TT 110: Superconductivity: Fe-based Superconductors - 1111 and Others

Time: Friday 9:30–11:45 Location: H 3010

TT 110.1 Fri 9:30 H 3010

Nematicity and structure in single-crystalline LaFeAsO — •Sven Sauerland[1], Francesco Scaravaggi[2,3], Liran Wang[1,2], Rhea Kappenberger[2,3], Saicharan Aswartham[2], Anja U.B. Wolter[2], Bernd Büchner[2,3], and Rüdiger Klingeler[1] — [1]Kirchhoff Institute for Physics, Heidelberg University, Germany — [2]Leibniz Institute for Solid State and Materials Research Dresden IFW, Dresden, Germany — [3]Institute for Solid State Physics, TU Dresden, Germany

We report the temperature dependence of the elastic shear modulus response and the thermal expansion of detwinned LaFeAsO single crystals. The orthorhombic distortion parameter is derived. While the evolution of orthorhombic distortion at $T_S \sim 150$ K is associated with strong uniaxial pressure dependencies in particular along the *a*- and *b*-axes as well as sizeable volume effects, our data imply much smaller lattice effects at the antiferromagnetic ordering temperature T_N. By means of the three-point bending technique in the capacitance dilatometer, we obtain the nematic susceptibility from the shear modulus response in LaFeAsO. Similar to $BaFe_2As_2$, the shear modulus softens well above T_S implying a Curie-Weiss-like behaviour of the nematic susceptibility. The relation of the nematic susceptibility in LaFeAsO to spin, structure and orbital degrees of freedom is discussed.

TT 110.2 Fri 9:45 H 3010

Determination of nematic, magnetic and superconducting phase transitions in Co doped LaOFeAs single crystals by NMR — •Piotr Lepucki, Rhea Kappenberger, Saicharan Aswartham, Adam Paul Dioguardi, Bernd Büchner, and Hans-Joachim Grafe — IFW Dresden, Helmholtzstraße 20, 01069 Dresden, Germany

Single crystals are a prerequisite to perform angular dependent NMR measurements in solids. However, these were not available in sufficient size for doped LaOFeAs until recently [1]. Here we present such NMR measurements on single crystals of LaOFeAs doped with 3.4% , 4.1% , and 6.2% Co. The underdoped samples show clear signatures of the nematic transition in the ^{75}As NMR linewidth as well as in the spin lattice relaxation rate, T_1^{-1}, and its anisotropy. At lower temperatures, a peak in T_1^{-1} signals the onset of long-range magnetic order, whereas the superconducting transition cannot be determined unambiguously in a magnetic field of 7 T, which has been applied for the NMR measurements. In contrast, the optimally doped sample with 6.2% Co shows neither nematic nor long range magnetic order. Instead, T_1^{-1} decreases at the superconducting transition, indicating bulk superconductivity at $T_c = 12$ K even in an applied field of 7 T. Our NMR results in Co doped LaOFeAs single crystals are broadly consistent with those obtained in Co doped $BaFe_2As_2$.

[1] R. Kappenberger et al., J. Cryst. Growth 483, 9 (2018)

TT 110.3 Fri 10:00 H 3010

Interplay between electronic order and superconductivity in pnictides: The case of NdFeAs(OF) — •Mahmoud Abdel-Hafiez[1], H. K. Mao[2], Masaki Mito[3], Agnes Adamski[1] und Cornelius Krellner[1] — [1]Institute of Physics, Goethe University Frankfurt, 60438 Frankfurt/M, Germany — [2]Center for High Pressure Science and Technology Advanced Research, Shanghai, 201203, China — [3]Graduate School of Engineering, Kyushu Institute of Technology, Kitakyushu 804-8550, Japan

One of the crucial issues to elucidate the mechanism leading to high-temperature superconductivity is the nature of pairing, e.g., the symmetry and structure of the superconducting order parameter. Recently, we have reported on the superconducting gap in the newly synthesized single crystals of F-doped NdFeAsO. Our observations clearly show that the superconducting energy gap is nodeless. Additionally, pressure has long been recognized as a versatile tuning parameter which can sensitively change the electron correlations in materials. Through an extensive transport study under high-pressure up to 50 GPa, we have clarified in bulk NdFeAs(OF) the competition between ferromagnetism (FM) and superconductivity, where FM is induced by the 4f moments of Nd upon compression. We construct a comprehensive pressure-temperature phase diagram which shows a crossover from Fermi-liquid to non-Fermi-liquid to Fermi-liquid (FL-NFL-FL) alongside a monotonic suppression of the superconductivity with increasing the pressure, before the FM appears at pressures above.

