TT 31: Superconductivity: Fe-based Superconductors – 122 and 111

Time: Tuesday 9:30–12:45 Location: H 2053

Topical Talk TT 31.1 Tue 9:30 H 2053

Electronic Correlations in Hole- and Electron-Doped Fe-Based Superconductors and Evidence for the C_4-Magnetic Phase in $Ba_{1-x}K_xFe_2As_2$ — •Frédéric Hardy[1], Anna Böhmer[1], Thomas Wolf[1], Peter Schweiss[1], Rolf Heid[1], Robert Eder[1], Robert A. Fisher[2], and Christoph Meingast[1] — [1]IFP, Karlsruhe Institute of Technology, Karlsruhe, Germany — [2]Lawrence Berkeley National Laboratory, Berkeley CA, USA

High-T_c superconductivity in the cuprates occurs at the crossover from a correlated Mott insulating state to a weaker correlated Fermi liquid as a function of doping. The Fe-pnictides were initially thought to be weakly correlated. However, we have recently shown that KFe_2As_2 is in fact highly correlated. These correlations are even further enhanced in Rb- and $CsFe_2As_2$. The temperature dependence of both the susceptibility and the thermal expansion provides strong evidence for the existence of a coherence-incoherence crossover. Whereas the correlations in the cuprates result from a large value of the Hubbard U, recent works have stressed the particular relevance of Hund's coupling J in the pnictides. Our data may be interpreted in terms of a close proximity to an orbital-selective Mott transition. We now have good thermodynamic data covering both the hole and electron doping sides of the $BaFe_2As_2$ system and we will discuss how these correlations are modified by doping. We have also re-examined in detail the underdoped region of $Ba_{1-x}K_xFe_2As_2$. We find a small region of C_4 symmetry inside the SDW state similar to that of $Na_{1-x}Ba_xFe_2As_2$. We will show how this new phase interacts with both superconductivity and SDW.

TT 31.2 Tue 10:00 H 2053

Evolution of magnetic and superconducting phases with doping and pressure in the underdoped iron-arsenide superconductor $Ba_{1-x}K_xFe_2As_2$ — •Elena Hassinger[1,2,3], Gregory Gredat[1], Fabrice Valade[1], Samuel Rene de Cotret[1], Alexandre Juneau-Fecteau[1], Jean-Philippe Reid[1], H. Kim[4], Makariy A. Tanatar[4], Ruslan Prozorov[4], B. Shen[5], H.H. Wen[5], Nicolas Doiron-Leyraud[1], and Louis Taillefer[1,2] — [1]Université de Sherbrooke, Québec, Canada — [2]Canadian Institute for Advanced Research, Toronto, Ontario, Canada — [3]Max Planck Institut für Chemische Physik fester Stoffe, Dresden, Germany — [4]Ames Laboratory, Ames, Iowa, USA — [5]Nanjing University, China

The electrical resistivity ρ of the iron-arsenide superconductor $Ba_{1-x}K_xFe_2As_2$ was measured in applied pressures up to 2.75 GPa for seven underdoped samples. Six of them are antiferromagnetic at $P = 0$ with $0.16 < x < 0.24$ and one is non-magnetic with $x = 0.26$. The stipe-like antiferromagnetic ordering temperature T_N, detected as a sharp anomaly in $\rho(T)$, decreases linearly with pressure. For every magnetic sample a second phase appears with pressure at a lower temperature T_0, which rises with pressure. The critical pressure above which this phase appears decreases with doping going to zero for $x = 0.24$ just below the critical doping for the magnetic phase. This behaviour is reminiscent of the second magnetic phase appearing in $Ba_{0.76}Na_{0.24}Fe_2As_2$ where the tetragonal symmetry is restored in favour of the scenario in which the nematic order in the iron pnictides is of magnetic origin.

