TT 17: Correlated Electrons: Quantum-Critical Phenomena 1

Time: Tuesday 14:00–16:15 Location: HSZ 03

TT 17.1 Tue 14:00 HSZ 03

Radiography of weakly ferromagnetic metals with polarized neutrons — •Michael Schulz[1,2], Peter Boeni[2], Elbio Calzada[1,2], Martin Muehlbauer[1,2], Andreas Neubauer[2], Christian Pfleiderer[2], and Burkhard Schillinger[1,2] — [1]FRM II, Garching, Germany — [2]E21, Physik Department TUM, Garching, Germany

The depolarization of a neutron beam passing through a ferromagnet crucially depends on the magnetic properties of the sample. Combining neutron depolarisation measurements with neutron radiography allows obtaining spatially resolved information about these properties. For measuring the depolarization, we have installed a longitudinal polarized beam setup at the ANTARES beamline consisting of ^3He polarizers and flat coil spin flippers. With this setup we have performed radiography with polarized neutrons in the weak itinerant ferromagnets $Pd_{1-x}Ni_x$ in order to determine the spatial distribution of the Curie temperatures T_C in the samples. The results show that the single crystals are rather inhomogeneous showing large variations in T_C. The data allows firstly to cut out small crystals with improved homogeneity for neutron scattering experiments and secondly to provide feedback for improving the growth techniques for the crystals. In the future we hope to use the potential of this method to map out magnetic domains across large volume samples.

TT 17.2 Tue 14:15 HSZ 03

Experimental Investigation of $Pd_{1-x}Ni_x$ at the border of Quantum Criticality — •Christian Franz[1], Christian Pfleiderer[1], Michael Schulz[1,2], Björn Pedersen[2], and Peter Böni[1] — [1]Physik Department E21, Technische Universität München, D-85748 Garching, Germany — [2]Forschungsneutronenquelle Heinz Maier-Leibnitz (FRM II), Technische Universität München, D-85748 Garching, Germany

Polycrystals of the transition metal system $Pd_{1-x}Ni_x$ display ferromagnetic quantum criticality at a critical concentration x_c assumed to be well described by the SCR theory. We report comprehensive studies of the magnetic field and temperature dependence of the magnetization, resistivity, Hall effect and specific heat of Czochralsky grown $Pd_{1-x}Ni_x$ for four Ni-concentrations near x_c. Only the lowest Ni-concentration has crystallized as a single crystal, while the higher concentrations remained polycrystalline. For large values of x the typical behavior of a weakly ferromagnetic metal akin stoichiometric compounds like Ni_3Al, YNi_3 or $ZrZn_2$ is observed. In contrast, for low concentrations two regimes may be distinguished. Moreover, an analysis of the mode-mode coupling as inferred from the magnetic field dependence of the magnetization suggests that the it stays positive for all x as expected of quantum criticality. But the concentration dependence of the spontaneous moment indicates that $Pd_{1-x}Ni_x$ stays ferromagnetic on local scales even for very small concentrations. This suggests that quantum criticality in $Pd_{1-x}Ni_x$ is more complex then previously thought.

TT 17.3 Tue 14:30 HSZ 03

Polarized neutron tomography of Ni_3Al and Fe_2TiSn — •Andreas Neubauer[1], Michael Schulz[1], Christian Pfleiderer[1], Peter Böni[1], Anke Köhler[2], Nadja Wizent[2], and Günther Behr[2] — [1]Physik Department E21, Technische Universität München, D-85748 Garching, Germany — [2]Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden, PF270116, 01171 Dresden, Germany

The transition metal compounds Ni_3Al and Fe_2TiSn are weakly ferromagnetic metals, for which the magnetic properties are extremely sensitive to composition. We have attempted the growth of polycrystalline and single-crystal rods of these compounds with an UHV compatible image furnace. The polycrystalline starting material as well as the floating-zoned rods have been characterized by means of conventional bulk properties and EDX. As a new method we have additionally carried out polarized neutron tomography. The depolarization of the neutron beam proves to be extremely sensitive to tiny variations of the ferromagnetic transiton temperature, thus providing key information on the metallurgical phase diagram and the ideal growth conditions. The possible implications of our observations for the nature of quantum criticality in these compounds will be discussed.

TT 17.4 Tue 14:45 HSZ 03

Pressure Dependence of the Magnetization and Magnetotransport in Ferromagnetic Pr_5Si_3 — Christian Franz[1], •Stefan Legl[1], Christian Pfleiderer[1], Philipp Niklowitz[1], Dmitri Souptel[2], and Günther Behr[2] — [1]Physik Department E21, Technische Universität München, D-85748 Garching, Germany — [2]Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden, PF270116, 01171 Dresden, Germany

Pr_5Si_3 is an easy-plane ferromagnet with a comparatively low Curie temperature. We report the pressure dependence of the magnetization under pressures up to 18 kbar at magnetic fields up to 9 T. We have further measured the magnetotransport properties under pressure up to 60 kbar and magnetic field up to 14 T using a Bridgman pressure cell. Anomalous contributions to the Hall signal allow us to track the magnetic state up to the highest pressures studied. Our data suggest that the magnetic state of Pr_5Si_3 fairly abruptly develops an additional modulation for pressure in excess of $\sim$ 25 kbar, thus avoiding ferromagnetic quantum criticality.