TT 110.4 Fri 10:15 H 3010

The nematic phase in $LaFe_{1-x}Co_xAsO$ probed by thermal expansion — •Francesco Scaravaggi[1,2], Sven Sauerland[3], Rhea Kappenberger[1,2], Liran Wang[1,3], Saicharan Aswartham[1], Sabine Wurmehl[1,2], Rüdiger Klingeler[3], Anja U. B. Wolter[1], and Bernd Büchner[1,2] — [1]Leibniz-Institute for Solid State and Materials Research, IFW Dresden, Dresden, Germany — [2]Institute for Solid State Physics, TU Dresden, Dresden, Germany — [3]Kirchhoff Institute for Physics, Heidelberg University, Heidelberg, Germany

Nematicity in electron doped 1111 systems $LaFe_{1-x}Co_xAsO$ (x > 0) has been studied on polycrystalline samples, revealing a rich phase diagram. Measurements suggest an abrupt suppression of the AFM/orthorhombic phase with doping upon approaching the superconducting dome, but signatures of the nematic phase could still be detected in the underdoped region. In order to better understand the unique La-1111 phase diagram among the Fe-based superconductors, we report a systematic investigation of the evolution of the nematic state of Co-doped LaFeAsO single crystals. The availability of macroscopic phase pure single crystals for different doping compositions allows us to directly probe structural changes via high resolution dilatometry. Detwinning of the crystals, achieved by the application of a small uniaxial force in the dilatometer, permits us to probe thermal expansion in different crystallographic directions (a,b,c). From this we can obtain information about the structural order parameter (δ) as a function of temperature and doping, thus allowing us to study the nematic phase at different regions in the phase diagram.

TT 110.5 Fri 10:30 H 3010

Equivalence of hydrostatic and chemical pressure? Suppression of the magnetism in CeFeAsO — •Philipp Materne[1,2], Wenli Bi[2,3], Esen Ercan Alp[2], Jiyong Zhao[2], Michael Yu Hu[2], Dongzhou Zhang[2], Til Goltz[1], Anton Jesche[4], Christoph Geibel[4], Rhea Kappenberger[5], Saicharan Aswartham[5], Sabine Wurmehl[5,1], Bernd Büchner[5,1], and Hans-Henning Klauss[1] — [1]Institute of Solid State and Materials Physics, TU Dresden, D-01069 Dresden, Germany — [2]Argonne National Laboratory, Argonne, IL 60439, USA — [3]Department of Geology, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801, USA — [4]Max Planck Institute for Chemical Physics of Solids, Nöthnitzer Str. 40, 01187 Dresden, Germany — [5]Leibniz Institute for Solid State and Materials Research (IFW) Dresden, D-01069, Germany

We present a detailed study of the equivalence of hydrostatic and chemical (due to As by P substitution) pressure in CeFeAsO by means of energy- and time-domain Mössbauer spectroscopy. We observed a nearly linear suppression of the magnetic hyperfine field to zero between 0 and 40 % P-substitution level while the field is reduced by 25 % between 0 and 4.5 GPa followed by an abrupt decrease to zero at 5.2 GPa. We found a quantitatively equal suppression of the magnetic order below a P-substitution level of 5 % and hydrostatic pressures below 0.3 GPa. Above these values the suppression is qualitatively different. Our findings set an upper boundary for the equal treatment of chemical and hydrostatic pressure in this system.

15 min. break.

