Journal of Physics: Conference Series 145, 012076 (2009)

MA 60.3 Thu 18:00 HSZ 103

Spin echo measurements of magnetic fluctuations in helical $Mn_{1-x}Fe_xSi$ — •Alexander Tischendorf[1], Wolfgang Häussler[1,2], Andreas Bauer[1], Peter Böni[1], and Christian Pfleiderer[1] — [1]Technische Universität München, Physik Department E21, 85748 Garching, Germany — [2]Forschungsneutronenquelle Heinz Maier-Leibnitz (FRM-II), 85748 Garching, Germany

Manganese silicide (MnSi) is a 3d inter metallic compound and crystallizes in a cubic B20 structure. In absence of an external magnetic field for temperatures below T_c the magnetization caused by the spin of the electrons forms a chiral long-period ferromagnetic helix with a period of approximately 180 Å. Furthermore, the phase transition temperature in $Mn_{1-x}Fe_xSi$ changes with the conzentration x. At a critical concentration x_c the phase transition temperature $T_c = 0$ and there is a quantum phase transition (QPT).

By means of neutron spin echo we investiaged the linewidth of magnetic fluctuations in absence of an external magnetic field. The high energy resolution and the small angle scattering set up of the spin echo instrument RESEDA at the Forschungs-Neutronenquelle Heinz Maier-Leibnitz (FRM II) offer paramter ranges, which are not accessable in triple axes measurements. We measured the linewidth in dependence of different temperatures and Q-values in pure MnSi and also compared them to an iron doped sample. The measured linewidth will be discussed, regarding the spin-fluctuation theory of weakly magnetic itinerant-electron compounds, which allows the identification of anomalous behavior at QPTs.

MA 60.4 Thu 18:15 HSZ 103

Field-induced chirality in Dy/Y multilayer systems — •Dieter Lott[1], Sergey V. Grigoriev[2], Yury O. Chetverikov[2], Roger C. Ward[3], Alexander Grünwald[1], and Andreas Schreyer[1] — [1]Helmholtz Zentrum Geesthacht, Geesthacht, Germany — [2]Petersburg Nuclear Physics Institute, Gatchina, Russia — [3]University of Oxford, Oxford, United Kingdom

In this work a series of Dy/Y multilayer samples with different Dy and Y layer thicknesses were studied to modify the interlayer and intralayer RKKY coupling mechanism in the system. Polarized neutron reflectometry studies reveal the occurrence of chirality effects which can be manipulated by the application of a magnetic field applied during the Field Cooling process. The studies show intriguing features giving experimental hints for the theoretical interpretation of the observed phenomena. The obtained results can be interpreted taking into account the interplay of the RKKY and Zeeman interactions. Upon Zero Field cooling a helix inside one Dy layer suffers from the domain walls between the right- and left skewed structures. The magnetic field applied upon cooling, firstly, removes the domain walls inside the Dy layer. Secondly, the Zeeman interaction, coupling the non-compensated moments of the Dy layer with the magnetic field, competes with the interlayer RKKY interaction. When at a certain condition the two interactions compensate each other, the third antisymmetric Dzyaloshinskii-Moriya interaction, appearing due to the lack of inversion symmetry on the interfaces, reveals itself through the sign of the average chirality of the structure.

MA 60.5 Thu 18:30 HSZ 103

Precursor states and Skyrmion confinement in cubic helimagnets — •Andrey A. Leonov, Anna B. Butenko, Alexei N. Bogdanov, and Ulrich K. Rössler — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

Within the phenomenological Dzyaloshinskii model we show that precursor effects [1] experimentally observed in cubic helimagnets with B20 structure near the ordering temperature can be explained by the unconventional behavior of 'Skyrmion matter'[2]. Skyrmion states in the form of staggered half-Skyrmion configurations and $\pm\pi$-hexagonal lattices undergo confinement in the temperature range $\Delta T = T_N - T_L$ and can exist as bound liquid-like or ordered arrays [2]. Confined Skyrmion textures arise from the disordered state through a rare case of an instability-type nucleation transition. Their field-driven transformation is marked by the interplay of angular and longitudinal order parameters. The confinement temperature T_L separates the major part of the magnetic phase diagram with regular chiral modulations [3] from the precursor regime. The stabilization of Skyrmionic textures against the competing helical and conical modulations near magnetic ordering can be achieved by small additional interactions such as dipolar couplings, thermal fluctuations, cubic and uniaxial anisotropies, anisotropic exchange etc. [1] C. Pappas et al., Phys. Rev. Lett. **102**, 197202 (2009); [2] U. K. Rößler et al., J. Phys., in press; [3] A. Bogdanov, A. Hubert, J. Magn. Magn. Mater. **138**, 255 (1994); A.B. Butenko et al., Phys. Rev. B **80**, 134410 (2009).

MA 60.6 Thu 18:45 HSZ 103

Itinerant electrons on the Coulomb phase — •Ludovic Jaubert[1], Masud Haque[1], Swann Piatecki[1,2], and Roderich Moessner[1] — [1]MPI-PkS, Dresden — [2]ENS Paris, France

The Coulomb phase describes a state encountered in frustrated systems where geometrical constraints lead to the emergence of a gauge field. Its effective description is quite analogous to that of a free magnetic field, with large fluctuations coexisting with algebraic correlations.

In this talk, we shall use this exotic phase as a magnetic background for the motion of itinerant electrons. This permits us to study, within a largely analytical framework, the interplay between frustration and conduction on two- and three-dimensions lattice models. We shall in

particular focus on how Coulomb phase fluctuations persist (or not) in the presence of electron doping, and whether they tend to favor insulating or metallic behaviour.

MA 60.7 Thu 19:00 HSZ 103

Effective magnetic Hamiltonians — •Vaclav Drchal[1], Josef Kudrnovsky[1], and Ilja Turek[2] — [1]Institute of Physics, AS CR, Praha, Czech Republic — [2]Institute of Physics of Materials, AS CR, Brno, Czech Republic

The effective magnetic Hamiltonian which can be used to derive magnetic structure of a solid or a nanostructure, consists of: (i) Local exchange part that describes formation of local moments on individual atoms. This part can be calculated using the fixed spin moment method. (ii) Isotropic Heisenberg Hamiltonian that describes interactions between spin moments on different atoms. It is responsible for ordering of magnetic moments. The isotropic exchange interactions are calculated from the Liechtenstein formula. (iii) Anisotropic part which includes relativistic effects and dipole-dipole interactions. These terms determine the orientation of magnetic moments with respect to crystallographic axes. The methods of statistical mechanics can be applied to the effective magnetic Hamiltonian in order to predict properties (such as the size and orientation of magnetic moments, the Curie/Néel temperature, magnon spectra, etc.) of complex magnetic systems. Simultaneous treatment of local exchange interactions and the interatomic exchange interactions makes possible to correctly describe the varying values of magnetic moments and origin of induced moments. We will show in some detail how to construct the effective magnetic Hamiltonian for 3d and 4d metals and their alloys from first principles, and the importance of anisotropic interactions for determination of the magnetic structure of magnetic monolayers on non-magnetic substrates.