TT 31.3 Tue 10:15 H 2053

Coaction of marginal Fermi liquid behavior and van Hove singularities in unconventional superconductors — •J. Fink[1,6], A. Charnukha[1], E.D.L. Rienks[2], Z.H. Liu[1], S. Thirupathaiah[1], I. Avigo[3], F. Roth[4], H.S. Jeevan[5], P. Gegenwart[5], M. Roslova[1], I. Morozov[1], S. Wurmehl[1,6], U. Bovensiepen[3], S. Borisenko[1], M. Vojta[6], and B. Büchner[1,6] — [1]IFW Dresden Germany — [2]HZB Berlin Germany — [3]Universität Duisburg-Essen Germany — [4]Center for Free-Electron Laser Science Hamburg Germany — [5]Universität Augsburg Germany — [6]TU Dresden Germany

Using ARPES we have studied the scattering rates and effective masses of the ferropnictides $(Ba/Eu)Fe_2(As_{1-x}P_x)_2$ and $NaFe_{1-x}(Co/Rh)_xAs$ as a function of the control parameter (chemical pressure/ electron doping). The detected scattering rates of all electron and hole pockets are nearly independent of the control parameter, strongly differ for pockets having different orbital character, and are linear in energy indicating marginal Fermi liquid behavior near otimal substitution/doping. The measurements also indicate a crossing of the top of that hole pocket, having the largest scattering rate, through the Fermi level. A calculation as well as the experiments show that a coaction of marginal Fermi liquid behavior and the weakly dispersive band crossing the Fermi level leads to an extended singularity. The later can explain, possibly also in other unconventional superconductors, the strong mass enhancement near optimal doping/substitution and a superconducting phase with a small effective Fermi energy favoring a BCS-BE crossover state.

TT 31.4 Tue 10:30 H 2053

Suppressed thermal transport in Rh-doped $BaFe_2As_2$ — •Frank Steckel[1], Sheng Ran[2], Sergey L. Bud'ko[2], Paul C. Canfield[2], Bernd Buechner[1,3], and Christian Hess[1,3] — [1]Leibniz Institute for Solid State and Materials Research, IFW Dresden, 01069 Dresden — [2]Ames Laboratory and Department of Physics and Astronomy, Iowa State University, Ames, Iowa 50011, USA — [3]Center for Transport and Devices, TU Dresden, 01069 Dresden

We investigated Rh-doped $BaFe_2As_2$ by means of electrical and heat transport. The underdoped compounds show a clear suppression of phononic heat transport in the intermediate temperature regime above the structural transition temperature T_S and up to 170 K. We interprete this suppression as a strong indication towards electron-phonon coupling, spin-phonon coupling or lattice softening by nematic fluctuations above the structural transition. Additionally, strong anomalies mark the structural and superconducting transition.

TT 31.5 Tue 10:45 H 2053

Phase transitions and phase separation in undoped and Rh doped $CaFe_2As_2$ — Vladimir Gnezdilov[1,2], •Peter Lemmens[1], Yurii Pachkevich[3], Tetiana Shevtsova[3], Masataka Danura[4], Masakazu Kobayashi[4], Tasuku Mizukami[4], Kazutaka Kudo[4], and Minoru Nohara[4] — [1]IPKM, TU-BS, Braunschweig — [2]ILTPE NAS, Ukraine — [3]DonFTI, Donetsk, Ukraine — [4]Department of Physics, Okayama, Japan

Iron-pnictides $Ca(Fe1\text{-}xRhx)_2As_2$ (x = 0, 0.035 and 0.19) were studied across the tetragonal-orthorhombic and tetragonal collapsed tetragonal phase transitions using Raman spectroscopy. Effects of phase separation were observed in the high-temperature phase for the first time. An orbital order scenario at low temperatures for the Rh doped samples which requires a symmetry lowering down to P4/mnc or I422 without atomic displacements relative to the parent I4/mmm symmetry is discussed.

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15 min. break.

TT 31.6 Tue 11:15 H 2053

Strain effect on the phase diagram of Ba-122 — Kazumasa Iida[1,2], •Vadim Grinenko[1], Fritz Kurth[1], Dmitriy Efremov[1], Stefan-Ludwig Drechsler[1], Marco Langer[1,3], Jan Engelmann[1], Ataru Ichinose[4], Ichiro Tsukada[4], Eike Ahrens[5], Saicharan Aswartham[1], Sabine Wurmehl[1], Ingolf Mönch[1], Manuela Erbe[1,3], Jens Hänisch[1,3], Bernhard Holzapfel[1,3], Hiroshi Ikuta[2], and Ruben Hühne[1] — [1]IFW Dresden, Germany — [2]Nagoya University, Japan — [3]Karlsruhe Institute of Technology (KIT), Germany — [4]Central Research Institute of Electric Power Industry, Nagasaka, Japan — [5]TU Dresden, Germany

