# TT 30: Superconductivity: Cuprate High-Temperature Superconductors 2

Time: Wednesday 14:00–15:30 Location: HSZ 304

TT 30.1 Wed 14:00 HSZ 304

**Enhancement of the incommensurate magnetic order by an applied magnetic field in underdoped $YBa_2Cu_3O_{6.45}$** — •Daniel Haug[1], Vladimir Hinkov[1], Anton Suchaneck[1], Dmytro Inosov[1], Niels Christensen[2], Christof Niedermayer[2], Philippe Bourges[3], Yvan Sidis[3], Ji Tae Park[1], Alexandre Ivanov[4], Chengtian Lin[1], Joël Mesot[2], and Bernhard Keimer[1] — [1]Max-Planck-Institut für Festkörperforschung, Stuttgart, Germany — [2]Paul-Scherrer-Institut, Villigen, Switzerland — [3]Laboratoire Léon Brillouin, CEA-CNRS Saclay, France — [4]Institut Laue-Langevin, Grenoble, France

The discovery of quantum oscillations in the high-temperature superconductor $YBa_2Cu_3O_{6.5}$ above its critical magnetic field showed that the concepts of Fermi liquid theory are applicable to the strongly correlated electron system in the underdoped cuprates. However, the observation of small electron pockets in these experiments puts a new question as such pockets are incompatible with band structure calculations and the Fermi surface topology found in angle-resolved photoemission at zero magnetic field. Our recent neutron scattering experiments on $YBa_2Cu_3O_{6.45}$ reveal an enhancement of the static incommensurate magnetic signal at low temperatures when applying an external magnetic field. This field-enhanced magnetic order may lead to a Fermi surface reconstruction and thus provide a natural explanation for the unexpected Fermi surface topology observed in the quantum oscillation experiments at high magnetic fields.

TT 30.2 Wed 14:15 HSZ 304

**Normal State Magnetotransport Properties of high quality $Nd_{2-x}Ce_xCuO_4$ single crystals** — •Michael Lambacher, Toni Helm, Wolfgang Prestel, Mark Kartsovnik, Andreas Erb, and Rudolf Gross — Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Walther-Meißner-Str. 8, 85748 Garching, Germany

We present normal state magnetotransport data taken on a series of high quality $Nd_{2-x}Ce_xCuO_4$ single crystals grown by the TSFZ (traveling solvent floating zone) technique. We show that the unusual transport data of the optimally doped and overdoped crystals can be well explained within a two-band model using standard Boltzmann transport theory and anisotropic scattering rates. In particular, the observed sign change of the Hall effect with varying temperature is nicely reproduced. The presented model deviates from the general picture of the Fermi surface (FS) topology and doping dependent FS reconstruction deduced from ARPES measurements. This work has been supported by the DFG within the research unit FOR 538

TT 30.3 Wed 14:30 HSZ 304

**Revealing the Fermi surface of $Nd_{2-x}Ce_xCuO_4$ by high-field magnetotransport** — Toni Helm[1], •Mark Kartsovnik[1], Marek Bartkowiak[2], Michael Lambacher[1], Nikolaj Bittner[1], Ilya Sheikin[3], Andreas Erb[1], and Rudolf Gross[1] — [1]Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Hochfeld-Magnetlabor Dresden, Germany — [3]High Magnetic Field Laboratory, Grenoble, France

Knowing the exact Fermi surface and its evolution with the doping level is one of the vitally important issues in the field of high-$T_c$ superconducting cuprates. A promising tool to explore the Fermi surface is high-field magnetotransport which has been widely employed in studies of other layered systems, such as organic conductors. Recently, a breakthrough in the Fermiology of hole-doped cuprates was made by the observation of angular magnetoresistance oscillations (AMRO) and magnetic quantum oscillations. For electron-doped cuprates, however, no high-field magnetotransport data related to their Fermi surface has been reported so far. Here, we present results of high-field studies of the interlayer magnetoresistance of high-quality electron-doped $Nd_{2-x}Ce_xCuO_4$ single crystals. Samples with doping levels $x = 0.13$ to 0.17 have been studied at different temperatures and field orientations. We compare our data with those obtained on hole-doped cuprates and discuss them in terms of the Fermi surface geometry and its doping dependence.

This work is supported by DFG via Research Unit 538.

