Session 22aB

Concepts in High Temperature Superconductivity 22aB1

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The fact that the repulsive interactions between electrons are large compared to the Fermi energy is the defining feature of highly correlated electronic fluids. It has long been known that this can give rise to high temperature magnetic phenomena, and more recently it has become clear that this leads to various forms of local charge inhomogeneity and charge order. I will explore the relation between these phenomena and high temperature superconductivity. In particular, I will discuss the theoretical reasons to believe that magnetism opposes superconductivity, and that charge inhomogeneity on appropriate scales has the potential to enhance high temperature superconducting pairing, although it tends to suppress superconducting phase coherence.

Gap Inhomogeneity, Phase Separation and Pseudogap in $Bi_2Sr_2CaCu_2O_{8+\delta}$ 22aB2

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Recent STM study showed that the electronic system of $Bi_2Sr_2CaCu_2O_8$ (Bi-2212) is inhomogeneous. We have studied the detailed doping and temperature dependence of gap inhomogeneity. The temperature dependence showed clear evidence of phase separation into the ”superconducting” and pseudogapped regions as a double peaked structure in the gap distribution function. The doping dependence supports this view. It also suggests the monotonic increase in the gap energy with reducing doping is due to diverging inhomogeneity. The gap energy dependence of the peak-dip-hump structure suggests gap inhomogeneity accompanies the Fermi level shift or in-plane charge inhomogeneity.

22aB3 **^{63}Cu NQR Observation of Spatial Variation of Electronic Properties in $La_{2-x}Sr_xCuO_4$**

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The common assumption made in the debate over the mechanism of high T_c cuprates is that electronic properties are spatially uniform in the doped CuO_2 planes. In this talk, we will present our detailed NQR and NMR studies of $La_{2-x}Sr_xCuO_4$ that reveal evidence for the presence of short length-scales in the local electronic properties [P.M. Singer, A.W. Hunt and T. Imai, PRL88 (2002) 047602]. We will also compare the results with the Ca substitution effects in $Y_{1-x}Ca_xBa_2Cu_3O_{6+\delta}$ [P.M. Singer and T. Imai, PRL88 (2002) 187601].

22aB4 **STM Observation of Inhomogeneity as a Function of Doping in the High Temperature Superconductor BSCCO-2212**

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We present results from low temperature scanning tunneling microscopy of the high temperature superconductor $Bi_2Sr_2CaCu_2O_{8+x}$, focusing on atomic scale spatial variations in the local density of states. By using maps of the local variation of the energy gap magnitude and gap-edge peak amplitude, and by studying the local properties of impurity atom resonances, we examine the local density of states of this material at a variety of oxygen doping-levels. In particular, I will discuss both the granular nature of the electronic structure as observed in underdoped crystals, and its evolution with increasing oxygen doping.

22aB5 **In-plane anisotropy and temperature dependence of oxygen phonon modes in $YBa_2Cu_3O_{6.6}$**

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The dispersion of the Cu-O bond-stretching and bond-bending vibrations in $YBa_2Cu_3O_{6.6}$ has been studied by high-resolution inelastic neutron scattering. While the behavior of the bond-bending vibrations can be well accounted for by a simple potential model, the bond-stretching vibrations show a highly anomalous behavior. The displacement pattern of the most anomalous phonons is in principle consistent with dynamic charge stripe formation. However, the pattern is rotated by 90 degrees to what was expected from the magnetic fluctuations reported in the literature. Temperature dependent measurements revealed only moderate changes of phonon frequencies between 10 K at 300 K.