TT 4 Symposium Superconducting Cuprates

Zeit: Freitag 14:00–17:45 Raum: TU H104

Hauptvortrag

TT 4.1 Fr 14:00 TU H104

Phase Sensitive Tests with Cuprate Superconductors Based on the Josephson Effect and Andreev bound states — •Boris Chesca[1], Dietmar Dönitz[1], Dieter Kölle[1], Reinhold Kleiner[1], A. Tsukada[2], Michio Naito[2], Ariando[3], and Hans Hilgenkamp [3] — [1]Physikalisches Institut-Experimentalphysik II, Universität Tübingen, Germany — [2]NTT Basic Research Lab., Japan — [3]Faculty of Science and Technology and MESA+ Research Inst., University of Twente, The Netherlands

Junctions formed between two superconductors provide the unique opportunity to obtain information on the symmetry of the superconducting order parameter simultaneously from tunneling of Cooper pairs and of quasiparticles. Indeed, on one hand the d-wave symmetry leads to striking anomalies in the Cooper pair Josephson tunneling in both hole- and electron-doped cuprate junctions: spontaneous appearance of half flux quanta [1] or GHz circulating currents [2], or field enhanced Josephson currents [2-4]. On the other hand, Andreev bound states induced zero-bias conductance peak (ZBCP) in the tunneling spectra of quasiparticles is also a clear signature of d-wave symmetry. We discuss the controversy of ZBCP physics in electron-doped cuprate junctions [5] as well as the importance of the complementary character of these two different phase sensitive tests. We consider two cases: junctions formed between cuprates or between cuprate and conventional superconductors.

[1] C.C. Tsuei and J.R. Kirtley, Rev. Mod. Phys. 72, 969 (2001); [2] B. Chesca et al., Phys. Rev. Lett. 88, 177003 (2002); [3] B. Chesca et al., Phys. Rev. Lett. 90, 057004 (2003); [4] R. R. Schulz, et al., Appl. Phys. Lett. 76, 912 (2000); [5] B. Chesca et al., Condmat-0402131 (2003).

TT 4.2 Fr 14:30 TU H104

Pseudogap, superconductivity and conservation of states in electron doped HTS: results from tunneling spectroscopy — •Bettina Welter[1], Andreas Winkler[1], Lambert Alff[1], Yoshiharu Krockenberger[1], Michio Naito[2], and Rudolf Gross[1] — [1]Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]NTT Basic Research Laboratories, Atsugi, Japan

Exploring the doping dependent properties of the electron doped cuprates and comparing them to the hole doped systems will help to understand the origin of superconductivity in these materials. Here, we report on tunneling spectroscopy measurements on grain boundary junctions of electron doped high-temperature superconductors $La_{2-x}Ce_xCuO_4$, $Pr_{2-x}Ce_xCuO_4$ and $Nd_{2-x}Ce_xCuO_4$ with different Ce concentrations around optimal doping. We focus on the pronounced depletion in the density of states near E_F observed in the normal state above B_{c2} and its evolution with temperature, magnetic field and doping [1]. Considerations concerning the conservation of states rule indicate a coexistence of this pseudogap regime and the superconducting state.[2]. As in this context the method of normalization is crucial, we show a detailed comparison of different methods and discuss their justification.

[1] L. Alff, Y. Krockenberger, B. Welter, M. Schonecke, R. Gross, D. Manske and M. Naito, Nature **422**, 698 (2003)
[2] B. Welter, Y. Krockenberger, M. Naito, L. Alff and R. Gross, Physica C **388**, 299 (2003)

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Hauptvortrag

TT 4.3 Fr 14:45 TU H104

Angle-Resolved Photoemission Spectroscopy of High-T_c Superconductors: Identifying the Pairing Boson — •Sergey Borisenko — Leibniz-Institute for Solid State and Materials Research, IFW-Dresden, Helmholtzstrasse 20, D-01069, Dresden

The search for the pairing mechanism in High-Temperature Superconducting cuprates has converged to the choice between the electron-phonon and electron-electron interactions. This dilemma remains one of the main problems of the modern condensed matter physics. We study HTSC using the Angle-Resolved Photoemission Spectroscopy. Due to the recent improvement of the resolution, this method allows to detect the "fingerprints"of the coupling between the electrons and bosonic excitations conceivably responsible for the pairing. Analysing the momentum, doping and temperature dependences of the electron-boson coupling effects in Bi-based cuprates we make an attempt to identify the pairing boson in high-Tc superconductors.

