TT 27: Superconductivity: Cuprate Superconductors

Time: Wednesday 11:30–13:15 Location: H 2053

TT 27.1 Wed 11:30 H 2053

Quantum and classical magnetoresistance oscillations in the electron-doped cuprate superconductor $Nd_{2-x}Ce_xCuO_4$ — •Toni Helm[1], Mark V. Kartsovnik[1], Nikolaj Bittner[1], Andreas Erb[1], Rudolph Gross[1], Carsten Putzke[2], Erik Kampert[2], Frederik Wolff-Fabris[2], Iliya Sheikin[3], Stephan Lepault[3], Cyril Proust[3], Andhika Kiswandhi[4], Eun San Choi[4], and James S. Brooks[4] — [1]Walther-Meissner-Institute, Garching, Germany — [2]Dresden High Magnetic Field Laboratory, Dresden-Rossendorf, Germany — [3]Laboratoire National des Champs Magnétiques Intenses, Grenoble, France — [4]National High Magnetic Field Laboratory, Tallahassee, USA

The fundamentals of high-temperature superconductivity have not been understood completely, yet. Compared to most of the hole-doped cuprates, the electron-doped compound $Nd_{2-x}Ce_xCuO_4$ (NCCO) is rather simple and has a lower critical temperature T_c. By applying sufficiently high magnetic fields superconductivity is suppressed and the normal-conducting state can be accessed for even lowest temperatures. In pulsed and steady field experiments we observed Shubnikov-de Haas (SdH) and angle-dependent magnetoresistance oscillations (AMRO) for a series of NCCO single crystals in the range of $x = 0.14 - 0.17$. Starting from optimal doping up to the higher edge of the superconducting region our results provided clear evidence for the existence of a translational symmetry breaking. Here we report on how it develops towards the underdoped side and give an explanation for the AMRO arising only for overdoped samples in very high fields.

TT 27.2 Wed 11:45 H 2053

Optical investigation of nominally undoped Pr_2CuO_4 films — •G. Chanda[1], A. V. Pronin[1], R. P. S. M. Lobo[2], J. Wosnitza[1], H. Yamamoto[3], and M. Naito[4] — [1]Dresden High Magnetic Field Laboratory (HLD), Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]LPEM, ESPCI-ParisTech, CNRS, UPMC, Paris, France — [3]NTT Basic Research Laboratories, NTT Corporation, Kanagawa, Japan — [4]Department of Applied Physics, Tokyo University of Agriculture and Technology, Tokyo, Japan

Superconducting Pr_2CuO_4 films with T' structure and T_c beetween 25 and 27 K have been investigated by different optical methods in a wide frequency range ($5 - 55000$ cm^{-1}) and for temperatures from 2 to 300 K. From the infrared reflectivity spectra, a superconducting gap of $2\Delta_0 = 17$ meV $= 7.4\ k_BT_c$ is estimated. Absolute values of the London penetration depth (λ_L) have been calculated from phase-sensitive teraherz measurements. The zero-temperature limit of λ_L is 1.6 μm. The overall temperature dependence of λ_L shows a behavior typical for the cuprates. However, a closer look on the penetration depth at low temperatures reveals a flattening of the temperature dependence. We find $\lambda_L(T) \propto T^n$ with $n = 2.8 \pm 0.2$.

TT 27.3 Wed 12:00 H 2053

High Pressure Changes of the ^{17}O NMR Spin Shift Pseudo-Gap of $YBa_2Cu_4O_8$ — •Thomas Meissner[1], Swee K. Goh[2], Jürgen Haase[1], Grant V. M. Williams[3], and Peter B. Littlewood[2,4] — [1]Faculty of Physics and Earth Science, University of Leipzig, Leipzig, Germany — [2]Department of Physics, Cavendish Laboratory, University of Cambridge, United Kingdom — [3]The MacDiarmid Institute and Industrial Research Limited, Wellington, New Zealand — [4]Argonne National Laboratory, Argonne, Illinois, USA

The influence of high pressure up to 63 kbar on the electronic properties of the high-temperature superconductor $YBa_2Cu_4O_8$ above the superconducting transition temperature T_c was measured with an NMR anvil cell design [1]. An increase of the spin shift at all temperatures is observed and the pseudogap feature almost vanishes at 63 kbar. We show that this change of the temperature-dependent spin susceptibility can be explained by a pressure-induced decrease of a temperature-dependent component, and an increase of a temperature-independent component. The results are compared to doping effects.

