TT 13: Superconductivity: Fe-based Superconductors - 122

Time: Monday 15:00–18:15 Location: HSZ 103

TT 13.1 Mon 15:00 HSZ 103

Fermi surface and effective masses in photoemission response of the K doped $BaFe_2As_2$ superconductor — Gerald Derondeau[1], Federico Bisti[2], Jürgen Braun[1], Hubert Ebert[1], Vladimir Strocov[2], and •Jan Minar[1,3] — [1]LMU München, Germany — [2]Swiss Light Source, PSI, Villigen, Switzerland — [3]University of West Bohemia, Pilsen, Czech Republic

The angle-resolved photoemission spectra of the K doped superconductor $BaFe_2As_2$ have been investigated both experimentally and theoretically. Our results explain the previously obscured origins of all salient features of the ARPES response of this paradigm pnictide compound and reveal the origin of the Lifshitz transition. Comparison of calculated ARPES spectra with the underlying DMFT band structure shows an important impact of final state effects, which results for three-dimensional states in a deviation of the ARPES spectra from the underlying spectral function. In particular, the apparent effective mass enhancement seen in the ARPES response is not an entirely intrinsic property of the quasiparticle valence bands but has a significant extrinsic contribution from the photoemission process and thus differ from its true value. Because this effect is more pronounced for low photoexcitation energies, soft-X-ray ARPES delivers more accurate values of the mass enhancement due to a sharp definition of the 3D electron momentum.

TT 13.2 Mon 15:15 HSZ 103

Nematic susceptibility of hole-doped $Ba_{1-x}Na_xFe_2As_2$ iron pnicdies studied by shear-modules measurements — •Liran Wang[1], Frédéric Hardy[1], Mingquan He[1], Liping Xu[1,2], Peter Schweiss[1], Thomas Wolf[1], and Christoph Meingast[1] — [1]Institute für Festkörperphysik,Karlsruher Institut für Technologie (KIT), 76344 Karlsruhe, Germany — [2]Key Laboratory of Polar Materials and Devices, Department of Electronic Engineering, East China Normal University, Shanghai 200241, China

In order to study the complex electronic phase diagram of hole-doped doped $Ba_{1-x}Na_xFe_2As_2$[1] iron based superconductor, we investigate the nematic susceptibility extracted from shear modulus data obtained using a three-point-bending method[2,3] in a capacitance dilatometer. Other complimentary measurements, including thermal expansion[4], specific heat, as well as transport, have also been performed on this system. We find that the nematic susceptibility of doped $Ba_{1-x}Na_xFe_2As_2$ does not follow a Curie-Weiss temperature dependence over the entire doping region, which is in contrary to the electron-doped $Ba(Fe_{1-x}Co_x)_2As_2$ yet similar to its analogue $Ba_{1-x}K_xFe_2As_2$[2]. In particular, we find a large increase of the nematic susceptibility upon entering the $C4$ magnetic phase.

[1] L. Wang et al., Phys. Rev. B 93, 014514 (2016)
[2] A. Böhmer et al., Phys. Rev. Lett. 112, 047001 (2014)
[3] A. Böhmer et al., Comptes Rendus Physique 17, 1-2, 90-112 (2016)
[4] C. Meingast et al, Phys. Rev. B 41, 11299 (1990)

TT 13.3 Mon 15:30 HSZ 103

Search for broken time reversal symmetry of the superconducting order parameter in $Ba_{1-x}K_xFe_2As_2$ — •Vadim Grinenko[1], Philipp Materne[1], Rajib Sarkar[1], Sirko Kamusella[1], Hubertus Luetkens[2], Kunihiro Kihou[3], Chul-Ho Lee[3], Shavkat Akhmadaliev[4], Dmitriy Efremov[5], Stefan-Ludwig Drechsler[5], and Hans-Henning Klauss[1] — [1]Institute for Solid State Physics, TU Dresden, D-01069, Germany — [2]Laboratory for Muon Spin Spectroscopy, Paul Scherrer Institute (PSI), CH-5232 Villigen, Switzerland — [3]National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Ibaraki 305-8560 Japan — [4]Helmholtz-Zentrum Dresden-Rossendorf, 01314 Dresden, Germany — [5]IFW Dresden, P.O. Box 270116, 01171 Dresden, Germany

Multi-band iron pnictides superconductors provide a unique possibility to study the effect of competing interactions on the superconducting (SC) order parameter symmetry. In $Ba_{1-x}K_xFe_2As_2$ a change of the SC order parameter symmetry at high K doping level x was predicted theoretically by S. Maiti *et al.*, Phys Rev. B **91**, 161102(R) (2015). This change occurs through an intermediate state with a complex order parameter which can lead to spontaneous currents below the SC critical temperature T_c. Here we report our muon spin rotation/relaxation (μSR) experiments on single crystalline samples of the title compound. In our experiments we observe an enhancement of the zero field muon relaxation rate below T_c for the sample with $x \approx 0.7$. This result is interpreted as an evidence for the complex SC order parameter at this doping level.

