TT 67: Correlated Electrons: f-Electron Systems

Time: Wednesday 15:00–17:45 Location: H 3005

TT 67.1 Wed 15:00 H 3005

Electronic Structure and Core-Level Spectroscopy of Light Actinide Dioxides — •Jindrich Kolorenc — Institute of Physics, Academy of Sciences of the Czech Republic, Prague, Czech Republic

The correlated band theory implemented as a combination of the local density approximation with the dynamical mean-field theory (LDA+DMFT) is applied to UO_2, NpO_2, and PuO_2 [1]. The calculated band gaps and valence-band spectra are in very good agreement with optical absorption measurements and with experimental photoemission spectra. The relatively large hybridization of the actinide 5f shell with the p states of oxygen causes a sizable increase of the filling of the 5f orbitals from the nominal ionic configurations with 2, 3, and 4 electrons to fractional values 2.5, 3.4, and 4.4. This enhancement is compatible with the 4f core-level photoemission spectra [2] but in the same time it appears to disagree with the recent synchrotron experiments employing the resonant x-ray emission spectroscopy (RXES) [3,4]. The discrepancy will be analyzed in the LDA+DMFT framework.

[1] A. B. Shick, J. Kolorenc, L. Havela, T. Gouder, and R. Caciuffo, Phys. Rev. B **89**, 041109(R) (2014).
[2] A. Kotani and T. Yamazaki,
Prog. Theor. Phys. Suppl. **108**,117 (1992).
[3] K. O. Kvashnina, Y. O. Kvashnin, and S. M. Butorin,
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[4] C. H. Booth (private communication).

TT 67.2 Wed 15:15 H 3005

$GdRh_2Si_2$: Single crystal growth and characterization — •Kristin Kliemt and Cornelius Krellner — Physikalisches Institut, Goethe Universität Frankfurt, 60438 Frankfurt am Main, Germany

Among the ternary silicides of the type RT_2Si_2 (R = rare earth, T = transition metal) which crystallize in the bodycentered tetragonal $ThCr_2Si_2$ structure, $GdRh_2Si_2$ has attracted much attention in the last decades [1,2] as it belongs to the compounds with rare earth elements with exceptional magnetic properties e.g. $CeRh_2Si_2$, $YbRh_2Si_2$ and $EuRh_2Si_2$. Single crystals of $GdRh_2Si_2$ were grown for the first time by a modified Bridgman method from indium flux.

We report on the growth procedure and show the results of specific heat, magnetic and electrical transport measurements on the single crystals. The high quality of the crystals was proved by Laue X-ray scattering, X-ray powder diffraction, EDX microprobe analysis and resistivity measurements.

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[2] G.A. Cabrera-Pasca *et al.*,
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TT 67.3 Wed 15:30 H 3005

Measuring the T-dependence of the penetration depth of $CeCu_2Si_2$ with superconducting microwave resonators at mK temperatures — •Markus Thiemann[1], Martin Dressel[1], Marc Scheffler[1], Silvia Seiro[2], Christoph Geibel[2], and Frank Steglich[2] — [1]1. Physikalisches Institut, Universität Stuttgart, Germany — [2]Max-Planck-Institut für Chemische Physik fester Stoffe, Dresden, Germany

Microwave measurements on superconductors can reveal the temperature dependence of the penetration depth, which can indicate the presence of nodes in the superconducting gap function. $CeCu_2Si_2$ is a heavy-fermion superconductor with critical temperature $T_c \approx 0.6$ K. Though $CeCu_2Si_2$ for a long time was believed to be a d-wave superconductor, at present it is under debate whether its order parameter features nodes or not.

Therefore, we have performed microwave measurements to study the penetration depth, but we address the microwave surface resistance as well. To be able to probe superconducting bulk samples at mK temperature, we have developed a new experimental approach based on superconducting stripline resonators. We evaluate the performance of this technique at temperatures down to 30 mK by studying the conventional superconductor zirconium (T_c similar to that of $CeCu_2Si_2$). Comparing our data on the penetration depth of a $CeCu_2Si_2$ single crystal with that of zirconium, we find a clear difference in the temperature dependence, which we discuss in terms of possible nodes or multiband superconductivity.

