

TT 12 Correlated Electrons - Spin Systems and Itinerant Magnets: Experiment

Zeit: Samstag 10:45–12:45

Raum: TU H2053

TT 12.1 Sa 10:45 TU H2053

Small Angle Neutron Scattering Study of the Magnetic Phase Diagram of MnSi at High Pressure — ●C. PFLEIDERER^{1,2}, D. REZNIK^{2,3}, L. PINTSCHOVUS², and H. V. LÖHNEYSSEN^{1,2} — ¹Physikalisches Institut, Wolfgang-Gaede Str. 1, D-76128 Karlsruhe, Germany — ²Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe, Germany — ³Laboratoire Leon Brillouin, CEA Saclay, F-91191 Gif-sur-Yvette Cedex, France

The electrical resistivity of the itinerant-electron magnet MnSi suggests as function of pressure an abrupt change from a Fermi liquid to an extended non-Fermi liquid phase above $p_c = 14.6$ kbar. Recently we reported the existence of partial magnetic order in a small pocket of the regime of the non-Fermi liquid phase, where the partial order is characterised by scattering intensity everywhere on the surface of a small sphere in reciprocal space. Here we report a small angle neutron scattering study of the magnetic state of MnSi at pressures up to 22 kbar and magnetic field up to 1 T. Above the critical pressure long-range helical order may be stabilised in magnetic field, where the pressure dependence of the pinning potential of the helical order and key features of hysteresis loops provide microscopic hints consistent with the formation of a stable new phase.

TT 12.2 Sa 11:00 TU H2053

Observation of a Griffiths phase in paramagnetic La_{1-x}Sr_xMnO₃ — ●JOACHIM DEISENHOFER¹, D. BRAAK², H.A. KRUG VON NIDDA¹, J. HEMBERGER¹, R.M. EREMINA³, V.A. IVANSHIN⁴, A.M. BAL-BASHOV⁵, A. LOIDL¹, T. KIMURA⁶, and Y. TOKURA⁶ — ¹EP V, Center for Electronic Correlation and Magnetism, University of Augsburg, 86135 Augsburg, Germany — ²TP II, Institute for Physics, University of Augsburg, 86135 Augsburg, Germany — ³E.K. Zavoisky Physical-Technical Institute, 420029 Kazan, Russia — ⁴Kazan State University, 420008 Kazan, Russia — ⁵Moscow Power Engineering Institute, 105835 Moscow, Russia — ⁶Department of Applied Physics, University of Tokyo, Tokyo 113-8656, Japan

We report on the discovery of a new phase boundary above magnetic ordering in low doped La_{1-x}Sr_xMnO₃ by means of ESR and susceptibility measurements. The observed triangular phase regime in the paramagnetic state is identified as a realization of a Griffiths phase, where disorder in the ferromagnetic bonds leads to the existence of a temperature scale above T_C . The influence of quenched disorder to allow for the occurrence of a Griffiths phase becomes evident by its appearance within the Jahn-Teller distorted orthorhombic structure.

TT 12.3 Sa 11:15 TU H2053

Magnetic Excitations in Layered Manganites — ●D. SENFF¹, M. BENOMAR¹, F. KRÜGER², S. SCHEIDL², Y. SIDIS³, P. REUTLER^{4,5}, A. REVCOLEVSCHI⁵ und M. BRADEN¹ — ¹II. Physikalisches Institut, Universität zu Köln, Germany — ²Institut für Theoretische Physik, Universität zu Köln, Germany — ³Laboratoire Léon Brillouin, France — ⁴IFW Dresden, Germany — ⁵Laboratoire de Physico-Chimie de l'Etat Solide, Université

The most prominent member of the series La_{1-x}Sr_{1+x}MnO₄ is the half-doped compound with $x=0.5$. This system exhibits a very stable charge/orbital ordering, which at lower temperatures is accompanied by an antiferromagnetic ordering of ferromagnetic zig-zag chains, usually called CE-type order. We present the results of our experimental and theoretical work on the spin-wave spectrum in this phase.

