TT 44: Correlated Electrons: Quantum-Critical Phenomena – Experiments

Time: Tuesday 14:00–15:45 Location: H 3005

TT 44.1 Tue 14:00 H 3005

Magnetic structure of $CeCu_2Ge_2$ and its implications on filed tuned quantum criticality — •Philipp Geselbracht[1], Karin Schmalzl[2], Micha Deppe[3], Christoph Geibel[3], and Astrid Schneidewind[4] — [1]Heinz Maier-Leibnitz Zentrum (MLZ), Technische Universität München, Garching, Germany — [2]Jülich Centre for Neutron Science (JCNS) at ILL, Forschungszentrum Jülich GmbH, Grenoble, France — [3]Max-Planck-Institut für Chemische Physik fester Stoffe, Dresden, Germany — [4]Jülich Centre for Neutron Science (JCNS) at Heinz Maier-Leibnitz Zentrum (MLZ), Forschungszentrum Jülich GmbH, Garching, Germany

Recently, the common understanding of quantum criticality (QC) has been challenged for $CeCu_2Ge_2$ [1]. An external magnetic field can suppress the magnetic order, regardless of its direction, but only for the field along the a-direction, a quantum critical point could be identified. Such a behavior resembles the situation for QC of an Ising magnet in a transversal magnetic field, as already applied to less complicated model systems [2]. In this model, the field direction relative to the spin direction plays a crucial role. Therefore, we determined the magnetic structure of $CeCu_2Ge_2$ on a single crystal by means of polarized neutrons and solution of the magnetic structure. Our results are more thorough as in previous works [3], were the exact direction of the magnetic moments were left unclear. We will then interpret our new findings in analogy to the previous model systems.

[1] PRB 90, 155101 (2014).
[2] PRX 4, 031008 (2014).
[3] PRB 55, 6416-6420 (1997) and references.

TT 44.2 Tue 14:15 H 3005

Quantum Criticality in $Yb(Rh_{0.93}Co_{0.07})_2Si_2$ — •Alexander Steppke[1], Luis Pedrero[1,2], Robert Borth[1], Michael Nicklas[1], Cornelius Krellner[3], Christoph Geibel[1], Frank Steglich[1], and Manuel Brando[1] — [1]Max-Planck-Institut für Chemische Physik fester Stoffe, Nöthnitzer Str. 40, 01187 Dresden, Germany — [2]Technische Universität Dresden, 01062 Dresden, Germany — [3]Johann Wolfgang Goethe-Universität, Max-von-Laue-Straße 1, 60438 Frankfurt am Main, Germany

The heavy-fermion compound $YbRh_2Si_2$ is a prototype system which allows us to study an unconventional quantum critical point. With slight isoelectronic substitution of Rh by 7% Co the AFM order is stabilized ($T_N = 0.4\,K$) and in thermodynamic ($\chi_{ac}(T)$) and electrical transport measurements ($\rho(T, H)$) the Kondo-breakdown energy scale T^* detaches from the putative conventional spin-density wave QCP [1]. To investigate the existence of this quantum phase transition and the possible role of the additional energy scale we performed thermodynamic measurements at low temperatures. At a QCP the absence of characteristic energy scales other than the temperatures has been shown to lead to power-law scaling behavior in the Grüneisen ratio [2]. Combining results from specific heat, magnetization and thermal expansion we exclude a SDW QCP when the AFM order is suppressed by a magnetic field from the thermal and magnetic Grüneisen ratio. This is corroborated by measurements under hydrostatic pressure.

[1] S. Friedemann *et al.*, Nat. Phys. **5** (2009) 465.
[2] L. Zhu *et al.*, PRL **91** (2003) 066404.

TT 44.3 Tue 14:30 H 3005

Magnetic order in $CePd_{1-x}Ni_xAl$ — •Stefan Lucas[1], Zita Hüsges[1], Sarah Woitschach[1], Akito Sakai[2], Veronika Fritsch[2,3], Hilbert von Löhneysen[3], and Oliver Stockert[1] — [1]Max Planck Institute CPfS, Dresden, Germany — [2]University of Augsburg, Augsburg, Germany — [3]Karlsruhe Institute of Technology, Karlsruhe, Germany

$CePd_{1-x}Ni_xAl$ is a heavy-fermion system, which shows both, geometric frustration arising from the hexagonal crystal structure and quantum critical behavior. By substituting palladium with nickel the Néel temperature of $T_N = 2.7\,K$ in CePdAl can be suppressed to zero at a nickel concentration of 14 %, where an antiferromagnetic quantum critical point is reached. Due to the combination of magnetic frustration and quantum criticality $CePd_{1-x}Ni_xAl$ may be a model system for investigating the influence of frustration on quantum critical behavior. To study the evolution of magnetic order in the substitution series detailed heat capacity measurements under magnetic fields were performed. The resulting phase diagrams for magnetic fields applied along the easy axis will be shown and discussed for CePdAl, the 5 %- and 10 %-nickel substituted system. A suppression of the Néel temperature as well as of the critical magnetic field are observed. In contrast to CePdAl no additional antiferromagnetic phases were detected in the Ni-alloyed systems. Furthermore, magnetic phase diagrams for fields applied along the hard ab-plane were established. Due to the frustration a slight increase of the ordering temperature was observed for small magnetic fields $B < 1\,T$.