TT 67.4 Wed 15:45 H 3005

Elastic Response of URu_2Si_2 under High Magnetic Fields — •Tatsuya Yanagisawa[1], Shota Mombetsu[1], Hiroyuki Hidaka[1], Hiroshi Amitsuka[1], Mitsuhiro Akatsu[2], S. Yasin[3], S. Zherlitsyn[3], J. Wosnitza[3], K. Huang[4], M. Janoschek[4], and M. B. Maple[4] — [1]Dept. of Physics, Hokkaido Univ., Sapporo, Japan — [2]Grad. School of Science and Technology, Niigata Univ., Niigata, Japan — [3]Hochfeld-Magnetlabor Dresden, Helmholtz-Zentrum Dresden-Rossendorf and TU Dresden, Dresden, Germany — [4]Dept. of Physics, Univ. of California, San Diego, La Jolla, U.S.A.

We have measured the elastic constants, C_{44}, C_{66}, $(C_{11} - C_{12})/2$ in URu_2Si_2 by means of high-frequency ultrasonic measurements in pulsed magnetic fields up to 68.7 T in a wide temperature range from 1.5 to ∼120 K. We found a reduction of $(C_{11} - C_{12})/2$ for magnetic field $H \parallel [001]$ that appears only in the temperature and magnetic field region in which URu_2Si_2 exhibits a heavy-electron state and hidden order. This change in $(C_{11} - C_{12})/2$ appears to be a response of the $5f$ electrons to an orthorhombic and volume conservative strain field $\varepsilon_{xx} - \varepsilon_{yy}$ with Γ_3 symmetry. The lattice instability is likely related to a symmetry-breaking band instability that arises due to the hybridization of the localized $5f$ electrons with the conduction electrons and is probably linked to the hidden-order parameter of this compound. Recent progress obtained by our measurements of the transverse ultrasonic modes C_{44} and C_{66} will also be discussed.

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TT 67.5 Wed 16:00 H 3005

Magnetic and transport properties of structural variants of Remeika phases: $Th_3Ir_4Ge_{13}$ and $U_3Ir_4Ge_{13}$ — •Roman Gumeniuk[1,2], Walter Schnelle[1], Andreas Leithe-Jasper[1], and Yuri Grin[1] — [1]Max-Planck-Institut für Chemische Physik fester Stoffe, Nöthnitzer Str. 40, 01187 Dresden, Germany — [2]Institut für Experimentelle Physik, TU Bergakademie Freiberg, Leipziger Str. 23, 09596 Freiberg, Germany

$Th_3Ir_4Ge_{13}$ and $U_3Ir_4Ge_{13}$ crystallize with primitive cubic $Tm_3Co_4Ge_{13}$ and non-centrosymmetric rhombohedral HT-$Y_3Pt_4Ge_{13}$ type of structures, respectively, which are derivatives of the cubic $Yb_3Rh_4Sn_{13}$ prototype. Measurements of magnetic susceptibility, electrical resistivity, specific heat, thermopower, and thermal conductivity reveal, that $Th_3Ir_4Ge_{13}$ is a diamagnetic bad metal and undergoes a first-order phase transition at ≈ 200 K. Charge-density wave (CDW) and structural phase-transition scenarios for $Th_3Ir_4Ge_{13}$ are discussed. $U_3Ir_4Ge_{13}$ is Curie-paramagnetic ($\mu_{\text{eff}} = 4.05\ \mu_B$) and orders ferromagnetically at $T_C = 15$ K. The U $5f$ electrons in $U_3Ir_4Ge_{13}$ are predominantly of itinerant nature.

