Quantum magnetic excitations from stripes in copper-oxide superconductors

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Recent inelastic neutron scattering studies show that the magnetic excitation spectra of two well-studied families of cuprate superconductors are much more similar than previously believed. In particular, I will present results we have obtained on La$_{2-x}$Ba$_x$CuO$_4$ (LBCO) with $x=0.125$ [1,2]. Using very large single crystals grown at Brookhaven, we were able to measure the magnetic excitations up to 200 meV using the MAPS time-of-flight spectrometer at the ISIS spallation source. While the lowest energy excitations are split incommensurately, these disperse inwards towards the antiferromagnetic wave vector with increasing energy, merging at $\sim$50 meV. At higher energies the excitations disperse outwards again. There is a significant enhancement of the $\mathbf{Q}$-integrated magnetic scattering near $\sim$50 meV compared to lower energies, suggestive of quantum correlations and distinct from spin-wave predictions. Many features of the spectrum are quite similar to those found in YBa$_2$Cu$_3$O$_6$ [3]. One can qualitatively characterize the results with a universal excitation spectrum, together with a material-dependent spin gap in the superconducting state. It is important to note that the LBCO sample exhibits static stripe order [2], as this has significant implications for the origin of the magnetic excitations in superconducting cuprates.


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