TT 13.4 Mon 15:45 HSZ 103

Effects of enhanced electron correlations on upper critical field properties in AFe_2As_2 (A = K, Rb, and Cs) superconductors — •Seunghyun Khim[1,2], Dmitry Efremov[1], Anja U. B. Wolter[1], Sabine Wurmehl[1], and Bernd Büchner[1,3] — [1]Leibniz Institute for Solid State and Materials Research, Helmholtzstraße 20, 01069 Dresden, Germany — [2]Max-Planck-Institut für Chemische Physik fester Stoffe, Nöthnitzer Straße 40, 01187, Dresden — [3]Institute for Solid State Physics, TU Dresden, 01069 Dresden, Germany

Unusually large Sommerfeld coefficients (γ_0) in the stoichiometric AFe_2As_2 (A = K, Rb, and Cs) superconductors imply enhanced electron correlations which might be related to its unconventional pairing origin of superconductivity. Including experimental data from our $CsFe_2As_2$ single crystals, we summarize magnetic susceptibility and specific heat properties of the AFe_2As_2 series to clarify the impact of electron correlations on normal and superconducting states. Toward $CsFe_2As_2$, γ_0 increases to ~ 160 mJ/mol K^2 and the broad local maximum in the magnetic susceptibility systematically shifts to lower temperatures. The slope of upper critical fields near T_c is also enhanced as predicted in accordance with the growing γ_0. Taking into account these observations, the effect of the enhanced correlations on superconductivity will be discussed together with the multiband nature, orbital-selective Mottness, and suggested quantum criticality.

TT 13.5 Mon 16:00 HSZ 103

Superconductivity induced changes of phonon lifetime in $Ba(Fe_{0.94}Co_{0.06})_2As_2$ — •Maximilian Kauth[1], Frank Weber[1], Thomas Wolf[1], and Thomas Keller[2] — [1]Institut für Festkörperphysik, Karlsruher Institut für Technologie — [2]Max-Planck-Institut für Festkörperforschung, Stuttgart

We have investigated the life time of the transversal acoustic (TA) phonon mode in the Fe-based high-temperature superconductor $Ba(Fe_{0.94}Co_{0.06})_2As_2$ along the [100] direction. We used the neutron resonant spin echo (NRSE) technique at the TRISP spectrometer at the Heinz Maier-Leibnitz Zentrum [1]. This phonon mode is the soft mode of the structural phase transition present in lower doped samples. Recent measurements showed evidence that it is sensitive to nematic fluctuations in this compound [2]. We observe a clear maximum of the TA phonon linewidth at the superconducting transition temperature $T_C \approx 24$ K. This is the first experimental evidence of changes of the phonon lifetime in Fe-based superconductors.

[1] MPI für Festkörperforschung et al., Journal of large-scale research facilities, 1, A37 (2015).
[2] F. Weber et al., arXiv:1610.00099 (2016)

TT 13.6 Mon 16:15 HSZ 103

Spin space anisotropy in Co-underdoped $BaFe_2As_2$ — •Florian Wasser[1], Chul-Ho Lee[2], Kunihiro Kihou[2], Karin Schmalzl[3], Paul Steffens[4], Navid Qureshi[1,4], and Markus Braden[1] — [1]II. Physikalisches Institut, Universität zu Köln, Zülpicher Straße 77, D-50937 Köln, Germany — [2]National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Ibaraki 305-8568, Japan — [3]Jülich Centre of Neutron Scattering (JCNS), Forschungszentrum Jülich GmbH, Outstation at Institut Laue-Langevin, 71 avenue des Martyrs, 38000 Grenoble, France — [4]Institut Laue-Langevin, 71 avenue des Martyrs, 38000 Grenoble, France

We studied by polarised inelastic neutron scattering the spin space anisotropy in Co-underdoped $BaFe_2As_2$ in the normal as well as in the superconducting state. The spin space anisotropy in the normal state is reminiscent of the magnetic response in the pure antiferromagnetic host compound, and displays broadened spin gaps in all three directions. In particular, the longitudinal spin excitations are largely gapped by ~ 16 meV, which seems to be sufficient larger than twice the superconducting gap value and thus prohibits any interplay with superconductivity. Consequently, in the superconducting state, we observe an anisotropic spin resonance mode, which peaks at two differ-

ent energies in the two transversal spin directions respectively. The suppression of longitudinal spin fluctuations can explain the reduced superconducting transition temperature and indicates that the coexistence of antiferromagnetic order and superconductivity occurs locally.

