SESSION 5

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Intrinsically disordered spin dynamics in lanthanum cuprate

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We report Cu and La nuclear magnetic resonance (NMR) measurements in lanthanum cuprate that reveal an inhomogeneous glassy behavior of the spin dynamics. A strong peak in the ^{139}La spin-lattice relaxation rate observed below the antiferromagnetic (AF)ordering temperature is well described by the well-known BPP mechanism and demonstrates continuous slowing of electronic spin fluctuations with decreasing temperature. The mechanism underlying these slow spin fluctuations is not known at present, but it is characterized by a *distribution* of activation energies centered around ~70 K revealing evidence for dynamical disorder. These spin fluctuations exhibit XY-like anisotropy in the ordered state, and we find that the spin pseudogap is strongly enhanced by the static charge-stripe order in the immediate vicinity of 1/8 doping [1]. This inhomogeneous slowing of spin fluctuations is evident in *all* AF ordered lanthanum cuprates and its character is essentially independent of doped-hole density across a decade of doping ($.014 \leq x \leq .15$). Inhomogeneous and very slow spin fluctuations appear to be a general feature of doped lanthanum cuprate. The “wipeout ”of Cu intensity is shown to arise from these same slow electronic spin fluctuations; this indicates that Cu wipeout is *not* a direct measure of the stripe order parameter [2].

References

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Cu-63 and La-139 NQR study of "stripe" phase in La-Sr-Cu-O

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Over the past decade, many NMR/NQR measurements have been reported on various high T_c cuprates based on more and more sophisticated experimental techniques. However, the measurement of the intensity of NMR/NQR had been attracting little attention despite an earlier report that charge localization in La-Sr-Cu-O causes anomalous wipeout of 63-Cu NMR intensity [1]. In this talk, we discuss our recent efforts on 63-Cu NQR and 139-La NQR intensity measurements that provide valuable information regarding the slowing down of stripes in La-Sr-Cu-O with and without Nd/Eu co-doping [2-4]. The on-set of loss of signal intensity of 63-Cu NQR below charge ordering temperature is accompanied by the on-set of increase of 139-(1/T1T), 139-La nuclear spin-lattice relaxation rate divided by temperature T [2]. This is evidence that charge order triggers rather sudden on-set of glassy slowing down of spin stripe fluctuations [2]. We also discuss our recent efforts to map the spatial distribution of spin and charge density waves in the x=1/8 "stripe" phase of La-Ba-Cu-O and Eu co-doped La-Sr-Cu-O. We demonstrate that the single, broad, triangle shaped Zeeman perturbed 63-Cu NQR lineshape below ~10 K can be accounted for by assuming nearly random distribution up to ~0.2 Bohr magneton of ordered Cu moment without having any periodic spatial modulation or mesoscopic phase separation.

References

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Spin and charge dynamics in lightly-doped cuprates: from the antiferromagnetic to the underdoped regime

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NMR offers a unique tool to investigate the low-frequency spin and charge dynamics and to discern inhomogeneities at the microscopic level when the frequency of the motions becomes of the order of the MHz. Although a clear cut evidence that NMR spectra and relaxation rates in underdoped HTcSC are affected by the stripes dynamics is still missing, many indirect evidences of the presence of stripes have been put forward on the basis of NMR results. In particular, in LSCO, for doping levels lower than the one leading to the superconducting state, the little dependence of the spin stiffness on doping has been accounted for by a reduction of the effective hole concentration in the CuO_2 planes due to the stripes formation. In the same doping regime, the comparison of the frequency of spin fluctuations, derived from NQR relaxation rates, with the one of the lattice motions, derived from anelastic relaxation measurements, is expected to bring new insights on the stripes dynamics. In the underdoped regime of LSCO the coexistence of superconductivity and of a cluster spin-glass phase has been observed and attributed to the formation of a network of stripes percolating around antiferromagnetic clusters. In the same regime, the loss of ^{63}Cu NQR signal at low temperature has been shown to originate from the progressive slowing down of the antiferromagnetic correlations on cooling and to be indirectly related to the formation of stripes.

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Inhomogeneous magnetic and electronic state in underdoped high-T_c oxides

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A summary of results from muon spin rotation experiments is presented describing studies carried out over a broad concentration range for Sr doped La_2CuO_4 and Ca doped $YBa_2Cu_3O_{6+\delta}$. In the underdoped superconducting region for both systems clear evidence for concentration dependent spin freezing of strongly correlated antiferromagnetic regions is found. The persistence of these strong static antiferromagnetic correlations in the superconducting state is evidence for an inhomogeneous hole distribution relatable to the stripe phase deduced from the neutron experiments of Tranquada et al. Based on a variety of studies we argue that the particular ground state properties may be understood in terms of features of the hole dynamics.

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