TT 34: SC: Iron-Based Superconductors - 122

Time: Thursday 14:00–17:30 Location: H20

TT 34.1 Thu 14:00 H20

Photoemission in Ferropnictides — •Klaus Koepernik and Helmut Eschrig — IFW Dresden, Germany

High resolution angle resolved photoemission spectroscopy yields the most direct and most detailed information on the electronic structure of solids. This opens the opertunity to really compare theoretical band structures with experiment. However, the method is surface sensitive. For the ferro-pnictides highly resolved data are available, which are re-evaluated on the basis of density functional calculations.

TT 34.2 Thu 14:15 H20

Superconductivity induced anomalies in the dielectric response of $Ba_{0.68}K_{0.32}Fe_2As_2$ identified by spectral ellipsometry. — •Aliaksei Charnukha, Paul Popovich, Yulia Matiks, Oleg Dolgov, Alexander Yaresko, Dunlu Sun, Chengtian Lin, Bernhard Keimer, and Alexander Boris — Max-Planck-Institut für Festkörperforschung, Heisenbergstr. 1, Stuttgart, 70569 Deutschland

Spectroscopic ellipsometry was used to study the dielectric function of a hole-doped $Ba_{0.68}K_{0.32}Fe_2As_2$, with a sharp ($\Delta T < 0.6$ K) transition to the SC state below $T_c \approx 38.5$ K, in the spectral range $0.012 - 6.5$ eV at temperatures $7 - 300$ K. The optical conductivity spectra are dominated by a series of interband transitions, which all agree well with the predictions of LDA calculations. Our results provide clear evidence of SC gap formation in the far-infrared optical conductivity spectra, $2\Delta_{SC} \approx 5.5-6.5\ k_BT_c$. We find the penetration depth to be 1600 Å in close agreement with the values determined by other techniques. The data also provide detailed information about the evolution of the optical self-energy in the normal and SC states. The frequency and temperature dependencies of the SC gap formation speak for the extended $s_\pm-$wave pairing symmetry with strong coupling to the intermediate boson mode centered at $\approx$ 25meV. Examination of the conductivity in the optical spectral range uncovered superconductivity-induced suppression of interband transitions at energies more than $200\Delta_{SC}$.

TT 34.3 Thu 14:30 H20

Band and momentum dependent electron dynamics in superconducting $Ba(Fe_{1-x}Co_x)_2As_2$ — •Bernhard Muschler[1], Wolfgang Prestel[1], Rudi Hackl[1], Thomas P. Devereaux[2], Jiun-Haw Chu[3], James G. Analytis[3], and Ian R. Fisher[3] — [1]Walther Meissner Institute, Bavarian Academy of Sciences and Humanities, 85748 Garching — [2]SIMES, SLAC, Menlo Park, CA 94025, USA — [3]GLAM, Stanford University, CA 94304, USA

We report results of electronic Raman scattering (ERS) experiments on high quality single crystals of $Ba(Fe_{1-x}Co_x)_2As_2$ in the normal and superconducting states. With a light penetration depth of approximately 30 nm ERS is bulk sensitive. ERS highlights different regions in the Brillouin zone (BZ) for different combinations of the incoming and outgoing photon polarizations. Since the bands of the iron pnictides lie at high symmetry points in the BZ we can predominantly project out the hole (α) and electron (β) bands in A_{1g} and B_{1g} symmetry, respectively. We find a strong polarization dependence of the spectra which indicates band dependent carrier dynamics. In the superconducting state the presence of spectral weight down to the lowest accessible Raman shifts supports very small gaps. While true nodes with a sign change of the gap are unlikely, the spectra are compatible with accidental nodes, which may be lifted by doping and/or disorder. In the normal state we find Raman relaxation rates being almost constant and strongly temperature dependent on the α and β bands, respectively. This work is supported by the DFG under Grant No. Ha2071/3-4 in the Research Unit FOR538.