Fachvortrag

TT 4.4 Fr 15:15 TU H104

Ordering Phenomena in Cuprates — •Rudi Hackl[1], Leonardo Tassini[1], Francesca Venturini[2], Andreas Erb[1], Naoki Kikugawa[3], and Toshitsu Fujita[3] — [1]Walther-Meissner-Institut, D-85748 Garching — [2]Bruker BioSpin AG, CH-8117 Faellanden — [3]ADSM, Hiroshima University, Higashi-Hiroshima, 739-8526, Japan

We present results of Raman scattering experiments on hole doped cuprates with $0 \leq p \leq 0.26$. Spectra were measured for temperatures between 4.2 and 330 K as a function of polarization. In all compounds a strong anisotropy of the transport properties develops for doping levels below approximately 0.21. In agreement with recent photoemission experiments electrons with momenta along the diagonal of the copper-oxygen plane always exhibit metallic dynamics except for $p \equiv 0$. In contrast, for electronsmoving along the principal axes a metal-insulator transition is found at $x \simeq 0.21$. In addition to this quite general phenomenon, a new type of low-temperature response is found at material-dependent doping levels in $La_{2-x}Sr_xCuO_4$ and $Y_{0.97}Ca_{0.03}Ba_2Cu_3O_{6+x}$. Both the spectral shape and the selection rules provide strong evidence that the new low-energy response originates from the formation of fluctuating one-dimensional charge order. In $La_{2-x}Sr_xCuO_4$ the lattice apparently helps to stabilze stripes making them visible in a Raman experiment at doping levels up to at least 0.10.

Pause

Fachvortrag

TT 4.5 Fr 16:00 TU H104

Magnetic Excitations in High-Temperature Superconductors — •Götz S. Uhrig[1], Kai P. Schmidt[1], and Markus Grüninger[2] — [1]Institut für Theoretische Physik, Universität zu Köln, 50937 Köln — [2]II. Physikisches Institut, Universität zu Köln, 50937 Köln

Recently, more and more evidence is emerging that the magnetic excitations in high temperature superconductors have a universal character. The resonance mode at $\mathbf{Q}_{\mathrm{AF}}$ and the incommensurate satellites need no longer be regarded as mutually exclusive phenomena pertaining to different families of cuprates. This observation revives the interest in the quantitative theoretical description of the magnetic excitations. One route in the quest for such a theory is to consider charge modulated phases like stripes or tiling patterns which are suggested experimentally by scanning tunnel microscopy and theoretically by phenomenological quantum dimer models.

We present a quantitative description of the universal magnetic excitations which is based on charge stripes where the collective magnetic excitations result from dispersing triplon modes. The anisotropy of the dispersion implies the observed two different energy scales. Very good agreement is obtained for realistic coupling parameters which include a sizable cyclic exchange.

Evidence and counter-evidence for the validity of the model proposed and for possible alternatives is discussed.

TT 4.6 Fr 16:30 TU H104

Testing stripe theories: Geometry of spin excitations in the superconducting and normal state of $YBa_2Cu_3O_{6+x}$ — •Vladimir Hinkov[1], Bernhard Keimer[1], Philippe Bourges[2], Stephane Pailhes[2], Yvan Sidis[2], Alexandre Ivanov[3], Andrey Kulakov[1], Chengtian Lin[1], Dapeng Chen[1], and Christian Bernhard[1] — [1]Max-Planck-Institut für Festkörperforschung, Stuttgart, Germany — [2]Laboratoire Leon Brillouin, Saclay, France — [3]Institut Laue Langevin, Grenoble, France

The physics of high-temperature cuprate superconductors exhibits a two-dimensional (2D) character due to the layered structure. An influential theory predicts a further reduction of dimensionality: In the CuO_2-layers charge and spin are supposed to separate spontaneously forming one-dimensional (1D) stripes of antiferromagnetically ordered spins separated by charge rivers. Such stripe arrangements should become visible by virtue of their quasi-1D spin excitations. We use inelastic neutron scattering (V. Hinkov et al., Nature 430, 650) to investigate the in-plane geometry of spin excitations in $YBa_2Cu_3O_{6+x}$ with T_c of 90K, 61K and 35K, respectively. We use fully untwinned samples, as the signal from twinned crystals contains contributions from both perpendicular twin domains. We demonstrate, that the spin excitations are 2D and form

a ring in reciprocal space, thus excluding simple, 1D arrangements of stripes. However, amplitude and width are modulated along the ring. Therefore, configurations of stripes are possible with strong orientational fluctuations, which can be quantified by our data. Further, we show that a great deal of the observed modulation originates from the normal state.

