TT 28: Correlated Electrons: Spin Systems, Itinerant Magnets 3

Time: Tuesday 9:30–12:45 Location: H19

TT 28.1 Tue 9:30 H19

Structure and Phase Transitions of the Spiral Antiferromagnet $Ba_2CuGe_2O_7$ — •Sebastian Mühlbauer[1], Markus Garst[2], Ekaterina Pomjakushina[3], Severian Gvasaliya[4], Eric Ressouche[5], Charles Dewhurst[5], Joachim Kohlbrecher[3], and Andrey Zheludev[4] — [1]Forschungsneutronenquelle Heinz Maier-Leibnitz, Garching, Germany — [2]Institut für Theoretische Physik, Universität zu Köln, Germany — [3]Paul Scherrer Institut, Villigen, Switzerland — [4]Neutron Scattering and Magnetism, ETH Zürich, Switzerland — [5]Institut Laue Langevin, Grenoble, France

Neutron diffraction and small angle neutron scattering (SANS) in combination with measurements of susceptibility and specific heat have been used to systematically study the different magnetic structures of the non-centrosymmetric tetragonal antiferromagnet (AF) $Ba_2CuGe_2O_7$, that evolve for different orientation of the magnetic field. A complete description of the magnetic phase diagram could be achieved [1,2]: For magnetic field close to the tetragonal *c*-axis, a phase transition from the soliton lattice to a recently reported incommesurate double-*k*-phase is confirmed. In contrast, for large angles enclosed by the magnetic field and the *c*-axis, a complexly distorted non-sinusoidal structure is observed. For magnetic field in the basal *a*,*b*-plane, a incommensurate/commensurate transition is observed at 9 T. The staggered component of the Dzyaloshinsky-Moriya vector is identified as key element for the understanding of $Ba_2CuGe_2O_7$.

[1] S. Mühlbauer et al., Phys. Rev. B **84**, 180406 (2011).
[2] S. Mühlbauer at al., Phys. Rev. B **86** 02217 (2012).

TT 28.2 Tue 9:45 H19

Spin-charge-lattice coupling in the semimetallic ferromagnet EuB_6 — •F. Schnelle[1], R. S. Manna[1], P. Das[1], J. Müller[1], Z. Fisk[2], and M. Lang[1] — [1]Institute of Physics, Goethe-University Frankfurt, 60438 Frankfurt (M), Germany — [2]Department of Physics, University of California, Irvine, California 92697, USA

The semimetallic EuB_6 exhibits a complex sequence of electronic and magnetic phase transitions at ∼15.5 K (T_{c1}) and ∼12.5 K (T_{c2}). In the paramagnetic regime below ∼35 K, magnetic polarons (MPs) are expected to form since it is energetically favorable for the charge carriers to localize and thereby spin polarize the local Eu^{2+} moments over a finite distance. Thermal expansion measurements show pronounced lattice effects at the phase transition temperatures, the one occurring at T_{c2} being much larger than that at T_{c1}. By applying a small magnetic field of less than 50 mT, the anomaly at T_{c1} is fully suppressed, while the one at T_{c2} shifts to higher temperature and broadens as the field is increased and finally fades out at a field $B > 5$ T. The complementary magnetostriction measurements for a set of temperatures from below T_{c2} to above T_{c1} highlight the extraordinarily large magnetoelastic effects in this material. This supports the notion that charge localization, due to the formation of isolated MPs at temperatures corresponding to the paramagnetic regime, gives rise to lattice expansion. By cooling or applying external magnetic fields, the MPs merge and percolation sets in, resulting in lattice contraction. We discuss the relation of this mechanism to the observed large negative magnetoresistance in this material.

TT 28.3 Tue 10:00 H19

Studying the local magnetic induction of EuB_6 by high-resolution micro-Hall magnetometry — •Merlin Pohlit[1], Adham Amyan[1], Jens Müller[1], and Zachary Fisk[2] — [1]Physikalisches Institut, Goethe-Universität, Frankfurt (M), Germany — [2]University of California, Irvine, USA