TT 34.4 Thu 14:45 H20

Direct observation of superconducting energy gap in the conductivity spectra of iron-pnictide films — •Dan Wu[1], Boris Gorshunov[1,2], Philipp Kallina[1], Martin Dressel[1], A-Voronkov[2], Kazumasa Iida[3], Silvia Haindl[3], Fritz Kurth[3], Ludwig Schultz[3], and Bernhard Holzapfel[3] — [1]1. Physikalisches Institut, Universiät Stuttgart, Germany — [2]Prokhorov Institute of General Physics, Russian Academy of Sciences, Russia — [3]IFW Dresden, Germany

The optical reflection, transmission and phase shift of a $Ba(Fe_{0.9}Co_{0.1})_2As_2$ thin film with a superconducting transition temperature $T_c = 20$ K was measured over a wide frequency range. The evaluated optical conductivity and permittivity show a clear evidence of the complete opening of superconducting gap $2\Delta/(2\pi\hbar c) = 30$ cm^{-1}. The behavior agrees very well with the BCS prediction for an s-wave superconductor with no nodes in the order parameter or additional state in the gap. The normal state conductivity shows a incoherent-like background up to mid-infrared range, which is very similar to the spectra obtained from single crystals, confirming the intrinsic property of this broad contribution in 122 pnictide systems.

TT 34.5 Thu 15:00 H20

Optical studies on iron pnictides under pressure — •Johannes Ferber, Hunpyo Lee, Yu-Zhong Zhang, Harald O. Jeschke, and Roser Valenti — Institut für Theoretische Physik, Goethe-Universität Frankfurt

The recent discovery of superconductivity in the iron pnictides draws high attention to the investigation of their properties. In particular, the measurement of the optical response provides experimental access to the electronic structure and the presumably important correlation effects. We examine the optical properties of different iron-based pnictides under pressure. Various 1111 and 122 systems are analyzed and compared using DFT and DMFT techniques.

15 min. break

TT 34.6 Thu 15:30 H20

Lattice dynamics of 122 pnictides from first principles — •Rolf Heid and Klaus-Peter Bohnen — Karlsruher Institut für Technologie, Institut für Festkörperphysik

The pnictide superconductors exhibit a complex interplay of structural and magnetic degrees of freedom, which also has a significant impact on the lattice dynamics properties. Here, we present a first-principles study of the phonon dispersion of 122 pnictides using linear-response theory within a mixed-basis pseudopotential approach. We focus on the dependence of the phonon spectra on structural parameters and magnetic order, and also consider the impact of pressure and doping. The accuracy and potential shortcoming of this first-principles approach are discussed in the light of experimental phonon measurements on $CaFe_2As_2$ (both at ambient pressure and in the collapsed phase [1,2]) and on $BaFe_2As_2$ (both pure and doped [3]).

[1] Mittal *et al.*, Phys. Rev. Lett. **102**, 217001 (2009)
[2] Mittal *et al.*, arXiv0911.1665 (2009)
[3] Reznik *et al.*, arXiv0908.4359 (2009)

TT 34.7 Thu 15:45 H20

Phonon anomalies in pure and doped $R_{1-x}K_xFe_2As_2$ (R=Ba, Sr) investigated by Raman light scattering — •Martin Rahlenbeck[1], Mathieu Le Tacon[1], Guoli Sun[1], Dunlu Sun[1], Chengtian Lin[1], Bernhard Keimer[1], and Clemens Ulrich[1,2,3] — [1]Max-Planck-Institut für Festkörperforschung, Heisenbergstraße 1, D-70569 Stuttgart, Germany — [2]School of Physics, University of New South Wales, Sydney, New South Wales 2052, Australia — [3]The Bragg Institute, Australian Nuclear Science and Technology Organization, Lucas Heights, New South Wales 2234, Australia

We present a detailed temperature dependent Raman light scattering study of optical phonons in superconducting and non-superconducting $R_{1-x}K_xFe_2As_2$ (R=Ba, Sr) single crystals. In all samples we observe a strong continuous narrowing of the Raman-active Fe and As vibrations upon cooling below the spin-density-wave transition T_s. We attribute this effect to the opening of the spin-density-wave gap. The electron-phonon linewidths inferred from these data greatly exceed the predictions of ab-initio density functional calculations without spin polarization, which may imply that local magnetic moments survive well above T_s. A first-order structural transition accompanying the spin-density-wave transition induces discontinuous jumps in the phonon frequencies. These anomalies are increasingly suppressed for higher potassium concentrations. We also observe a pronounced splitting of the E_g modes at this transition temperature. At the superconducting transition temperature T_c we observe subtle phonon anomalies with a

behavior qualitatively similar to that in the cuprate superconductors.