Using inelastic neutron scattering we mapped out a large part of the magnetic excitation spectrum, which consists of one acoustic and two optic bands. All parts of the observed spectrum can be well described within linear spin-wave, taking account only two nearest-neighbor exchange constants, one ferromagnetic coupling $J_{||}$ and an antiferromagnetic interaction J_{\perp} . Our experimental data proof, that the intrachain coupling $J_{||}$ is the dominant magnetic interaction in this system and we thus conclude that the CE-type ordering is driven by the underlying orbital ordering.

In addition, we want to discuss the spin-wave spectrum of the parent system LaSrMnO₄ ($x=0$), which exhibits conventional G-type AFM-ordering, and compare the different coupling constants in these two compounds.

TT 12.4 Sa 11:30 TU H2053

Weak Itinerant Ferromagnetism and Half-Metallic State among Filled Skutterudites: MFe₄Sb₁₂ (M = Na, K, Ca, Ba) — ●A. LEITHE-JASPER, W. SCHNELLE, H. ROSNER, M. BAENITZ, A. RABIS, A.A. GIPPIUS, E.N. MOROZOVA, J.A. MYDOSH, and Y. GRIN — Max-Planck-Institut für Chemische Physik fester Stoffe, Dresden, Germany

The chemical, structural and magnetic properties of alkali and alkaline-earth metal compounds with filled-skutterudite structure, MFe_4Sb_{12} ($M = Na, K, Ca, Ba$), are described [1,2]. X-ray and neutron diffraction and elemental analysis established the crystal structure without defects and disorder on the cation site. The electronic structure is calculated by LMTO and FPLO methods. Quantum chemical calculations (electron localization function, ELF) reveal the covalent character of both Fe-Sb and Sb-Sb interactions. Electronic structure calculations within the LDA exhibit a band ferromagnetic ground state and predict a half-metallic behaviour for $M = Na, K$. In contrast to Ca/BaFe₄Sb₁₂, the alkali-metal skutterudites are itinerant electron ferromagnets with small magnetic moments ($\approx 0.25 \mu_B/\text{Fe atom}$) and $T_C \approx 85$ K. Yet, the paramagnetic moments of all four compounds are between 1.5 and 1.7 μ_B per Fe atom, indicating similar Stoner-factors.

[1] A. Leithe-Jasper et al. Phys. Rev. Lett. 91, 037208 (2003).

[2] A. Leithe-Jasper et al. Phys. Rev. B, in print (1 Dec 2004).

TT 12.5 Sa 11:45 TU H2053

Specific Heat, Electronic State and Einstein Phonon Modes of Filled Iron Antimony Skutterudites: MFe₄Sb₁₂ (M = Na, K, Ca, Ba, La, Yb) — ●W. SCHNELLE, H. ROSNER, A. LEITHE-JASPER, M. BAENITZ, J.A. MYDOSH, and Y. GRIN — Max-Planck-Institut für Chemische Physik fester Stoffe, Dresden, Germany

Filled skutterudites adopt crystal structures with weakly bonded fillers M which can move in an oversized cavity. While the compounds NaFe₄Sb₁₂ and KFe₄Sb₁₂ are weak itinerant electron ferromagnets below ≈ 80 K [1,2], the isostructural alkaline-earth and the La and Yb-filled compounds are paramagnets down to 2 K. Specific heat measurements at low temperatures reveal electronic terms γ ranging from 100 to 200 mJ/molK², irrespective of the ground state. A field dependence of γ is only found for LaFe₄Sb₁₂. In addition, an Einstein term to $c_p(T)$ with Θ_E between 70 K and 105 K is detected. Full potential band structure calculations for NaFe₄Sb₁₂ suggest an energetically driven off-center motion of the Na in its cage by about 0.1 Å. From temperature-dependent atomic displacement factors determined by X-ray diffraction the Einstein temperature and the heat capacity are calculated and compared with our structural data.