In the ferromagnetic semimetal EuB_6 two consecutive transitions occur at T_{c1}=15.5 K and T_{c2}=12.6 K. They are related to electronic and magnetic phase separation, and bulk magnetic ordering, but the details are not yet fully understood. Recently, there has been experimental evidence for the CMR effect observed at T_{c1} beeing caused by percolation of magnetic polarons [1]. Local magnetic measurements, however, have not been performed so far. In this talk we discuss local magnetic induction measurements on a high-quality single crystal using micro-Hall magnetometers based on a high-mobility 2DEG in GaAs/AlGaAs. The sample is positioned on top of the Hall device where a series of adjacent lithographically defined crosses allow for spatially-resolved measurements with micron-size resolution. Strayfield measurements close to the sample give evidence for a spontaneous magnetisation at T_{c1} and allow further insights in the field and temperature dependence of the magnetic transitions. Simultanously performed measurements below the sample give evidence for magnetic domains/inhomogeneities which seem to exist even below the second magnetic transition but vanish by application of a small external field.

[1] Das et al., Phys. Rev. B 86, 184425 (2012)

TT 28.4 Tue 10:15 H19

Analysis of chemical and external pressures in ReCoPO (Re = La, Pr) and LaCoAsO by means of μ^+ spin spectroscopy — •Giacomo Prando[1], Pietro Bonfà[2], Gianni Profeta[3], Rustem Khasanov[4], Fabio Bernardini[5], Marcello Mazzani[2], Eva Maria Bruening[1], Anand Pal[6], Veer Awana[6], Hans-Joachim Grafe[1], Bernd Buechner[1], Roberto De Renzi[2], Pietro Carretta[7], and Samuele Sanna[7] — [1]Leibniz-Institut für Festkörper- und Werkstoffforschung (IFW) Dresden, Germany — [2]Dipartimento di Fisica, Universitá di Parma and CNISM, Italy — [3]SPIN-CNR and Dipartimento di Fisica, Universitá dell'Aquila, Italy — [4]Laboratory for Muon Spin Spectroscopy, Paul Scherrer Institut, Switzerland — [5]Dipartimento di Fisica, Universitá di Cagliari, Italy — [6]National Physical Laboratory (CSIR), New Delhi, India — [7]Dipartimento di Fisica,, Universitá di Pavia and CNISM, Italy

In this contribution we will discuss the local magnetic properties of ReCoPO (Re = La, Pr) as investigated by means of muon spin spectroscopy. Electrons localized on the Pr^{3+} ions do not play any role in the overall magnetic features of the compounds. The increase of the chemical pressure triggered by the different ionic radii of La^{3+} and Pr^{3+} plays a crucial role in enhancing the value of the critical temperature to the magnetic phase and can be mimicked by the application of external hydrostatic pressure. A sharp discontinuity in the local magnetic field at the muon site in LaCoPO suggests a sizeable modification in the band structure of the material upon increasing P. This scenario is qualitatively supported by *ab-initio* DFT calculations.

TT 28.5 Tue 10:30 H19

Heisenberg like critical properties, Magnetocaloric effect and Scaling in Lead doped $NdMnO_3$ Single Crystal — •Nilotpal Ghosh — School of Advanced Sciences, VIT University, Vellore-632014, Tamilnadu

Magnetic isotherms for single crystals of $Nd_{0.7}Pb_{0.3}MnO_3$ have been measured around the ferromagnetic(FM) to paramagnetic(PM) transition temperature T_C. Critical exponents have been obtained by modified Arrott plots and the Kouvel Fisher method. The values of exponents are consistent with those expected for 3D Heisenberg universality class. Magnetocaloric effect (MCE) has been also studied from the magnetic isotherms. Relative cooling power (RCP) is estimated as 56.725, 66.252 and 77.163 J/Kg for 1.2, 2.2 and 4.8 T fields respectively. Universal scaling behaviour in the relative change of magnetic entropy ΔS_M has been observed. The rescaled magnetic entropy change curves for different applied fields are noticed to collapse onto a single curve. It has been found that the peak entropy change, ΔS_M peak at T_C and RCP follow a scaling power law in magnetic field H with the exponents which are reduced in comparison to their theoretically estimated value.

