MAR14-2013-020278

Abstract for an Invited Paper
for the MAR14 Meeting of
the American Physical Society

Pairing, Pair-Breaking, and the Critical Temperature in the Cuprate Superconductors

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In conventional superconductors, the pairing strength sets the majority of the physical properties including the superconducting transition temperature, T_C. However, the cuprates show no such link between the pairing interactions and T_C. Using a new variant of photoelectron spectroscopy, we measure both the pair-forming (Δ) and pair-breaking (Γ_S) processes with greatly improved accuracy over a wide range of doping and temperatures. We find that, across the phase diagram, Δ directly scales with the temperature marking the onset of pairing, T_{Pair}, rather than those for the onsets of superconductivity, T_C, or the pseudogap, T^*. Instead, T_C is set by a simple ratio of $\Delta(T_C)$ and $\Gamma_s(T_C)$, in contrast to conventional superconductivity in which the pairing alone, $\Delta(T=0)$, sets T_C. This finding shows the pair-breaking processes are a critical limiting factor for superconductivity in the cuprates. Finally, we will discuss the merits of the potential candidates for the origin of Γ_s.