TT 4.7 Fr 16:45 TU H104

Novel neutron resonance mode in $d_{x^2-y^2}$ superconductors — •Ilya Eremin[1], Dirk K. Morr[2], Andrey V. Chubukov[3], Karl Bennemann[1], and Michael R. Norman[4] — [1]Institut für Theoretische Physik, Freie Universität Berlin, 14195 Berlin, Germany — [2]Department of Physics, University of Illinois at Chicago, Chicago, IL 60607 — [3]Department of Physics, University of Wisconsin, Madison, WI 53706 — [4]Materials Science Division, Argonne National Laboratory, Argonne, IL 60439

We show that a new resonant magnetic excitation at incommensurate momenta, observed recently by inelastic neutron scattering experiments on $YBa_2Cu_3O_{6.85}$ and $YBa_2Cu_3O_{6.6}$, is a *spin exciton*. Its location in the magnetic Brillouin zone and its frequency are determined by the momentum dependence of the particle-hole continuum. We identify several features that distinguish this novel mode from the previous resonance mode observed near $\mathbf{Q} = (\pi, \pi)$, such as its intensity maximum which occurs in a different part of the magnetic Brillouin zone.

TT 4.8 Fr 17:00 TU H104

Investigation of HTSC with ARPES using the circularly polarized light. — •Volodymyr Zabolotnyy, Sergey Borisenko, Alexander Kordyuk, Jochen Geck, Jörg Fink, Martin Knupfer, and Bernd Büchner — IFW Dresden, Helmholtzstraße 20, 01069 Dresden

There exist certain theoretical suggestions that in copper-oxide based high-temperature superconducting materials, the so-called time-reversal and rotational symmetry-breaking phase should be observed. To reveal this effect a set of experiments whith circularly polarized light has been done. Anticipated effect has not been observed and therefore the answer whether this phase exists still remains unclear. Instead a new effect was discovered. We observe the dichroism of different signs on the bonding and antibonding components of the CuO-band in lead doped BISCO samples. Here we present the detailed behaviour of the dichroic signal in the 1st and partly 2nd Brillouin zones, as well as the temperature dependence for the optimally- and over-doped samples. Some plausible explanations of the effect are given.

TT 4.9 Fr 17:15 TU H104

Lattice dynamics and electron-phonon coupling in $YBa_2Cu_3O_{6.5}$ — •K.-P. Bohnen[1], V. Pankoke[2] und R. Heid[1] — [1]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, P.O.B. 3640, D-76021 Karlsruhe — [2]Forschungszentrum Karlsruhe, Institut für Wissenschaftliches Rechnen, P.O.B. 3640, D-76021 Karlsruhe

Recently the lattice dynamics of $YBa_2Cu_3O_7$ has been calculated successfully with modern ab-initio density functional methods [1]. However, the superconducting properties depend sensitively on the oxygen content thus it is of great interest to study the lattice dynamics and the electron-phonon coupling as function of doping. Here we present results for the Ortho-II phase of $YBa_2Cu_3O_{6.5}$ which has been possible to treat in detail with density-functional perturbation approach. The structure, lattice dynamics and electron-phonon coupling has been determined and will be compared with available experimental data as well as with results for $YBa_2Cu_3O_7$. The calculations indicate that the oxygen-apex modes are most strongly affected by doping.

[1] K.-P. Bohnen, R. Heid, M. Krauss, Europhys. Lett. **64**, 104 (2003)

TT 4.10 Fr 17:30 TU H104

Fermi-liquid based theory for the in-plane magnetic anisotropy in untwinned cuprates — •Dirk Manske[1] and Ilya Eremin[2] — [1]Max-Planck-Institut für Festkörperforschung, 70569 Stuttgart — [2]Freie Universität Berlin, Institut für Theoretische Physik, 14195 Berlin

Using a generalized RPA-type theory we calculate the in-plane anisotropy of the magnetic excitations in hole-doped high-T_c superconductors. Extending our earlier Fermi-liquid based studies on the resonance peak by inclusion of orthorhombicity, we still find two-dimensional spin excitations, however, being strongly anisotropic. This reflects the underlying anisotropy of the hopping matrix elements and of the superconducting gap function. We compare our calculations with experimental date on fully untwinned YBCO (V. Hinkov et al., Nature 2004) and find good agreement. Our results are in contrast to earlier interpretations on the in-plane aniostropy in terms of stripes (H. Mook et al., Nature 2000).