SPIN DYNAMICS OF THE ELECTRON-DOPED HIGH T_C SUPERCONDUCTING CUPRATES

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It is crucial to understand the differences between hole and electron-doped high T_C superconducting cuprates. The spin dynamics has been studied intensively in hole-doped cuprates and it is only recently that the first inelastic neutron results were obtained for the electron-doped cuprate $Nd_{1.85}Ce_{0.15}CuO_4$ in both the normal and the superconducting state, with an impressive difference from what is found with hole doping. The resonance peak that is the most prominent feature of the hole-doped cuprates is not observed and the spin response which is also peaked at antiferromagnetic wave vector has an extremely narrow q width (one order of magnitude smaller than in hole doped cuprates). The spin gap is extremely small. It has been proposed by theoreticians at LLB that the basic difference between electron and hole doped cuprates is the proximity of the two electronic systems to two different critical situations (for the corresponding free Fermion system on a square lattice), one related to saddle point electrons (electronic topological transition) and the other to the nodal electrons (antiferromagnetic nesting). These two borderline situations behave as quantum critical points (QCP) and it is shown that the narrow q width and the low spin gap are the signature of the proximity to one of the QCP while the resonance peak is a signature of a proximity to the other one. This is illustrated in Figure 4[a,b] which shows the calculated electron-hole spin excitation continuum in the superconducting state, for hole and electron-doped cuprates, with very striking predicted differences in the energy and wave vector scales. The same simple conceptual framework is actually developped to explain the differences in the anomalies of the electronic spectral functions between hole and electron-doped cuprates as measured by photoemission.

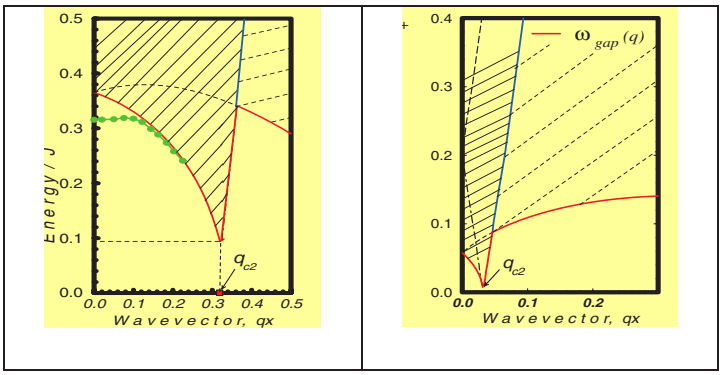

Figure 4[a,b]: Calculated electron-hole continuum, at low energy and in the vicinity of the antiferromagnetic wave vector, in the d-wave superconducting state for hole doping in 4-a [left figure] and for electron doping in 4-b [right figure]. The red line corresponds to a true gap, the blue line to a pseudogap and the green line to the resonance peak dispersion (only present for hole doping).

Reference:

F. Onufrieva and P. Pfeuty, Phys.Rev.Lett. 92 247003 (18 Juin 2004).