Thin films offer a possibility for tuning superconducting (SC) properties without external pressure or chemical doping. In-plane strain controls the Neél temperature of the antiferromagnetic (AF) transition and the SC transition temperature or even induce superconductivity in the parent compound [1]. We studied the electronic and magnetic properties of Co, Ru, and P doped Ba-122 thin films in different strain states. We have found that the strain shifts nearly rigidly the whole phase diagram including the AF region and the SC dome in the direction of higher or lower substitution levels depending on the direction of strain (i.e. compressive or tensile). In particular, we found that the strain affects the band structure similarly as Co doping despite that the crystal structure changes differently. As a result tensile or compressive strain acts as additional *el* or *h* doping, respectively.

[1] APL **95**, 192501 (2009); **102**, 142601 (2013);
Nat. Commun. **4**, 2877 (2013).

TT 31.7 Tue 11:30 H 2053

A calorimetric investigation of $RbFe_2As_2$ single crystals — •Seunghyun Khim[1], Saicharan Aswartham[1], Vadim Grinenko[1], Christian C. F. Blum[1], Frank Steckel[1], Daniel Gruner[1], Anja U. B. Wolter[1], Christian Hess[1], Stefan-Ludwig Drechsler[1], Bernd Büchner[1,2], and Sabine Wurmehl[1,2] — [1]Leibniz Institute for Solid State and Materials Research, Helmholtzstrasse 20, 01069 Dresden, Germany — [2]Institute for Solid State Physics, TU Dresden, 01069 Dresden, Germany

We present physical properties of single crystals of the iron pnictide superconductor $RbFe_2As_2$ grown by a self-flux method. A bulk superconducting transition at $T_c \sim 2.7$ K was consistently observed in resistivity, magnetic susceptibility and specific heat measurements. While the normal state resistivity following a T^2 dependence at low T is that of a conventional metal, the magnetic susceptibility shows a deviation from a conventional Curie-Weiss behavior and an unusual broad local maximum around 80 K. Similar humps have been observed for KFe_2As_2 and $SrCo_2As_2$. A large Sommerfeld coefficient, $\gamma_0 = 127$ mJ/mol K^2, was observed seemingly a common feature of heavily hole-doped 122 pnictides. We analyze the superconducting transition seen in our specific heat data by using the s-wave BCS two-gap model. The presence of a small gap is discussed as possible explanation to account for the large specific heat contribution far below T_c. The large H_{c2} anisotropy ratio, $\Gamma = H_{c2}^{ab}/H_{c2}^{c} \sim 7$ near T_c is also discussed within this multiband nature of the Fermi surface.

TT 31.8 Tue 11:45 H 2053

Detailed phase diagram of (Ba,Na)Fe_2As_2 — •Liran Wang[1], Anna Böhmer[1,2], Frédéric Hardy[1], Peter Schweiss[1], Thomas Wolf[1], and Christoph Meingast[1] — [1]Institute für Festkörperphysik,Karlsruher Institut für Technologie (KIT), 76344 Karlsruhe, Germany — [2]Department of Physics and Astronomy and Ames Laboratory, Iowa State University, Ames, Iowa 50011, USA

Recently a $C4$-symmetric magnetic phase has been discovered in $(Ba_{1-x}Na_x)Fe_2As_2$ [1], close to where the usual Spin Density Wave (SDW) transition disappears upon doping. Single crystal neutron diffraction showed that the spin orientation in this phase changes from in-plane in the $C2$-magnetic phase to out-of-plane [2]. Here, we reinvestigate the phase diagram of this system by closely following the doping evolution of structural, magnetic and superconducting transitions by using high-resolution thermal expansion and specific heat measurements. The resulting phase diagram is shown to be considerably more complex than previously thought [1]. Differences and similarities between the Na- and K-doped [3] systems will be discussed.

[1] Avci et al., Nature Commun. 5, 3845 (2014).
[2] F.Waβer et al., unpublished.
[3] A.Böhmer et al., unpublished.

