SESSION 2

(September 26, 2000)

Spin fluctuations and stripes - I

S2-I
G. Shirane
Stripes in Sr doped La_2CuO_4 insulators and superconductors

S2-II
B. Lake
Spin-gap and magnetic coherence in a high-temperature superconductor

S2-III
M. Arai
Spin-charge stripe structure of superconducting $YBa_2Cu_3O_{6+x}$

S2-IV
A. Bianconi
The quantum critical point for superstripes: self organization of quantum wires in high T_c superconductors

Stripes in Sr doped La_2CuO_4 insulators and superconductors

G. Shirane
Department of Physics, Brookhaven National Laboratory, Upton, NY, USA.

A review is given of the series of magnetic satellite peaks revealed by recent elastic neutron scattering measurements on $La_{2-x}Sr_xCuO_4$ ($0.02 < x < 0.13$). The stripe geometry changes drastically from parallel directions (to the tetragonal axis) to the diagonal ones at the critical concentration of x - 0.055, the boundary of superconductor and insulator. High resolution neutron scattering measurements demonstrate the intrinsic relation between the stripe directions and the orthorhombic symmetry of these crystals [Lee et al., Phys. Rev. B60, 3643 (1999) and Wakimoto et al., Phys. Rev. B61, 3699 (2000)]. These studies were carried out in collaboration with scientists at MIT, Sendai, Kyoto, NIST, and JAERI.

Keywords: *Stripe, neutron scattering,* $La_{2-x}Sr_xCuO_4$.

Gen Shirane
Dept. of Physics, Bldg. 510A,
Brookhaven National Laboratory,
P.O. Box 5000
Upton, NY, USA 11973-5000
phone: (631) 344-3732
fax: (631) 344-2918
e-mail: shirane@bnl.gov

Spin-gap and magnetic coherence in a high-temperature superconductor

B. Lake[1,2,3], G. Aeppli[4,3], T. E. Mason[1,2], A. Schröder[5], D. F. McMorrow[3], K. Lefmann[3], M. Isshiki[6], M. Nohara[6], H. Takagi[6], S. M. Hayden[7]
[1]Department of Physics, University of Toronto, Toronto, Canada. [2]Solid State Division, Oak Ridge National Laboratory, Oak Ridge, U.S.A. [3]Department of Condensed Matter Physics and Chemistry, Risϕ National Laboratory, Roskilde, Denmark. [4]N.E.C. Research, Princeton, U.S.A. [5]Department of Physics, University of Karlsruhe, Karlsruhe, Germany. [6]ISSP, University of Tokyo, Tokyo, Japan. [7]H. H. Wills Physics Laboratory, University of Bristol, Bristol, U.K.

An inelastic neutron scattering study of $La_{2-x}Sr_xCuO_4$ has been carried out for a range of doping *x*. A dispersionless energy gap was found. This result contrasts with the findings of, for example, photoemission spectroscopy where the gap was demonstrated to be a function of wavevector and to have the dispersion characteristic of a *d*-wave superconductor. The technique of photoemission is sensitive to the pairing of the charges while neutron scattering is sensitive only to the spins of these paired charges. Given the overwhelming evidence for *d*-wave superconductivity in cuprate superconductors we see our data not as evidence against *d*-wave superconductivity but as an indication that the spin excitations in the superconducting state do not parallel the charge excitations in the manner assumed by conventional *d*-wave theories. Other findings include a superconductivity-induced increase in the magnetic coherence length above the spin-gap.

Keywords: *cuprates, neutron scattering, spin-charge separation.*

B. Lake
BLDG 7962 MS 6393,
Solid State Division,
Oak Ridge National Laboratory,
Oak Ridge, TN 37831-6393, USA
phone: +1 865 241 0098
fax: +1 865 574 6268
e-mail: bella.lake@risoe.dk

Spin-charge stripe structure of superconducting $YBa_2Cu_3O_{6+x}$

M. Arai[1], Y. Endoh[2], S. Tajima[3], K. Tomimoto[3], Y. Shiohara[3], S. M. Bennington[4]
[1]KEK, [2]IMR, [3]ISTEC, [4]RAL.