TT 44.4 Tue 14:45 H 3005

High-pressure Fermi surface of Mott insulator NiS_2 — •Sven Friedemann[1,2], Hui Chang[2], Monica Gamza[3], William Coniglio[4], David Graf[4], Stan Tozer[4], and F Malte Grosche[2] — [1]HH Wills Laboratory, University of Bristol, UK — [2]Cavendish Laboratory, University of Cambridge, Cambridge, UK — [3]Department of Physics, Royal Holloway University of London, Egham, UK — [4]National High Magnetic Field Laboratory, Tallahassee, USA

Metals can turn into insulators when correlations become sufficiently strong. This is captured in the Mott-Hubbard model where onsite Coulomb repulsion leads to the opening of a gap at the Fermi energy for a half-filled band. This insulating state is realized for instance in the parent compounds of cuprate superconductors. Whilst cuprates are turned into metals by controlling the filling, i.e. doping, the metallic state can also be recovered by controlling the ratio of Coulomb repulsion and kinetic energy as can be done by pressure tuning. For this case, Luttinger theorem dictates the electrons to localize via a divergence of the effective mass [1]. Here, we report resistivity and quantum oscillation measurements on the pressure-induced insulator-to-metal transition in the Mott insulator NiS_2. We demonstrate the quality of our single crystals, discuss the phase diagram and present Fermi surface measurements in comparison with band structure calculations of the non-correlated case. We discuss these results in the light of the theoretical model.

[1] W. F. Brinkman, T. M. Rice; Phys Rev B; **10** 4302 (1970).

TT 44.5 Tue 15:00 H 3005

Neutron scattering of modulated magnetic order at the border of ferromagnetism in $NbFe_2$ — •Philipp G Niklowitz[1], Max Hirschberger[2], James Poulten[1], William Duncan[1], Andreas Neubauer[3], Petr Cermak[4], Astrid Schneidewind[4], Klaus Seemann[5], Enrico Faulhaber[5], Christian Pfleiderer[3], and F Malte Grosche[6] — [1]Dept of Physics, Royal Holloway, University of London, Egham, UK — [2]Dept of Physics, Princeton University, Princeton, USA — [3]Fakultät für Physik, TU München, Garching, Germany — [4]JCNS at MLZ, Forschungszentrum Jülich GmbH, Garching, Germany — [5]MLZ, TU München, Garching, Germany — [6]Cavendish Laboratory, University of Cambridge, Cambridge, UK

The border of ferromagnetism in the C14 Laves phase $NbFe_2$ is characterised by non-Fermi liquid properties consistent with ferromagnetic quantum criticality [1], but the ferromagnetic quantum critical point appears to be masked by modulated magnetic order (MMO).[2] With our elastic neutron scattering studies of three single-crystalline $Nb_{1-y}Fe_{2+y}$ samples ranging from Fe-rich composition to a nearly stoichiometric sample we have directly determined the ordering wave vector q_1 of MMO. A weak T and H and considerable y dependence of q_1 is observed. Our inelastic neutron data is dominated by strong quasielastic scattering in the vicinity of (002) and contains further features near q_1. The results indicate that $NbFe_2$ could display the theoretically predicted scenario of a ferromagnetic quantum critical point, which is masked by emerging modulated magnetic order.

[1] M. Brando *et al.*, PRL **101**, 026401 (2008).
[2] D. Rauch *et al.*, arXiv1312.2357

TT 44.6 Tue 15:15 H 3005

Effect of anisotropic strain on the quantum critical phase of $Sr_3Ru_2O_7$ — Daniel Brodsky[1,2], Mark Barber[1,2], •Clifford Hicks[1], Robin Perry[3], and Andrew Mackenzie[1,2] — [1]MPI-Chemische Physik fester Stoffe, Dresden, Germany — [2]Scottish Universities Physics Alliance (SUPA), School of Physics and Astronomy, University of St Andrews, St Andrews, UK — [3]SUPA, School of Physics, University of Edinburgh, Edinburgh, UK

We have developed a novel piezoelectric-based device for applying both compressive and tensile strains to single crystals. One particularly appealing target for such studies is $Sr_3Ru_2O_7$. $Sr_3Ru_2O_7$ has a novel quantum critical phase around a metamagnetic transition at 8 T, which shows very strong transport anisotropy in the presence of weak symmetry-breaking fields. We discuss the response of this phase to applied anisotropic lattice strain.

TT 44.7 Tue 15:30 H 3005

Towards ferromagnetic quantum criticality in $FeGa_{3-x}Ge_x$: ^{71}Ga NQR as a zero field microscopic probe — •Mayukh Majumder[1], Maik Wagner-Reetz[1], Raul Cardoso-Gil[1], Peter Gille[2], Yu Grin[1], and Michael Baenitz[1] — [1]Max Plank Institute for Chemical Physics of Solids, Dresden, Germany — [2]Ludwig-Maximilians-Universität Munchen, Germany

$FeGa_3$ is an ideal candidate to study the evolution of a metallic state and probably approaching to a ferromagnetic (FM) critical point upon Ge substitution by the local nuclear quadrupolar resonance (NQR) probe [1, 2]. ^{71}Ga NQR, magnetization and specific heat measurements have been performed in $FeGa_{3-x}Ge_x$ polycrystalline sample with x = 0.05, 0.1 (absent magnetic order), x = 0.15 (critical) and 0.2 ($T_C \sim 6$ K). NQR spectra provide direct information about the degree of local disorder (line width) and the critical fluctuations at the verge of FM ordering (spin-lattice relaxation at zero field). For x = 0.15 we found 3D quantum critical itinerant FM fluctuations and x = 0.2 exhibits weakly FM Moriya like behavior. Low doped samples surprisingly show heavy fermion behavior at low temperature ($\gamma = 70$ mJ/mole-K^2) with dominating antiferromagnetic correlations.

[1] Phys. Rev.B 86, 144421, (2012).
[2] arXiv: 1304.1897 (2013).
[3] Phys. Rev. B 89, 104426 (2014).