Abstract submitted to the
Conference on Concepts in Electron Correlation
September 24 - 30, 2008 Hvar, Croatia

Visualizing pair formation on the atomic scale in high-Tc superconductors [1]

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Submitted : 11-09-2008
Keywords : superconductivity, STM

Unlike traditional superconductors, the density of states (DOS) of the high-Tc superconductor Bi-2212 shows large nanoscale variations that have been detected using scanning tunneling microscopy (STM) [1],[2]. Such variations are seen in the low temperature superconducting gap [1] and in features associated with the coupling of pairs to boson modes [2]. In order to understand these variations in the spectra, we perform atomic resolution STM measurements of Bi-2212 as a function of temperature [3]. Using newly developed experimental techniques, we measure the evolution of the DOS from low temperature (T«Tc) to temperatures where all gaps in the spectrum have disappeared (T>T*). Such measurements show that the pairing gap nucleates in nanoscale regions at temperatures between Tc and T*. By normalizing the low temperature DOS (T«Tc) to the DOS at high temperature, we are able to fit the superconducting DOS to the d-wave BCS form. We find that the experimental spectrum deviations from a simple d-wave fit indicating a strong coupling between electrons and bosonic modes. We will discuss the temperature evolution of these as well as other features in the DOS, and correlate such measurements with the inhomogeneity seen in the gap magnitude at low temperature.

[1] Howald et al., Phys Rev B **64**, 100504(R) (2001).
[2] Lee et al., Nature **442**, 546 (2006).
[3] Gomes et al., Nature **447**, 569 (2007).

[1] Work in collaboration with Ken Gomes, Aakash Pushp, Colin Parker, Shimpei Ono, Genda Gu, Yoichi Ando and Ali Yazdani.