[1] N. Ghosh, Journal of Superconductivity and Novel Magnetism, accepted (2012)
[2] N. Ghosh, S. Roessler, U.K. Roessler, K. Nenkov, S. Elizabeth, H.L. Bhat, K. Doerr, and K.H. Mueller, J. Phys.: Condens. Matter **18**, 557-567 (2006)

TT 28.6 Tue 10:45 H19

From Skyrmions to Helices: Changing the Topology in Chiral Magnets — •Stefan Buhrandt and Achim Rosch — Universität Köln

In chiral magnets, a small magnetic field stabilizes a lattice of magnetic whirls, so called skyrmions. They are characterized by a topologically quantized winding number. Using classical Monte Carlo simulations, we investigate the first order phase transition from the skyrmion phase to a helical phase when the magnetic field is reduced. As the topology of the magnetic texture changes, the phase transition is driven by singular magnetic configuration, which we identify as hedgehog point defect. These hedgehogs are responsible for the merging of skyrmions and changes of the winding number.

15 min. break

TT 28.7 Tue 11:15 H19

Thermal transport properties of single-crystal MnSi — •Marlies Gangl, Anna Kusmartseva, Andreas Bauer, and Christian Pfleiderer — Technische Universität München, Physik Department E21, Garching, Germany

The B20 transition metal compound MnSi has long been recognised as a model system for studies of weak itinerant ferromagnetism [1], when ignoring the formation of a well-understood helical modulation that may be suppressed in small magnetic fields. We report the thermal conductivity and thermopower of high-quality single crystals of MnSi over a wide range of temperatures from 2 to 300 K under magnetic fields up to 14 T. We discuss our findings in the framework of the spin fluctuation theory of weakly ferromagnetic compounds as recently advertised in the context of related studies of $ZrZn_2$ [2,3].

[1] G. Lonzarich and L. Tailefer, J. Phys. C: Solid State Phys. **18**, 4339 (1985)
[2] R.P. Smith et al., Nature **455**, 1220-1223 (2008)
[3] M. Sutherland et al., Phys. Rev. B **85**, 035118 (2012)

TT 28.8 Tue 11:30 H19

Neutron polarimetry of the fluctuation-induced first order helimagnetic transition in MnSi — •Jonas Kindervater[1], Wolfgang Häussler[1,2], Markus Garst[3], Marc Janoschek[4], Christian Pfleiderer[1], and Peter Böni[1] — [1]Physik Department E21, TU München — [2]Forschungsneutronenquelle Heinz Maier-Leibnitz, TU München — [3]Institute for Theoretical Physics, Universiät zu Köln — [4]Los Alamos National Laboratory

Chiral magnets, like the B20 compound MnSi, have recently attracted much scientific interest because a new spin structure representing a skyrmion lattice has been identified under moderate magnetic fields [1]. Besides these topological spin textures the phase transition from heli- to paramagnetism in MnSi has been under active investigation. Different scenarios on the mechanism of the transition have been proposed, ranging from a topological skyrmion liquid phase [2] over a second order mean field transition [3] to a fluctuation induced first order Brazovskii phase transition [4] that was recently confirmed experimentally in small angle neutron diffraction [5]. We report a comprehensive study of the so-called chiral fraction in MnSi using a newly developed miniature spherical neutron polarimetry device "MiniMuPAD". The temperature dependence and the isotropic decay of the measured chiral fraction are in excellent agreement with the Brazovskii scenario.

[1] S. Mühlbauer *et al.*, Science **323**, 915 (2009)
[2] C. Pappas *et al.*, PRL **102**, (2009)
[3] S. V. Grigoriev *et al.*, PRB **72**, 13 (2005)
[4] S. A. Brazovskii, Sov. Phys. JETP **41**, 85 (1975)
[5] M. Janoschek *et al.*, arXiv:1205.4780 (2012)

TT 28.9 Tue 11:45 H19

Thermodynamic signatures of the skyrmion lattice phase in MnSi and $Mn_{1-x}Fe_xSi$ — •Andreas Bauer and Christian Pfleiderer — Physik Department E21, Technische Universität München, D-85747 Garching, Germany

The recent discovery of skyrmion lattices in cubic helimagnets like MnSi, $Fe_{1-x}Co_xSi$, and Cu_2OSeO_3 lead to a large number of studies in this class of compounds. We report detailed measurements of the specific heat across the magnetic phase diagram of single-crystal MnSi and $Mn_{1-x}Fe_xSi$. Our data is fully consistent with earlier reports, e.g., in Ref. [1,2], showing a narrow peak ontop of a broad shoulder at the helimagnetic phase transition. However, a quasi-adiabatic large heat pulse technique enabled us to resolve distinct signatures of the skyrmion lattice phase for the first time. A peak upon entering the skyrmion lattice phase from low temperatures is observed in MnSi for all magnetic field directions studied as well as in $Mn_{1-x}Fe_xSi$ up to $x = 0.08$. This peak is a key signature of the first order phase transition where the topological winding number of the magnetic structure jumps from 0 to -1.

