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The structure of the high-energy spin excitations in $YBa_2Cu_3O_{6+x}$[1]

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The most obvious feature in the magnetic excitations of high-T_c superconductors is the so-called 'resonance-mode'. This mode is strongly coupled to the superconductivity, however, it has not been found in the $La_{2-x}(Ba,Sr)_xCuO_4$ family and is not universally present in $Bi_2Sr_2CaCu_2O_{8+\delta}$. Here we use inelastic neutron scattering to characterize other excitations at higher energies which may be relevant to the superconductive pairing in $YBa_2Cu_3O_{6.6}$. We observe a square-shaped continuum of excitations in reciprocal space [1]. These excitations have energies greater than the superconducting pairing energy, are present at T_c, and have spectral weight far exceeding that of the 'resonance'. The discovery of similar excitations in $La_{2-x}Ba_xCuO_4$ [2] suggests that they are a general property of the copper oxides, and a candidate for mediating the electron pairing. Our data show that the high-energy magnetic excitations in the high-temperature superconductor $YBa_2Cu_3O_{6.6}$ consists of a continuum of scattering bounded by a square and peaked at wavevector positions $\mathbf{Q}_\varepsilon$ =(1/2$\pm\varepsilon$,1/2$\pm\varepsilon$) and (1/2$\pm\varepsilon$,1/2$\mp\varepsilon$). A similar structure is observed in the high-energy magnetic excitations of the magnetically ordered but weakly superconducting compound $La_{1.85}Ba_{0.125}CuO_4$ [2]. This suggests there is universality, both in the low-energy and the high-energy spin dynamics between two very different classes of high-T_c superconductor.

[1] S.M. Hayden, H.A. Mook, P.C. Dai, T.G. Perring, and F. Dogan, Nature **429**, 531-534 (2004)
[2] J.M. Tranquada, H. Woo, T.G. Perring, H. Goka, G.D. Gu , G. Xu, M. Fujita, K.Yamada K, Nature **429,** 534-538 (2004).

[1]Work in collaboration with H. A. Mook, Pengcheng Dai, T. G. Perring and F. Dogan