

Fachvortrag

TT 4.5 Fr 16:00 TU H104

Magnetic Excitations in High-Temperature Superconductors — ●GÖTZ S. UHRIG¹, KAI P. SCHMIDT¹, and MARKUS GRÜNINGER² — ¹Institut für Theoretische Physik, Universität zu Köln, 50937 Köln — ²II. Physikalisches 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}_{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 $\text{YBa}_2\text{Cu}_3\text{O}_{6+x}$ — ●VLADIMIR HINKOV¹, BERNHARD KEIMER¹, PHILIPPE BOURGES², STEPHANE PAILHES², YVAN SIDIS², ALEXANDRE IVANOV³, ANDREY KULAKOV¹, CHENGTIAN LIN¹, DAPENG CHEN¹, and CHRISTIAN BERNHARD¹ — ¹Max-Planck-Institut für Festkörperforschung, Stuttgart, Germany — ²Laboratoire Leon Brillouin, Saclay, France — ³Institut 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 $\text{YBa}_2\text{Cu}_3\text{O}_{6+x}$ 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 EREMIN¹, DIRK K. MORR², ANDREY V. CHUBUKOV³, KARL BENNEMANN¹, and MICHAEL R. NORMAN⁴ — ¹Institut für Theoretische Physik, Freie Universität Berlin, 14195 Berlin, Germany — ²Department of Physics, University of Illinois at Chicago, Chicago, IL 60607 — ³Department of Physics, University of Wisconsin, Madison, WI 53706 — ⁴Materials 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 $\text{YBa}_2\text{Cu}_3\text{O}_{6.85}$ and $\text{YBa}_2\text{Cu}_3\text{O}_{6.6}$, 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 ZABOLOTNYI, 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 with 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 $\text{YBa}_2\text{Cu}_3\text{O}_{6.5}$ — ●K.-P. BOHNEN¹, V. PANKOKE² und R. HEID¹ — ¹Forschungszentrum Karlsruhe, Institut für Festkörperphysik, P.O.B. 3640, D-76021 Karlsruhe — ²Forschungszentrum Karlsruhe, Institut für Wissenschaftliches Rechnen, P.O.B. 3640, D-76021 Karlsruhe

Recently the lattice dynamics of $\text{YBa}_2\text{Cu}_3\text{O}_7$ 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 $\text{YBa}_2\text{Cu}_3\text{O}_{6.5}$ 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 $\text{YBa}_2\text{Cu}_3\text{O}_7$. 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 MANSKE¹ and ILYA EREMIN² — ¹Max-Planck-Institut für Festkörperforschung, 70569 Stuttgart — ²Freie 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 data 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 anisotropy in terms of stripes (H. Mook et al., Nature 2000).