SESSION 14

(September 29, 2000)

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High-resolution photoemission studies of self-energy effects in high T_c superconductivity

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Recent instrumentation developments in photoemission are providing new insights into the physics of complex materials. With increased energy and momentum resolution, it has become possible to examine in detail different contributions to the self-energy or inverse lifetime of the photohole created in the photoexcitation process. This information may be extracted either from momentum distribution curves, the photoemitted intensity as a function of momentum at constant binding energy, or from the more traditional energy distribution curves, the intensity as a function of binding energy at constant angle or momentum. In studies of a metallic systems such as Mo it is possible to isolate and identify the different contributions to the quasi-particle lifetime including electron-electron, electron-phonon and electron-impurity scattering. In contrast studies of the high Tc superconductor, $Bi_2Sr_2CaCu_2O_{8+\delta}$, show that the material at optimal doping behaves like a non-Fermi liquid rather a Fermi liquid. Further, detailed studies of the latter material reveal that interactions with spin excitations in the system lead to strong renormalization effects at the superconducting transistion.

This work has been carried out in different collaborations with Tonica Valla, Alexei Fedorov, Barry Wells, Zikri Yusof, Qiang Li, Genda Gu, N. Koshizuka. The work at BNL is supported by the Department of Energy under contract number DE-AC02-98CH10886.

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ARPES study of LSCO and PBCO: electronic structure of the stripe phase and the 1/4-filled Cu-O chains

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We have studied the electronic structure of the stripe phase in $La_{2-x}Sr_xCuO_4$ (LSCO) and the Cu-O chains in $PrBa_2Cu_3O_7$ and $PrBa_2Cu_4O_8$ (PBCO) using angle-resolved photoemission spectroscopy (ARPES). In the underdoped LSCO, the Fermi surface has a straight portion near $(\pi, \pi/4)$, indicating instability to the 1/4-filled stripe formation. While the 1/4-filled chain in $PrBa_2Cu_3O_7$ has a band gap probably because of charge ordering, the metallic chain in $PrBa_2Cu_4O_8$ has a dispersive feature which reaches the Fermi level at ~ $\pi/4$ and is similar to that observed in the stripe phase of LSCO.

Keywords*: ARPES, stripes, LSCO, chain, PBCO.*

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High resolution ARPES results on the lineshapes of high temperature superconductors

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Angle-resolved photoemission spectroscopy (ARPES) at very high energy and momentum resolution has been exploited to investigate the momentum, doping and temperature dependence of the photoemission line shapes of different high temperature superconductors. The existence of a new energy scale in the quasiparticle self-energy, present for all the momenta and well above the critical temperature has been observed.
The nature of this energy scale and its implication on the superconducting phenomena are discussed.

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Stability and single-particle excitations of the stripe phase

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We present a new technique to calculate the stability of stripe phases in the t-J model with long-range Coulomb interactions. It is based on including long-range effects into the DMRG calculations and may be termed a "density-functional" DMRG. The results clearly point to the crucial role of Coulomb correlations and thereby induced charge fluctuations on the superconducting pair-field correlations. In the second part of the paper, we discuss recent photoemission (ARPES) experiments on cuprate superconductors, which provide important guidelines for a theory of electronic excitations in the stripe phase. Using a cluster perturbation theory, where short-distance effects are accounted for by exact cluster diagonalization and long-distance effects by perturbation (in the hopping), we calculate the single-particle Green's function for a striped t-J model. The data obtained quantitatively reproduce salient (ARPES-) features and may serve to rule out “bond-centered” in favour of “site-centered” stripes.

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Structure of charged stripes in ordered stripe arrays in the cuprates

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We have introduced a tight-binding model of ordered stripe arrays, from which the photoemission spectrum can be calculated. We find that the magnetic and charged stripes give rise to separate dispersions. While the magnetic dispersion can be characterized as a lower Hubbard band, the nature of the charged stripe dispersion is less clear, and is strongly influenced by quantum size effects (QSE). The experimental photoemission spectra can be interpreted as a superposition of two features, with a charge band filling in the gap of the magnetic Hubbard bands with increasing doping, the charge-band gap being dominated by the QSE at low doping.
We explore a variety of possible states of the charged stripes, including charge-density wave, superconducting, and White-Scalapino stripes, and determine how their properties are modified by the QSE. We further propose a model for the origin of White-Scalapino stripes. Comparisons will be made to the photoemission spectra.

Keywords: *photoemission, Hubbard bands, charge-density waves.*

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