15 min. break.

TT 17.5 Tue 15:15 HSZ 03

Evidence for Unusual Magnetic Order in Cubic FeGe beyond its Quantum Phase Transition — •Heribert Wilhelm[1], Alessandro Barla[2], Martin Forthaus[3], Rudolf Rueffer[4], Marcus Schmidt[5], and Mohsen Abd-Elmeguid[3] — [1]Diamond Light Source Ltd, Chilton, OX11 0DE, UK — [2]Experiments Division, CELLS-ALBA, E-08193 Bellaterra, Barcelona, Spain — [3]II. Physikalisches Institut, Universität zu Köln, 50937 Köln — [4]European Synchrotron Radiation Facility, BP220, F-38043 Grenoble, France — [5]Max Planck Institut für Chemische Physik fester Stoffe, 01187 Dresden

Transport measurements on the cubic modification of FeGe under high pressure have shown that the long-wavelength helical order (T_C = 280K, at $p = 0$) is suppressed at a critical pressure $p_c \approx$ 19GPa [1]. The metallic ground state persisting above p_c can be described by band-structure calculations if zero-point motion is included. However, the electrical resistivity shows that the ground state can not be described by Fermi-liquid theory in a wide pressure range above p_c. This non-Fermi liquid behavior suggests that the phase transition occurs without quantum criticality. New information based on nuclear forward scattering measurements ($p <$ 25GPa, $T >$ 3K) revealed a finite but disordered magnetic moment above p_c and low temperature. The implication of this finding to the metallic ground state and an updated phase diagram will be discussed.

[1] P. Pedrazzini et al., Phys. Rev. Lett. 98, 047204 (2007).

TT 17.6 Tue 15:30 HSZ 03

Pressure Dependence of the Magnetotransport Properties of MnSi — •Robert Ritz, Christian Pfleiderer, Andreas Neubauer, Philipp Niklowitz, and Peter Böni — Physik Department E21, Technische Universität München, D-85748 Garching, Germany

The temperature dependence of the resistivity of the itinerant-electron magnet MnSi suggests the emergence of an extended non-Fermi liquid regime above a critical pressure $p_c = 14.6$ kbar. Various neutron scattering studies suggest that this state may not be related to quantum criticality, where one of the most promising scenarios concerns the spontaneous formation of topologically non-trivial spin textures composed of skyrmions. We report measurements of the low-temperature magnetoresistance and Hall-effect under pressure in excess of 40 kbar and magnetic field up to 14 T. We discuss our findings in the light of the recent discovery of a skyrmion lattice and a related topological Hall effect in MnSi at ambient pressure.

TT 17.7 Tue 15:45 HSZ 03

Novel coupled spin-electron liquid in the layered cobaltate Na_xCoO_2 — •Peter Lemmens[1], Dietrich Wulferding[1], Vladimir Gnezdilov[1,2], Alexander Doering[1], Chengtian Lin[3], Guo-Jun Shu[4], and Fang-Cheng Chou[5] — [1]IPKM, TU Braunschweig, Germany — [2]ILTP, Kharkov, Ukraine — [3]MPI-FKF, Stuttgart, Germany — [4]Center for Condensed Matter Sciences, Taipei, Taiwan — [5]Nat.

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In the layered cobaltate Na_xCoO_2 certain compositions (x=0.71) show a depression of long range magnetic ordering and a coexistence of itinerant and localized charge carriers with a comparably high conductivity and a Curie-Weiss like magnetic susceptibility. In Raman scattering a divergence of quasi-elastic fluctuations is observed towards low temperatures supporting a scenario of a novel coupled spin-electron liquid state. Work supported by DFG and ESF-HFM.

TT 17.8 Tue 16:00 HSZ 03

Ferromagnetic quantum phase transition in $Sr_{1-x}Ca_xRuO_3$ thin films — •Melanie Schneider, Vasile Moshnyaga, and Philipp Gegenwart — I. Physik. Institut, Georg-August Universität Goettingen, Friedrich-Hund-Platz 1, 37077 Goettingen

We report synthesis of $Sr_{1-x}Ca_xRuO_3$ thin films, which have been grown epitaxially on $SrTiO_3$ substrates by metalorganic aerosol deposition technique characterized by x-ray diffraction and room-temperature STM. The physical properties were investigated by electrical resistivity and magnetization measurements. We observe a continuous suppression of itinerant electron magnetism with T_C=160K for $SrRuO_3$ with increasing Ca concentration x in $Sr_{1-x}Ca_xRuO_3$ towards $T_C \rightarrow 0$ for $x_c \approx 0.8$. Non-Fermi liquid behaviour in the electrical resistivity is analysed for thin films with x=0.8 and x=1 down to mK temperatures.