[1] A. Leithe-Jasper et al. Phys. Rev. Lett. 91, 037208 (2003).

[2] A. Leithe-Jasper et al. Phys. Rev. B, in print (1 Dec 2004).

TT 12.6 Sa 12:00 TU H2053

Observation of Successive Phase Transitions and Orbital Ordering in Ca₂RuO₄ with Resonant X-ray Scattering —

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Resonant x-ray scattering (RXS) performed at the L_{II} and L_{III} absorption edges of Ru has been used to investigate the magnetic properties and orbital ordering of Ca₂RuO₄ single crystals. A very large resonance enhancement of the magnetic signal due to $2p \rightarrow 4d$ dipole electronic transitions is observed at the antiferromagnetic wave-vector (100). Besides the well-known antiferromagnetic phase transition at $T_N = 110$ K, an additional phase transition is observed around 260 K. The polarization dependence of the corresponding scattering intensity indicates the absence of any charge scattering contribution. No scattering is observed at several reciprocal space positions where orbital ordering has been theoretically predicted. Instead, a resonant peak is observed at the magnetically forbidden (110) position, which has not been reported by previous

experiments.

TT 12.7 Sa 12:15 TU H2053

Temperature dependent bulk sensitive valence band XPS measurements on LaCoO₃ single crystals — •T. KOETHE¹, M.W. HAVERKORT¹, Z. HU¹, M. REUTHER¹, T. LORENZ¹, N.B. BROOKES², J.C. CEZAR², and L.H. TJENG¹ — ¹II. Physikalisches Institut der Universität zu Köln, Germany — ²ESRF, Grenoble, France

The transition metal oxide compound LaCoO₃ displays a series of gradual spin state transitions from a diamagnetic state to a paramagnetic state with a maximum in the susceptibility at 100K and from semiconductor to metal above $\approx 500K$. The Co³⁺ ions have a 3d⁶ configuration and can take a low spin state (*LS*) $S = 0$, high spin state (*HS*) $S = 2$ or even an intermediate spin state (*IS*) $S = 1$. There is general agreement about the *LS* nature of the low temperature phase, whereas the spin state in the intermediate and high temperature phases is much debated in the literature concerning the amount of contribution from *IS* or *HS*. We address this question with photoelectron spectroscopy using high photon energies on high quality single crystals in order to enhance bulk sensitivity. Our spectra show for temperatures below 300K clearly more *LS* contribution than previous experimental results. However, we observe a considerable *HS* component even at 100K. We infer that this *HS* spectral weight originates from the surface since the crystal field at the surface is strongly reduced due to the smaller coordination number.

TT 12.8 Sa 12:30 TU H2053

Co-*L*_{2,3} XMCD study on one-dimensional Ca₃Co₂O₆ single crystals — •Z. HU¹, M.W. HAVERKORT¹, J. GEGNER¹, A. MAIGNAN², N.B. BROOKES³, J.C. CEZAR³, and L.H. TJENG¹ — ¹II. Physikalisches Institut, Universität zu Köln — ²Laboratoire CRISMAT, Caen, France — ³European Synchrotron Radiation Facility, Grenoble, France

We have carried out x-ray magnetic circular dichroism (XMCD) measurements at the Co-*L*_{2,3} edges on single crystals of Ca₃Co₂O₆, in which Co(1)O₆ octahedron alternates with Co(2)O₅ trigonal prism along the chain. We found that the dichroism in the L₃ edge mainly occurs in the lower part of the spectrum and that the dichroism in the L₂ edge is negligible. In combination with cluster model simulations, we deduce that the dichroism originates from the trigonal prism Co³⁺(2) ions which are in the high spin state and that the octahedron Co³⁺(1) ions are nonmagnetic, i.e. in the low spin state. From the orbital sum rule we obtain an orbital moment of 1.2 μ_B for the Co³⁺(2).