TT 34.8 Thu 16:00 H20

Self-energy effects, el-ph coupling and non FL behavior in Fe-As superconductors — •Peter Lemmens[1], Kwang-Yong Choi[1], Dirk Wulferding[1], Vladimir Gnezdilov[2], Ilya Eremin[3], Helmuth Berger[4], Chengtian Lin[5], Shigeru Kasahara[6], and Yuji Matsuda[6] — [1]IPKM, TU-BS, Braunschweig — [2]ILTP, Kharkov, Ukraine — [3]ITP, Univ. Bochum — [4]EPFL, Lausanne — [5]MPI-FKF Stuttgart — [6]GSS, Univ. Kyoto, Japan

Raman scattering experiments of the undoped Sr-122 and the doped, superconducting pnictides show anomalies of a B_{1g} phonon induced by SC and SDW transitions. We give estimates of the electron-phonon coupling related to this renormalization. We follow the cross over from Fermi to non-Fermi liquid behavior with P-doping. In addition, we observe a pronounced quasi-elastic Raman response and a weak renormalization of an electronic continuum. Work supported by DFG.

TT 34.9 Thu 16:15 H20

Calorimetric studies of hole-doped $Ba_{0.68}K_{0.32}Fe_2As_2$ multiband superconductor — •P. Popovich, A. V. Boris, O. V. Dolgov, D. L. Sun, C. T Lin, R. K. Kremer, and B. Keimer — Max-Planck-Institut für Festkörperforschung, Stuttgart, Germany

We report on the determination of the low temperature specific heat of hole-doped $Ba_{0.68}K_{0.32}Fe_2As_2$ single crystals with a sharp (< 0.6 K) anomaly at $T_c \approx 38.5$ K. The jump at T_c is $\Delta C/T \approx 120$ mJ/molK^2. The low residual electronic specific heat (< 2 mJ/molK^2) shows that the amount of the non-superconducting impurities in our single-phase samples is less than 3%. In order to investigate the electronic part of the specific heat we subtracted a phonon background. As a background we used either our experimental specific heat data on a non-superconducting non-magnetic isostructural substance or a set of Einstein modes. Both models give qualitatively the same result. The α-model with two superconducting gaps fits well to the SC-induced electronic specific heat. Our findings imply that the superconducting properties of $Ba_{0.68}K_{0.32}Fe_2As_2$ can be well described in a framework of the strong-coupling model.

TT 34.10 Thu 16:30 H20

Magnetic fluctuations and superconductivity in Fe pnictides probed by Electron Spin Resonance — •Nikola Pascher[1], Joachim Deisenhofer[1], Hans-Albrecht Krug von Nidda[1], H. S. Jeevan[2], P. Gegenwart[2], and Alois Loidl[1] — [1]Experimentalphysik V, Center for Electronic Correlations and Magnetism, Institute for Physics, Augsburg University, D-86135 Augsburg, Germany — [2]I. Physik. Institut, Georg-August-Universitaet Goettingen, D-37077 Goettingen, Germany

The electron spin resonance absorption spectrum of Eu^{2+} ions serves as a probe of the normal and superconducting state in $Eu_{0.5}K_{0.5}Fe_2As_2$. The spin-lattice relaxation rate $1/T_1^{\rm ESR}$ obtained from the ESR linewidth exhibits a Korringa-like linear increase with temperature above T_C evidencing a normal Fermi-liquid behavior. Below 45 K deviations from the Korringa-law occur which are ascribed to enhanced magnetic fluctuations upon approaching the superconducting transition. Below T_C the spin lattice relaxation rate $1/T_1^{\rm ESR}$ follows a $T^{1.5}$-behavior without the appearance of a coherence peak.