TT 67.6 Wed 16:15 H 3005

Magnetic order in CeAuSn — •O. Stockert[1], M-H. Lémée-Cailleau[2], C. L. Huang[1,3], Z. Huesges[1], S. Lucas[1], V. Fritsch[3,4], and H. v. Löhneysen[3] — [1]Max-Planck-Institut CPfS, Dresden, Germany — [2]Institut Laue-Langevin, Grenoble, France — [3]Physikalisches Institut, Karlsruher Institut für Technologie, Karlsruhe, Germany — [4]Institut für Physik, Universität Augsburg, Augsburg, Germany

CeAuSn is a hexagonal, rare-earth based intermetallic compound exhibiting antiferromagnetic order below $T_N = 4.1$ K as evidenced by anomalies in thermodynamic properties. In order to study the magnetic order using a microscopic probe, neutron diffraction was performed on a CeAuSn single crystal. Diffraction pattern were recorded using the neutron Laue diffractometer CYCLOPS at ILL. Allowing fast exploration of reciprocal space, this innovative instrument only recently became available for users. Data were taken at temperatures between $T = 1.6$ and 10 K. Our measurements confirm the hexagonal crystal structure at low temperatures and additional magnetic peaks are clearly visible at lowest temperatures. They can be indexed by a commensurate propagation vector $k = (1/2\ 0\ 0)$. Moreover, the magnetic intensity vanishes at $T_N \approx 4.1$ K in line with thermodynamic measurements. Although CeAuSn is an XY system on a triangular

lattice where geometrical frustration might play a role, we do not find evidence for the existence of frustration.

15 min. break.

TT 67.7 Wed 16:45 H 3005

Multiple magnetic-field-induced transitions in the Kondo lattice $YbNi_4P_2$ — •Heike Pfau[1], Ramzy Daou[2], Alexander Steppke[1], Dan Sun[1], Kristin Kliemt[3], Cornelius Krellner[3], Christoph Geibel[1], Frank Steglich[1], and Manuel Brando[1] — [1]Max-Planck Institute for Chemical Physics of Solids, Nöthnitzer Str. 40, 01187 Dresden, Germany — [2]Laboratoire CRISMAT, UMR 6508 du CNRS, ENSICAEN et Université de Caen, F-14050 Caen, France — [3]Institute of Physics, Goethe University Frankfurt, Max-von-Laue-Strasse 1, 60438 Frankfurt am Main, Germany

$YbNi_4P_2$ is a ferromagnetic Kondo lattice system with a Kondo temperature of 8K and a small Curie temperature of 0.15K. It is close to a ferromagnetic quantum critical point, which can be induced by substitution of phosphorus by arsenic. A magnetic field of 60mT applied along the crystallographic *c*-axis is also able to suppress the ferromagnetic order, above which $YbNi_4P_2$ is a field-polarized Fermi liquid. We performed thermopower, resistivity, and specific heat measurements to study the evolution of $YbNi_4P_2$ in magnetic fields up to 12T. While we observe signatures of strong fluctuations at small fields, our measurements detect multiple transitions at higher fields between 2T and 12T. To analyse this high field behaviour, we compare our results to previous studies on the two Kondo lattices $YbRh_2Si_2$ and $CeRu_2Si_2$.

TT 67.8 Wed 17:00 H 3005

Momentum-space structure of quasielastic spin fluctuations in $Ce_3Pd_{20}Si_6$ — •P. Y. Portnichenko[1], A. S. Cameron[1], M. A. Surmach[1], P. P. Deen[2,3], S. Paschen[4], A. Prokofiev[4], J.-M. Mignot[5], A.M. Strydom[6], M.T.F. Telling[7,8], A. Podlesnyak[9], and D. S. Inosov[1] — [1]TU Dresden, Germany — [2]ESS, Sweden — [3]Univ. of Copenhagen, Denmark — [4]Vienna Univ. of Technology, Austria — [5]LLB, France — [6]Univ. of Johannesburg, South Africa — [7]ISIS, UK — [8]Univ. of Oxford, UK — [9]SNS, USA