TT 110.6 Fri 11:00 H 3010

FeSi: a new building block for iron-based superconductivity — •Andres Cano — CNRS, France

We report the synthesis and characterization of the novel silicide hydride LaFeSiH displaying superconductivity with onset at 11 K. We find that this pnictogen-free compound is isostructural to LaFeAsO, with a similar low-temperature tetragonal to orthorhombic distortion. Using density functional theory we show that this system is also a multiband metal in which the orthorhombic distortion is likely related to single-stripe antiferromagnetic order. Electrical resistivity and magnetic susceptibility measurements reveal that these features occur side-by-side with superconductivity, which is suppressed by external pressure.

[1] F. Bernardini, G. Garbarino, A. Sulpice, M. Núñez-Regueiro, E.

Gaudin, B. Chevalier, A. Cano, S. Tencé; arXiv:1701.05010

TT 110.7 Fri 11:15 H 3010

Unconventional Superconductivity in Poly- and Single Crystal YFe_2Ge_2 — •Jiasheng Chen[1], Konstantin Semeniuk[1], Monika Gamza[2], and Malte Grosche[1] — [1]Cavendish Laboratory, University of Cambridge, Cambridge CB3 0HE, UK — [2]Jeremiah Horrocks Institute for Mathematics, Physics and Astrophysics, University of Central Lancashire, Preston PR1 2HE, UK

The d-electron system YFe_2Ge_2 exhibits an unusually high Sommerfeld coefficient C/T $\sim$ 100 mJ/(molK^2) at low temperatures, indicative of strong electronic correlations. Although superconductivity in YFe_2Ge_2 has been widely observed in electrical measurements below 1.8 K, it is strongly sample-dependent and fragile against disorders [1, 2]. Until now, thermodynamic signatures of bulk superconducting transitions have only been reported in polycrystals with residual resistance ratios (RRR) above 70 [2], but not in single crystals. Detail studies on the structures and electrical properties of polycrystals with varying nominal compositions have shed light on the origins of this strong sample dependence. It also led to our success in producing a new generation of single-crystal YFe_2Ge_2 with RRR reaching $\sim$ 170 which shows bulk superconductivity as seen in high quality polycrystals. This thus allows for further investigations into the nature of its apparently unconventional superconductivity by means of heat capacity, penetration depth and quantum oscillation measurements.

[1] Y. Zou et al., Physica Status Solidi - Rapid Research Letters 8, 928 (2014),
H. Kim et al., Philos Mag 95, 804 (2015).
[2] J. Chen et al., PRL 116, 127001 (2016)

TT 110.8 Fri 11:30 H 3010

Low temperature heat capacity in the iron-based superconductor YFe_2Ge_2 — •Keiron Murphy[1], Jiasheng Chen[1], Jacintha Banda[2], Jordan Baglo[1], Manuel Brando[2], Michael Sutherland[1], and Malte Grosche[1] — [1]Cavendish Laboratory, University of Cambridge, UK — [2]MPI Chemical Physics of Solids, Nöthnitzer Strasse 40, Dresden

Unconventional superconductivity is rare in transition metal compounds outside the layered iron pnictide/chalcogenide and cuprate material families. These systems typically have highly anisotropic electronic properties and nearly 2D Fermi surface geometries. The iron based unconventional superconductor YFe_2Ge_2, by contrast, displays a comparatively isotropic, 3D electronic structure. Its Sommerfeld ratio C/T, is enhanced by an order of magnitude above the band structure value to $\gamma \sim 100$ mJ/(mol K^2) at low temperature, and it displays an anomalous form for the temperature dependence of the resistivity, $\rho(T) = \rho 0 + AT^{3/2}$. Theoretical proposals for the pairing mechanism in YFe_2Ge_2 include both triplet [1] and singlet, s* order parameter wave functions [2], prompting a renewed effort to examine the heat capacity well below the transition temperature in newly available bulk superconducting single crystals.

[1] D. J. Singh, Phys. Rev. B 89, 024505 (2014).
[2] A. Subedi, Phys. Rev. B 89, 024504 (2014).