TT 34.11 Thu 16:45 H20

Evidence of Two-Band Superconductivity in K- and Co-doped 122 Barium Iron Pnictides from Point-Contact Spectroscopy — •Michael Marz[1], Oliver Berg[1], Samuel Bouvron[1], Thomas Wolf[2], Hilbert v. Löhneysen[1,2], and Gernot Goll[1] — [1]Physikalisches Institut, Karlsruher Institut für Technologie, 76131 Karlsruhe — [2]Institut für Festkörperphysik, Karlsruher Institut für Technologie, 76131 Karlsruhe

Point-contact spectroscopy (PCS) experiments on superconducting iron pnictides were performed to investigate the structure of the superconductive energy gap. We investigated K- and Co-doped $BaFe_2As_2$ single crystals in the superconducting state in the temperature range from $T = 2$ K to $T = 30$ K. We measured the differential conductance vs. voltage in superconductor/normal-metal point contacts using platinum as a normal-metal counterelectrode. Measurements were carried out with $I \perp c$ ('edge-to-edge' method) and $I \parallel c$ ('needle-anvil' geometry) to determine a possible orientation dependence. In all cases do the obtained spectra reveal signatures which we ascribe to the occurrence of two-band superconductivity in this material, in line with a recent analysis of high-resolution specific-heat measurements [1]. For a quantitative determination of the gap values, the spectra were analyzed within a modified BTK theory to describe two-band superconductivity.

[1] F. Hardy *et al.*, archiv cond-mat **0910.5006**.

TT 34.12 Thu 17:00 H20

Point-contact spectroscopy on doped and undoped 122 barium iron pnictides in the normal-conducting state — •Oliver Berg[1], Michael Marz[1], Thomas Wolf[2], Hilbert v. Löhneysen[1,2], and Gernot Goll[1] — [1]Physikalisches Institut, Karlsruher Institut für Technologie, 76131 Karlsruhe — [2]Institut für Festkörperphysik, Karlsruher Institut für Technologie, 76131 Karlsruhe

Point-contact spectroscopy (PCS) measurements in the superconducting state of K- and Co-doped $BaFe_2As_2$ single crystals exhibit, in addition to features due to superconductivity, an unexpected, weakly temperature-dependent voltage-dependence of the differential conductance dI/dV in both the superconducting and in normal states. To clarify the origin of this behavior we have investigated PCS of doped and undoped Ba-122 single crystals up to $T = 200$ K. In additon to this ubiquitous voltage dependence, undoped $BaFe_2As_2$ crystals reveal a significant zero anomaly (ZBA) of the differential conductance that is common to antiferromagnetic materials. Our observation that the ZBA is absent in the doped, i. e., superconducting samples supports this assignment because doping of $BaFe_2As_2$ with K or Co is known to suppress the antiferromagnetic ordering. The spectra can be described with two Lorentzian functions for the the different contributions. These doped samples ($Ba_{0.68}K_{0.32}Fe_2As_2$ and $Ba(Fe_{0.935}Co_{0.065})_2As_2$) exhbit at $T < T_c$ the dI/dV spectra expected of Andreev reflection for two-band superconductors.

TT 34.13 Thu 17:15 H20

J_c anisotropy in 122 and 1111 pnictide thin films — •Jens Hänisch, Kazumasa Iida, Martin Kidszun, Sivia Haindl, Thomas Thersleff, Alexander Kauffmann, Fritz Kurth, Bernhard Holzapfel, and Ludwig Schultz — IFW Dresden, Institute for Metallic Materials, P.O. Box: 270116, 01171 Dresden, Germany

We have successfully grown epitaxial, superconducting films in two families of iron pnictides, $Ba(Fe_{1-x}Co_x)_2As_2$ (122) [1] and $LaFeAs(O_{1-x},F_x)$ (1111) [2]. Detailed investigations of their critical current density J_c with respect to temperature as well as both the applied magnetic field magnitude and orientation will be shown in this contribution. Both films grow very clean and without observable correlated defects parallel to the c-axis, as confirmed by TEM. This is also reflected in the absence of a c-axis peak in $J_c(\theta)$. In contrast to cuprate high-T_c superconductors such as YBCO or even Bi2223, the pnictides have very low anisotropies in their $J_c(\theta)$ behaviour as well as in their characteristic and critical fields, such as $H_{\rm irr}$ and $H_{\rm c2}$. Both families show the same anisotropy behaviour, 122 having slightly lower anisotropies.

[1] K. Iida, J. Hänisch, R. Hühne, F. Kruth, M. Kidszun, S. Haindl, J. Werner, L. Schultz and B. Holzapfel, Appl. Phys. Lett. 95, 192501 (2009).

[2] M. Kidszun, S. Haindl, E. Reich, J. Hänisch, K. Iida, L. Schultz and B. Holzapfel, Supercond. Sci. and Techn., in print.