15 min. break.

TT 13.7 Mon 16:45 HSZ 103

Nernst effect and thermal conductivity of Rh-doped $BaFe_2As_2$ — •Christoph Wuttke[1], Frank Steckel[1], Federico Caglieris[1], Seunghyun Kim[1], Sabine Wurmehl[1], Sheng Ran[2], Paul C. Canfield[2], Bernd Büchner[1,3,4], and Christian Hess[1,4] — [1]Leibniz-Institute for Solid State and Materials Research, IFW-Dresden, 01069 Dresden, Germany — [2]Ames Laboratory and Department of Physics and Astronomy, Iowa State University, Ames, Iowa 50011, USA — [3]Institut für Festkörperphysik, TU Dresden, 01069 Dresden, Germany — [4]Center for Transport and Devices, Technische Universität Dresden, 01069 Dresden, Germany

We present results for the thermal conductivity and the Nernst coefficient of electron doped $BaFe_2As_2$ with a particular focus on exploring the nematic phase. The results show a significant sensitivity of both quantities with respect to nematic fluctuations. Interestingly, the magnitude of both the Nernst effect and the thermal conductivity exhibit a non-monotonic doping dependence where the strength of fluctuations feature a local maximum in the vicinity of optimal doping. These findings reinforce the notion that nematic fluctuations play a key role for rationalizing the nature of superconductivity in iron based superconductors.

TT 13.8 Mon 17:00 HSZ 103

Selective quantum criticality in a multi-band system: $BaFe_2(As_{1-x}P_x)_2$ — •Vadim Grinenko[1,2,3], Kazumasa Iida[2], Fritz Kurth[3], Dmitriy Efremov[3], Stefan-Ludwig Drechsler[3], Ivan Cherniavskii[4], Igor Morozov[4], Jens Hänisch[5], Tobias Förster[6], Chiara Tarantini[7], Jan Jaroszynski[7], Boris Maiorov[8], Marcelo Jaime[8], Akiyasu Yamamoto[9], Ibuki Nakamura[2], Hiroyuki Fujimoto[2], Takafumi Hatano[2], Hiroshi Ikuta[2], and Ruben Hühne[3] — [1]TU Dresden, Germany — [2]Nagoya University, Japan — [3]IFW Dresden, Germany — [4]Lomonosov Moscow State University, Russian Federation — [5]Karlsruhe Institute of Technology, Germany — [6]Hochfeld-Magnetlabor Dresden (HLD-EMFL), Germany — [7]NHMFL, Florida State University, USA — [8]MPA-CMMS, Los Alamos National Laboratory, USA — [9]Tokyo University of Agriculture and Technology, Japan

A quantum phase transition was recently reported for $BaFe_2(As_{1-x}P_x)_2$ at $x_c \sim 0.3$. For such a transition all thermodynamic and transport properties are believed to scale with a single characteristic energy, given by the quantum fluctuations. Here we reconsider this statement. We report the superconducting upper critical field H_{c2} for $BaFe_2(As_{1-x}P_x)_2$ single crystalline thin films in a wide range of P-doping by measuring the resistivity under high magnetic fields. The temperature and doping dependencies of H_{c2} signal that some parts of the Fermi surface exhibit no mass divergence at x_c in contrast to the common belief. We anticipate that the observed dual behavior could be found also in other quantum critical multi-band systems.

TT 13.9 Mon 17:15 HSZ 103

Tuning the magnetism with As - local moments in $BaFe_2As_{2-\delta}$ — •Ilka Vinçon[1,2], Rhea Kappenberger[1,2], Federico Caglieris[1], Hans-Joachim Grafe[1], Anja Wolter-Giraud[1], Christian Hess[1], Saicharan Aswartham[1], Sabine Wurmehl[1,2], and Bernd Büchner[1,2] — [1]Leibniz Institute for Solid State and Materials Research Dresden IFW, Dresden, Germany — [2]Institut für Festkörperphysik, TU Dresden, Dresden, Germany

An important aspect of iron based superconductors is the transition from magnetically ordered to a superconducting state by doping with various elements. As a novel type of doping, partial removal of arsenic from $La(O_{1-x}F_x)FeAs_{1-\delta}$ has been shown to slightly increase the transition temperature while simultaneously creating local magnetic moments.

We present an extended analysis of arsenic deficient $BaFe_2As_{2-\delta}$ aiming to understand this unexpected behaviour. The impact of a variable arsenic deficiency on the spin density wave and local moment formation has been studied by means of magnetic susceptibility, resistivity and nuclear magnetic resonance measurements. Systematic structural changes have been determined by powder diffraction data.

