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Angle-resolved photoemission spectroscopy study of $La_{1.6-x}Nd_{0.4}Sr_xCuO_4$

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Introduction

The observation of the pseudo-gap and superconducting gap in high-T_c cuprates and their relation to superconductivity remain a central issue [1]. Neutron scattering studies [2] have shown strong evidence for static spin and charge ordering (stripes) in the cuprate superconductor $La_{1.6-x-y}Nd_ySr_xCuO_4$ which shows an anomalous suppression of superconductivity at x≈1/8. Investigating the electronic structure of this system (dipersions, gaps, etc..) and making comparison with other high-T_c superconductors may give important clues about the relation of stripes with superconductivity and thus about the pairing mechanism in high-T_c cuprate superconductors.

Therefore, we have studied this system using angle-resolved photoemission spectroscopy (ARPES).

Results and Discussions

Figure 1 shows the E-k plots which represent the spectral intensity as a function of binding energy and momentum corresponding to several cuts across the Fermi surface from the nodal region (1) to the antinodal region (4). At cut (1), near the nodal region, we observe a well-defined dispersive feature suggesting that quasi-particles can exist in the stripe-ordered state. Also it is clear that the dispersive feature becomes weaker as we move away from the nodal region. From these data we could determine the shift in the leading edge midpoints (LEM) of the energy distribution curves (EDC's). We found out that the LEM which reflects the gap on the Fermi surface follows a d-wave-like symmetry reaching a size of ~ 8.8 meV near the antinodal region as shown in Figure 2. The gap behaviour in the stripe-ordered system $La_{1.6-x}Nd_{0.4}Sr_xCuO_4$ (x≈1/8) in the normal state is similar to that of $La_{2-x}Sr_xCuO_4$ (x=0.15) in the superconducting state [3]. This observation raises the question of whether the stripes in high-T_c cuprates compete with superconductivity or act as an enhancing factor. Also our results were compared to those of the stripe-ordered system $La_{2-x}Ba_xCuO_4$ [4] which shows a severe drop of superconductivity at x≈1/8 due to the formation of the stripes phase similar to the case of the system we are studying. Although both systems show a d-wave-like behaviour in the normal state, the gap size observed in

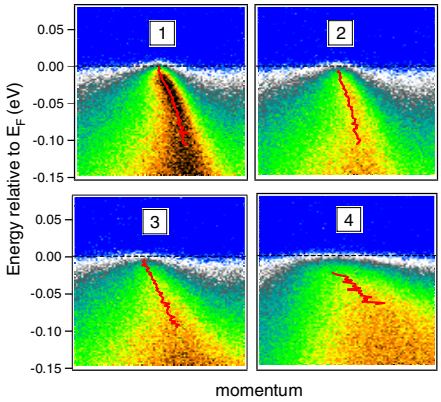

Fig. 1. E-k plots corresponding to several cuts on the Fermi surface.

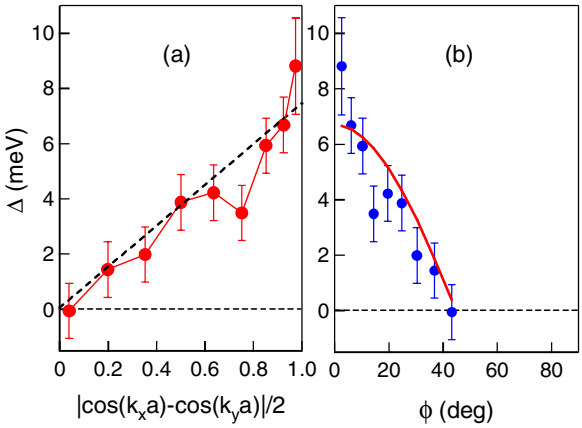

Fig. 2. Leading edge gap observed in the normal state of $La_{1.6-x}Nd_{0.4}Sr_xCuO_4$ (x≈1/8) plotted against (a) $|\cos(k_xa)-\cos(k_ya)|/2$ and (b) the Fermi angle (φ). In both cases the d-wave-like behaviour of the gap is confirmed.

$La_{2-x}Ba_xCuO_4$ (x≈1/8) is much larger than that we observed in $La_{1.6-x}Nd_{0.4}Sr_xCuO_4$ (x≈1/8). Thus the problem remains unsolved and needs further investigation.

References

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