TT 30.4 Wed 14:45 HSZ 304

**Effect of dopant atoms on local superexchange in cuprate superconductors: a perturbative treatment** — •Kateryna Foyevtsova[1], Roser Valenti[1], and Peter Hirschfeld[2] — [1]Institut für Theoretische Physik, Goethe-Universität Frankfurt, 60438 Frankfurt am Main, Germany — [2]University of Florida, Gainesville, FL 32611, USA

On the basis of the three-band Hubbard model for the cuprates, we calculate the magnetic superexchange between Cu ions in the presence of dopants up to fifth-order in perturbation theory. We find that fourth- and fifth-order contributions are equally important, and demonstrate that their sign depends on the relative dopant-induced spatial variation of the atomic levels in the $CuO_2$ plane, contrary to results obtained within the one-band Hubbard model. We discuss some realistic cases and their relevance for the pairing mechanism in the cuprate superconductors.

TT 30.5 Wed 15:00 HSZ 304

**Doping by metal-oxygen complexes and phase separation in the superconducting solid solution $Bi_{2+y}Sr_{2-x}La_xCuO_{6+\delta}$** — •Jürgen Röhler[1], Christoph Trabant[1], Sebastian Standop[1], Helmut Dwelk[2], and Alica Krapf[2] — [1]Universität zu Köln, 50937 Köln — [2]Humboldt Universität zu Berlin, 12489 Berlin

Hole doping, $n_h(x)$, of the single-layer superconductor $Bi_{2+y}Sr_{2-x}La_x$ $CuO_{6+\delta}$ (BLSCO) is shown from systematic x-ray absorption measurements at the Cu-, La- and Bi-sites to be controlled by formation of the metal-oxygen complexes [$La^{3+}$–$O^{2-}$], or/and [$Bi^{3+}$–$O^{2-}$]. It is not, as generally assumed, controlled simply by cationic $La^{3+}/Sr^{2+}$ mixed valency. Interstitial excess oxygen atoms, taken up together with the substitution of $Sr^{2+}$ by $La^{3+}$ and partially also by excess $Bi^{3+}$, reside at two different sites in two different complex ion formations : [La–O] and/or [Bi–O] close to the faces of the $CuO_6$ octahedra, and [$La_2$–O] in between the Sr–O and Bi–O layers. The former dope holes into the $CuO_2$ planes. The latter do not, but break the van der Waals bonds in the Bi-O double layers allowing for the stabilization of co-existing monoclinic and orthorhombic superstructures. The intricate competition between these three different complex formations is connected with the electronic inhomogeneities in the underdoped, and the macroscopic decomposition in the overdoped regimes. It may be also at the origin of the singular stability of BLSC around its optimum doped composition $x_{La} \simeq 0.35$, and of the hole saturation in the overdoped regime at $n_h \simeq 0.2$.

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TT 30.6 Wed 15:15 HSZ 304

**Nanomechanismus der Supraleitung in YBCO-Verbindungen** — •Van Tri Nguyen — Hanoi University of Technology, Hanoi, Vietnam

Aus zahlreichen Untersuchungen kann es gezeigt werden, dass in der YBCO-Struktur, das Sublayer mit Y zwischen beiden (a,b)-CuO2-Ebenen, das leitungsentscheidende Layer, sich als ein moduliertes Nanolayer zeigt. Andererseits, aus den ESR-Ergebnissen wurden zwei Typen der stark superaustauschgekoppelten Elektronenspinpaaren [Cu-Y-Cu] in den orthorombischen Y-Einheitszellen dieser Nanolayer nachgewiesen: Ein antiferromagnetisches Paar entspricht der supraleitenden Phase und ein ferromagnetisches Paar entspricht der halberleitenden Phase. Diese Sachverhalte zeigen, dass der Leitungsmechanismus in YBCO in einem engen Innenzusammenhang mit den Eigenheiten der Electronendynamik seiner Nanostruktur sein muss. Die ungepaarten und hybridisierten Cu-Electronen verhalten sich im modulierten Nanolayer als quasi-freien Electronen (QFE) in einem Nanowellenleiter. Die QFE müssen dadurch komplizierte Quanteneffekte der Paarung in einem Quantum Well (Quantentopf) erfahren. Auf diseer Grundlage kann es zu erklären und ableiten einige grundsätzliche Probleme der Supraleitung in YBCO wie: Die Existenz des Spingaps Egs(T), einer Pseudoenergielücke; Die Rolle des [Cu-Y-Cu]- Singulettpaar als eine neue Art der Cooper-Paare und eine Gleichung zur Bestimmung der Übergangstemperatur Tc; Die Rolle des [Cu-Y-Cu]- Triplettpaars in der halbleitenden Phase. Die erreichten Ergebnisse sind in einer überraschenden Übereinstimmung mit den experimentellen.