TT 13.10 Mon 17:30 HSZ 103

Quantum criticality in AFe_2As_2 (A = K, Rb, Cs) superconductors probed by ^{75}As NMR spectroscopy — Z.T. Zhang[1,2], D. Dmytriieva[1,3], S. Molatta[1,3], J. Wosnitza[1,3], S. Khim[4], S. Gass[4], A.U.B. Wolter-Giraud[4], S. Wurmehl[4], H.-J. Grafe[4], and •H. Kühne[1] — [1]Hochfeld-Magnetlabor Dresden, Helmholtz-Zentrum Dresden-Rossendorf, 01314 Dresden — [2]Key Laboratory of Materials Physics, Institute of Solid State Physics, Chinese Academy of Sciences, Hefei 230031, China — [3]Institut für Festkörperphysik, TU Dresden, 01060 Dresden — [4]IFW Dresden, Institute for Solid State Research, 01171 Dresden

We present ^{75}As nuclear magnetic resonance measurements on single crystals of $RbFe_2As_2$ and $CsFe_2As_2$. Taking previously reported results for KFe_2As_2 into account, we find that the anisotropic electronic correlations evolve towards a magnetic instability in the AFe_2As_2 series (with A = K, Rb, Cs). Upon isovalent substitution with larger alkali ions, a drastic enhancement of the anisotropic nuclear spin-lattice relaxation rate and decreasing Knight shift reveal the formation of pronounced spin fluctuations with stripe-type modulation. Furthermore, a decreasing power-law exponent of the nuclear spin-lattice relaxation rate for in-plane applied fields evidences an emergent deviation from Fermi-liquid behavior. All these findings clearly indicate that the expansion of the lattice in the AFe_2As_2 series tunes the electronic correlations towards a quantum critical point at the transition to a yet unobserved, magnetically ordered phase.

TT 13.11 Mon 17:45 HSZ 103

Impurity effects on spin dynamics in $Ba(Fe_{1-x}Mn_x)_2As_2$ (x = 12 %) — •M. A. Surmach[1], P. Y. Portnichenko[1], J. T. Park[2], J. A. Rodriguez-Rivera[3,4], D. L. Sun[5], Y. Liu[5], C. T. Lin[5], and D. S. Inosov[1] — [1]Institut fur Festkörperphysik, TU Dresden, Germany — [2]MLZ, TU München, Garching, Germany — [3]Materials Science and Engineering, University of Maryland, USA — [4]NIST Center for Neutron Research, Gaithersburg, USA — [5]MPI fur Festkörperforschung, Stuttgart, Germany

We present new results on the structure of magnetic fluctuations in $BaFe_2As_2$ single crystals doped with Mn local moments and discuss them in relationship to the previously reported (π, π) branch of checkerboard magnetic excitations.

Mn doping introduces strong magnetic impurities, which abruptly suppress superconductivity in Fe-based compounds and evoke the second branch of diffuse short-range spin fluctuations near the (π, π) wave vector, in contrast to other iron-based superconductors, where fluctuations are limited to (π, 0) and (0, π) nesting vectors.

Our neutron spectrscopy measurements reveal the true momentum and energy dependence of the (π, π) branch of magnetic excitations along the out-of-plane (π π L) direction. We firstly showed strong three-dimensional character of these spin fluctuations, in contrast to other iron-based systems. We also report the presence of the low temperature partial spin gap along the (π π L) direction, which gradually opens below 7 meV.

TT 13.12 Mon 18:00 HSZ 103

Crystal Growth and Characterization of $BaTM_2As_2$ with TM = 3d Transition Metal — •Sebastian Selter[1], Rhea Kappenberger[1,2], Francesco Scaravaggi[1,2], Anja Wolter-Giraud[1], Sabine Wurmehl[1,2], Saicharan Aswartham[1], and Bernd Büchner[1,2] — [1]IFW Dresden, Dresden, Germany — [2]TU Dresden, Dresden, Germany

To understand the role of iron as transition metal in superconductivity and magnetism in $BaTM_2As_2$, a thorough investigation with different 3d transition metals is needed. With this aim, $BaTM_2As_2$ with TM = 3d transition metal are to be investigated for trends.
Here we present a comprehensive overview on synthesis and crystal growth of $BaTM_2As_2$ with TM = 3d transition metal.
$BaCr_2As_2$, $BaMn_2As_2$, $BaCo_2As_2$, $BaNi_2As_2$ and $BaCu_2As_2$ were grown by state-of-the-art flux growth techniques. To obtain large size homogeneous crystals of $BaCr_2As_2$ and $BaCo_2As_2$, the respective growth profiles were optimized using DTA and EDS. All compounds were characterized using EDS and PXRD. A nice trend can be seen for the behavior of lattice parameters and cell volume over the exchange of TM. Additionally, first magnetic measurements were performed, showing a strong influence of TM in $BaTM_2As_2$ on the magnetic ordering.