Among heavy-fermion metals, $Ce_3Pd_{20}Si_6$ is one of the heaviest-electron systems known to date. Using high-resolution neutron spectroscopy, we observed low-energy magnetic scattering from a single crystal of this compound in the paramagnetic state. We investigated its temperature dependence and distribution in **Q** space. At low temperatures, a quasielastic magnetic response persists with varying intensity all over the Brillouin zone. It forms a broad hump centered at the (111) scattering vector, surrounded by minima of intensity at (002), (220) and equivalent wave vectors. The **Q**-space structure distinguishes this signal from a simple crystal-field excitation and rather lets us ascribe it to short-range dynamical correlations between the neighboring Ce ions, mediated by the itinerant heavy *f*-electrons via the RKKY mechanism. Upon heating, the energy width of the signal follows the conventional $T^{1/2}$ law, $\Gamma(T) = \Gamma_0 + A\sqrt{T}$. The **Q**-space symmetry of the quasielastic response suggests that it stems from the simple-cubic Ce sublattice occupying the 8c Wyckoff site, whereas the inequivalent 4a site remains magnetically silent.

TT 67.9 Wed 17:15 H 3005

Ambient pressure superconductivity emerging in the antiferromagnetic phases of the novel heavy fermion compounds Ce_3PdIn_{11} and Ce_3PtIn_{11} — •Marie Kratochvílová, Jan Prokleška, Klára Uhlířová, Vladimír Sechovský, and Jeroen Custers — Department of Condensed Matter Physics, Charles University, Prague, Ke Karlovu 5, 121 16, Czech Republic

$Ce_nT_mIn_{3n+2m}$ (n=1,2; m=1; T=transition metal) heavy fermion compounds are known to be on the verge of a magnetic to non-magnetic quantum critical point (QCP). In close vicinity of the QCP they exhibit an unconventional superconducting state. However, this family of compounds is interesting for an other reason. The compounds crystallize in the tetragonal structures which provide the possibility to tune the structural dimensionality from more 2D to 3D (stoichiometries: 115-218-103). This makes them ideal candidates to investigate the influence of the parameter dimensionality with respect to quantum criticality.

Ce_3TIn_{11} (T=Pd,Pt) single crystals were prepared for the first time. Ce_3PtIn_{11} (Ce_3PdIn_{11}) exhibits two successive transitions at T_1=2.2K (T_1=1.7K) and T_N=2.0K (T_N =1.5K) into incommensurate and commensurate local moment antiferromagnetic states, respectively. Applying magnetic field along the c-axis gradually suppresses both transitions; they merge at 4T and split again in higher fields. Superconductivity emerges at T_C=0.32K (T_C=0.39K) and it is enhanced by the application of hydrostatic pressure. The unusual magnetic phase diagram will be discussed in the context of superconductivity and magnetism in related compounds.

TT 67.10 Wed 17:30 H 3005

Charge fluctuations and coherence in the mixed-valence regime investigated on $Sm_{1-x}La_xB_6$ — •Chul-Hee Min[1], Kuang-Shing Chen[2], Hendrik Bentmann[1], Sebastian Fiedler[1], Boyoun Kang[3], Beongki Cho[3], Jan Werner[2], Fahker Assaad[2], and Friedrich Reinert[1] — [1]Universität Würzburg, EP7, Würzburg, Germany — [2]Universität Würzburg, TP1, Würzburg, Germany — [3]School of Materials Science and Engineering, Gwangju Institute of Science and Technology (GIST), Gwangju, Korea.

We present an investigation on the temperature dependence of $4f$ states and $3d$ core-levels in $Sm_{1-x}La_xB_6$ in order to identify the unique electronic properties of a mixed valence regime. By use of photon energies from VUV to hard x-rays (HAXPES), we separate surface and bulk properties, which show significant differences. Our results particularly by HAXPES indicate that charge fluctuations in SmB_6 are a rather local property, which might influence the expectation value of the potential energy. A characteristic feature and the signature of the lattice coherence in a mixed valence regime will be demonstrated and discussed.