[1] S. M. Stishov *et al.*, PRL **105**, 236403 (2010)
[2] A. Bauer *et al.*, PRB **82**, 064404 (2010)

TT 28.10 Tue 12:00 H19

Magnetic properties of $Mn_{1-x}Fe_xGe$ — •Sven-Arne Siegfried[1], Nadezhda Potapova[2], Evgeny Moskvin[2], Vadim Dyadkin[3], Dirk Menzel[4], Charles D. Dewhurst[5], Anatoly V. Tsvyashchenko[6], Dieter Lott[1], Andreas Schreyer[1], and Sergey Grigoriev[2] — [1]Helmholtz-Zentrum Geesthacht, Geesthacht, Germany. — [2]Petersburg Nuclear Physics Institute, Gatchina, Russia. — [3]Swiss-Norwegian Beamlines at ESRF, Grenoble, France — [4]TU Braunschweig, Braunschweig, Germany — [5]Institut Laue-Langevin, Grenoble, France — [6]Institute for High Pressure Physics, Troitsk, Russia

The cubic B20 type transition-metal monogermanides belong to the $P2_13$ space group. B20 systems order in a helical spin structure which can be transformed by a magnetic field into a conical and even a parallel ferromagnetic configuration. Close to the ordering temperature the so called A-phase exists. Polycrystalline $Mn_{1-x}Fe_xGe$ samples have been synthesized by high pressure method and investigated by SQUID magnetization measurements and small angle neutron scattering. For this compounds the variation of the helical period from 18 nm for MnGe up to 70 nm for FeGe comes along with a change in the ordering temperatures from 170 K up to 280 K. For concentrations below x = 0.5 our SANS patterns at zero field show a temperature dependent decrease of the helical wavelength with increasing temperature. For field dependent measurements different characteristic patterns appears indicating a complex H-T magnetic phase diagram for this compounds.

TT 28.11 Tue 12:15 H19

Signature of gap closure in the phonon spectra of FeSi — •Sven Krannich[1], Daniel Lamago[2], Rolf Heid[1], Klaus-Peter Bohnen[1], Yvan Sidis[2], Jean-Michel Mignot[2], Paul Steffens[3], Alexander Ivanov[3], and Frank Weber[1] — [1]Karlsruhe Institute of Technology, Institute of Solid State Physics, 76021 Karlsruhe — [2]Laboratoire Léon Brillouin, CEA - Saclay, F - 91191 Gif sur Yvette Cedex, France — [3]Institut Laue Langevin, F-38042 Grenoble Cedex, France

We report an inelastic neutron scattering study of the lattice degrees of freedom in the narrow gap semiconductor FeSi over a large temperature range $10\ K \leq T \leq 790\ K$. In our measurements we observe an unusually strong softening of various phonon modes with some notable exceptions. Calculations based on density-functional-perturbation theory (DFPT) show that only the softening between T = 100 K and room temperature is anomalous, i.e. cannot be explained by normal thermal expansion. Further calculations simulating a vanishing electronic gap at elevated temperatures can account for this anomalous softening and need not involve strong anharmonic lattice effects. Our results support a band-like approach to FeSi where electron-electron correlations are responsible for the gap closure.

TT 28.12 Tue 12:30 H19

Highly Dispersive Scattering From Defects In Non-Collinear Magnets — •Wolfram Brenig[1,2] and Alexander L. Chernyshev[3] — [1]Institute for Theoretical Physics, Technical University Braunschweig, Germany — [2]Technical University of Lower Saxony, NTH, Germany — [3]Department of Physics, University of California, Irvine, USA

We demonstrate that point-like defects in non-collinear magnets give rise to a highly dispersive structure in the magnon scattering, violating a standard paradigm of its momentum independence. For a single impurity spin coupled to a prototypical non-collinear antiferromagnet, we find that the resolvent is dominated by a distinct dispersive structure with its momentum-dependence set by the magnon dispersion and shifted by the ordering vector. This feature is a consequence of umklapp scattering off the impurity-induced *spin texture*, which arises due to the non-collinear ground state of the host system. Detailed results for the staggered and uniform magnetization of this texture as well as the T-matrix from numerical linear spin-wave theory are presented.