TT 31.9 Tue 12:00 H 2053

Spin-reorientation and Excitations in $Ba_{1-x}Na_xFe_2As_2$ — •Florian Wasser[1], Sabine Wurmehl[2], Saicharan Aswartham[2], Yvan Sidis[3], Astrid Schneidewind[4,5], Jitae Park[5], Bernd Büchner[2], and Markus Braden[1] — [1]II. Physikalisches Institut, D-50937 Köln, Germany — [2]Institute for Solid State Research, D-01171 Dresden, Germany — [3]Laboratoire Léon Brillouin, F-91191 Gif-sur-Yvette Cedex, France — [4]Jülich Centre for Neutron Science, D-85747 Garching, Germany — [5]Forschungsneutronenquelle Heinz Maier-Leibnitz, D-85747 Garching, Germany

Single crystals of $Ba_{1-x}Na_xFe_2As_2$ with $0.25 \leq x \leq 0.4$ have been studied by unpolarised and polarized neutron scattering. Unlike most FeAs-based compounds, Na doped $BaFe_2As_2$ exhibits two successive magnetic transitions at intermediate doping. First there is a transition into an antiferromagnetic phase with moments aligned along the plane, but at low temperatures spin reorient towards the c direction. The magnetic anisotropy of FeAs based compounds is thus of the easy plane type. In the range of coexisting antiferromagnetism and superconductivity we find very strong suppression of the ordered moments in the superconducting state. Inelastic experiments reveal a strong and sharp low-energy resonance in a sample with coexisting phases. This mode completely disappears upon increase of the doping and full suppression of the antiferromagnetic order.

TT 31.10 Tue 12:15 H 2053

Superconducting instabilities and quasipartical interference in the LiFeAs and Co-doped NaFeAs iron-based superconductors — •Dustin Altenfeld[1], Felix Ahn[1], Sergey Borisenko[2], and Ilya Eremin[1] — [1]Institut für Theoretische Physik III, Ruhr-Universität Bochum, D-44801 Bochum, Germany — [2]Leibniz-Institute for Solid State Research, IFW-Dresden, D-01171 Dresden, Germany

We analyze and compare the structure of the pairing interaction and superconducting gaps in LiFeAs and Co-doped NaFeAs by using the ten-orbital tight-binding model, derived from ab initio LDA calculations with hopping parameters extracted from the fit to ARPES experiments. We discuss the phase diagram and experimental probes to determine the structure of the superconducting gap in these systems with special emphasis on the quasiparticle interference, computed using the T-matrix approximation. In particular, we analyze how the superconducting state with opposite sign of the gaps on the two inner hole pockets in LiFeAs evolve upon changing the parameters towards NaFeAs compound.

TT 31.11 Tue 12:30 H 2053

Persistence of high-energy spin fluctuations in electron doped NaFeAs — •Jonathan Pelliciari[1], Yaobo Huang[1,2], Marcus Dantz[1], Valentina Bisogni[1], Paul Olalde Velasco[1], Changqing Jin[2], and Thorsten Schmitt[1] — [1]Paul Scherrer Institute, Villigen, Switzerland — [2]Institute of Physics Chinese Academy of Sciences, Beijing, China

Resonant Inelastic X-ray Scattering (RIXS) is a powerful method for probing spin fluctuations in cuprate and iron pnictide superconductors [1, 2]. We present a high resolution Fe L_3 RIXS study of parent and superconducting $NaFe_{1-x}Co_xAs$. Spectral shape decomposition reveals the persistence of broad dispersive magnetic excitations for all doping levels. In contrast to previous RIXS experiments on hole-doped $Ba_{1-x}K_xFe_2As_2$ compounds [1], the energy of such modes is not affected by doping. The magnetic weight per iron atom of such magnons and paramagnons remains constant. However, renormalized per formula unit the magnetic weight decreases with doping. We argue that cobalt-doping is mainly tuning the electronic correlations without affecting the dispersion range of the magnetic excitations, only reducing their intensity.

[1] K. J. Zhou et al, Nat. Comm., 4, 1470 (2013)
[2. M. P. M. Dean et al, Nature Materials 12, 1019 (2013)