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Magnetic phase diagram and magnetic dynamics of $\text{YBa}_2\text{Cu}_3\text{O}_{6+x}$: Implications for the mechanism of high- T_c superconductivity

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We will present a comprehensive study of the magnetic phase diagram of the high-temperature superconductor $\text{YBa}_2\text{Cu}_3\text{O}_{6+x}$. Using elastic neutron scattering, we show that the phase diagram includes incommensurate spin density wave and electronic liquid-crystal states, in addition to the well-known antiferromagnetic, d-wave superconducting, and paramagnetic phases [1]. Using a combination of inelastic neutron scattering and resonant inelastic x-ray scattering, we have also arrived at a comprehensive picture of the magnetic excitation spectrum in all of these phases [2]. The dispersion relations and spectral weights of all compounds, including the slightly overdoped superconductor $\text{YBa}_2\text{Cu}_3\text{O}_7$, are closely similar to those of magnons in undoped, antiferromagnetically ordered $\text{YBa}_2\text{Cu}_3\text{O}_6$. The results are in excellent agreement with the spin excitations obtained by exact diagonalization of the t-J Hamiltonian on finite-sized clusters. A numerical solution of the Eliashberg equations based on the experimental spin excitation spectrum of $\text{YBa}_2\text{Cu}_3\text{O}_7$ reproduces its superconducting transition temperature T_c within a factor of two, strongly supporting magnetic Cooper pairing models for the cuprates. Neutron scattering data of the buckling phonon in $\text{YBa}_2\text{Cu}_3\text{O}_7$ suggest that coupling to this phonon does not substantially enhance d-wave pairing [3].

[1] D. Haug, V. Hinkov, Y. Sidis, P. Bourges, N. B. Christensen, A. Ivanov, T. Keller, C. T. Lin, B. Keimer, *New J. Phys.* **12**, 105006 (2010).

[2] M. Le Tacon, G. Ghiringhelli, J. Chaloupka, M. Moretti Sala, V. Hinkov, M. W. Haverkort, M. Minola, M. Bakr, K. J. Zhou, S. Blanco-Canosa, C. Monney, Y. T. Song, G. L. Sun, C. T. Lin, G. M. De Luca, M. Salluzzo, G. Khaliullin, T. Schmitt, L. Braicovich, B. Keimer, to be published.

[3] M. Raichle *et al.*, to be published.