We have recently revealed that the spin dynamics of YBCO has also the same incommensurate feature as that of LSCO. Furthermore, we have found that there is superlattice peaks from charge stripes, whose periodicity can be a half of the spin modulation. Therefore, we highly anticipate the existence of "stripe structure" which is caused by a phase separated structure of charge and spin. On YBCO the incommensurability becomes 1/6 for the optimally doped region with T_c=90K associated with a jump from 1/8 in incommensurability of under doped region with T_c=60K. This jump in the incommensurability seems to be structural jump from 4a-stripe structure with 3-ladder spin system to 3a-stripe structure with 2-ladder spin system. A sharp spin excitation of the resonance peak of optimally doped composition may be explained by the singlet-to-triplet excitation in the two-ladder and the broad feature for under doped one by doublet state for 3-ladder. We will discuss a possible scenario of the superconductivity according to the formation of stripe structure.

Masatoshi Arai
Institute of Materials Structure Science
High Energy Accelerator Research Organization
1-1 Oho, Tsukuba 305-0801, Japan
phone: 0298-64-5613
fax: 0298-64-3202
e-mail masatoshi.arai@kek.jp

The quantum critical point for superstripes: self organization of quantum wires in high T_c superconductors

A. Bianconi
Dipartimento di Fisica, Universit di Roma La Sapienza , Roma Italy.

We report the experimental determination for the phase diagram for all cuprate superconductors, where the critical temperature is plotted as a function of microstrain ε of the in plane Cu-O(P) distance and the doping $T_c(\delta,\varepsilon)$. The microstrain has been measured by high resolution polarized Cu K-edge EXAFS data. The new phase diagram shows a quantum critical point (QCP) as a function of the microstrain at constant doping. Only for strain above the QCP we observe diffuse x-ray scattering probing charge stripes. The critical temperature for stripe formation increases with the microstrain above the QCP. The critical temperature T_c reaches the maximum value ˜150 K at the QCP. Near the QCP we have identified the self-organization of a superlattice of quantum wires giving high T_c superconductivity, called "superstripes" characterized by: 1) inter-stripes hopping for pairs, $t_p^2D_0$, larger than the transverse hopping, t_p, for single electrons; 2) the "shape resonance", giving the peak in the density of states D_0 near the Fermi level; 3) the amplification of the critical temperature in comparison with the homogeneous phase of the order of 10-100 times.

References

[1] A. Bianconi S. Agrestini, G. Bianconi, D. Di Castro and N.L. Saini, *Lattice charge stripes in high Tc superconductors* in "Stripes and Related Phenomena", Edited by Bianconi and Saini Kluwer Academic Plenum Publisher, New Your, pag. 9 (2000).
[2] N.L. Saini, A. Bianconi and Y. Oyanagi *Evidence for the critical lattice fluctuations in the high T_c cuprates* J. of Phys. Soc. Jpn. , *to be published* (2000).
[3] N.L. Saini, A. Bianconi A. Lanzara, S. Agrestini D. Di Castro and Y. Oyanagi *Local Lattice Fluctuations as a function of Chemical pressure* Int. J. Modern Physics B, *in press* (2000).
[4] A. Bianconi, D. Di Castro, N.L. Saini and G. Bianconi, *SUPERSTRIPES Self organization of quantum wires in high T_c superconductors* in Phase transitions and self-organization in electronic and molecular networks, edited by M.F. Thorpe and J.C. Phillips, Kluwer Academic/Plenum Publisher, Fundamental Materials Research Series (Proc. of the meeting at Cambridge 11-14 July, 2000).
[5] A. Bianconi, S. Agrestini, G. Bianconi, D. Di Castro and N. L. Saini *A Quantum Phase Transition Driven by the Electron Lattice Interaction gives High T_c Superconductivity* J. of Alloys and Compounds (2000) *in press.*

Antonio Bianconi
Dipartimento di Fisica
Università di Roma “La Sapienza”
Piazzale A. Moro,2 I-00185 Roma, Italy
phone: +39 06 49914612
fax: +39 06 4957697
e-mail: antonio.bianconi@roma1.infn.it