[1] T. Meissner, S. K. Goh, J. Haase, G. V. M. Williams, and P. B. Littlewood, Phys. Rev. B 83, 220517(R) (2011)

TT 27.4 Wed 12:15 H 2053

Peculiar temperature and momentum dependence in the spin ladder systems $Ca_xSr_{14-x}Cu_{24}O_{41}$ — •Friedrich Roth[1], Christian Hess[1], Udo Ammerahl[2], Alexandre Revcolevschi[2], Bernd Büchner[1], and Martin Knupfer[1] — [1]IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany — [2]Laboratoire de Physico-Chimie de l'État Solide, Université Paris-Sud, 91405 Orsay, France

Electron energy-loss spectroscopy has been used to investigate the loss-function of the single crystalline two-leg ladder system $Ca_xSr_{14-x}Cu_{24}O_{41}$ with various compositions. We find a strong anisotropy of the loss function for momentum transfers along the a and c-crystallographic axis, and a remarkable linear plasmon dispersion for a momentum transfer parallel to the legs of the ladders. The investigated spectral features are attributed to localized and delocalized charge-transfer excitations and the charge carrier plasmon. The charge carrier plasmon position and dispersion in the long wave-length limit agree well with expectations based upon the band structure of the two-leg ladder, while the observed quasi-linear plasmon dispersion might be related to the peculiar properties of underdoped cuprates in general. Furthermore, a remarkable temperature dependence of the plasmon was observed.

TT 27.5 Wed 12:30 H 2053

Temperature behavior of the hole density of (Bi,Pb)-2212 single crystals — •Aliakbar Ghafari[1], Ahmad Kamal Ariffin[2], Christoph Janowitz[1], Helmut Dwelk[1], Alica Krapf[1], and Recardo Manzke[1] — [1]Institute of Physics, Humboldt University of Berlin, Newtonstr. 15, D-12489 Berlin, Germany — [2]Dep. of Physics, Universiti Pendidikan Sultan Idris, 35900 Tanjong Malim, Malaysia

One of the most puzzling anomalies of high-T_C cuprates is the strong temperature dependence of the Hall coefficient (R_H) and the hole density (n_H). Gor'kov and Teitel'baum (GT) showed by using experimental data of $La_{2-x}Sr_xCuO_4$ (LSCO) that the number of holes per Cu atom, n_H, changes with temperature according to $n_H(T,x)=n_0(x)+n_1(x)\exp(-\Delta(x)/T)$ [1]. To clarify the temperature dependence of n_H we have determined n_H by x-ray absorption spectra (XAS) at the CuL_3 edge for nearly optimum and slightly underdoped (Bi,Pb)-2212 single crystals. Our results point out that the GT formula can not fit our data and therefore must be extended to the three terms.

[1] L. P. Gor'kov and G. B. Teitel'baum, Phys. Rev. B 77, 180511 (2008)

TT 27.6 Wed 12:45 H 2053

Electronic structure of $Bi_2Sr_2CaCu_2O_8$ by DFT and QMC — •Aliakbar Ghafari[1], Kaveh Haghighi mood[2], Christoph Janowitz[1], and Recardo Manzke[1] — [1]Institute of Physics, Humboldt University of Berlin, Newtonstr. 15, D-12489 Berlin, Germany — [2]Dep. of Physics, Science and Research Branch (IAU), Tehran, Iran

The electronic structure of high-TC cuprates superconductors (HTCS) is among the most interesting issues of condensed matter physics since their discovery by Bednorz and Müller. It has been proven that the antiferromagnetic ground state of the parent compound of the HTCS is not accessible by using local density approximation (LDA) and generalized gradient approximation (GGA) as exchange-correlation energy functionals within density functional theory (DFT). Therefore, we calculated the electronic structure of $Bi_2Sr_2CaCu_2O_8$ by adding the Hubbard parameter to DFT (GGA+U) and quantum Monte Carlo (QMC) methods. The calculations have been performed by Wien2k and Casino codes for GGA+U and QMC, respectively.

TT 27.7 Wed 13:00 H 2053

Effect of planar elastic strain on cuprate superconductivity — •Jürgen Röhler — Universität zu Köln, 50937 Köln, Germany

Elastic strain has important effects on the properties of hole doped superconducting cuprates, most significantly on T_c. While c-axis compression primarily enhances the number of hole carriers n, the intrinsic T_c^{intr} is determined by the in-plane lattice parameter a, or the area of the CuO_2 planes A. For optimal doping, $dT_c/dn = 0$, the available high pressure data suggest $T_c \propto A^{-2}$, universally within the various cuprate families [1]. This significant relationship requires $A(n)$ to exhibit an extremum around $n_{opt} = 0.16$, ubiquitously observed as "bulging" anomaly [2] riding the monotonous contraction of A from increasing covalency. We propose to express these findings in terms of the magnetoelastic strain exerted on the CuO_2 lattice by pseudogapped excitations of preformed $3a$ hole pairs with nn repulsion [2].

[1] J.S. Schilling in: Handbook of high-temperature superconductivity: theory and experiment, J.R. Schrieffer, J.S. Brooks (eds.), Springer 2007, p. 427.

[2] J. Röhler, Int. J. Mod. Phys B (2005), 19, 255.