

Doping evolution of the magnetic excitations in the high-temperature superconducting cuprates

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High resolution resonant inelastic x-ray scattering (RIXS) has recently emerged as a highly sensitive probe of magnetic excitations –it can even be used to measure magnetic excitations in isolated one-unit-cell-thick La_2CuO_4 layers [1]. This talk will describe how RIXS has provided new insights into the magnetic excitations in the high-temperature superconducting cuprates.

Photoemission and scanning tunneling spectroscopy have given us exquisitely detailed picture of the electronic structure of $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+\delta}$, but little is known about its high-energy (>100 meV) magnetic response. Using RIXS we measure the magnetic response [2] and show that a phenomenological theory based on electron pockets can consistently describe the electronic and magnetic response of this cuprate [2, 3].

In the heavily overdoped cuprates such as $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$ ($x>0.3$) superconductivity disappears despite the high electronic density of states. We used RIXS to measure the magnetic excitations across the whole $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$ phase diagram. The magnons induced by local moment physics in La_2CuO_4 evolve smoothly into broadened paramagnons in the overdoped state where itinerant quasi-particles dominate most properties of the cuprates. The fact that paramagnons persist relatively unchanged as superconductivity disappears is very difficult to reconcile with theories that suggest these high-energy paramagnons seen by RIXS, rather than the lower energy magnetic excitation in other regions of the Brillouin zone, are causing superconducting pairing [4].

[1] M. P. M. Dean et al. *Nature Materials* 11, 850–854 (2012)

[2] M. P. M. Dean et al. *Phys. Rev. Lett.* 110, 147001 (2013)

[3] A. J. A. James, T. M. Rice and R. M. Konik, *Phys. Rev. B* 86, 100508(R) (2012)

[4] M. P. M. Dean et al. arXiv:1303.5359 (2013) (in press at *Nature Materials*.)

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