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Doping-dependent vortex-state scanning tunneling spectroscopic (STS) studies of cuprate superconductors C.-C. CHEN, M. L. TEAGUE, Z.-J. FENG, R.T.-P. WU, N.-C. YEH, Dept. of Physics, Caltech, Pasadena, CA 91125 — We report STS studies of YBa2Cu3O7$-\delta$(Y-123) and Ca-doped Y-123 superconductors as a function of magnetic field (H) and hole doping level (p). Our studies suggest that the origin of the pseudogap (PG) is associated with competing orders (COs), and that the occurrence (absence) of PG above the superconducting (SC) transition T_c is associated with a CO energy Δ_{CO} larger (smaller) than the SC gap Δ_{SC}. We derive Δ_{SC} and Δ_{CO} by two approaches. For zero-field STS we apply Green function techniques to fit the "peak" features for Δ_{SC} and the "kink" features for $\Delta_{eff} \equiv [(\Delta_{SC})^2 + (\Delta_{CO})^2]^{1/2}$. For $H > 0$ we analyze the PG features in the intra-vortex STS for Δ_{CO} and the peak features in the inter-vortex STS for Δ_{SC}. Both approaches yield consistent results. For optimally and underdoped Y-123, we find that $\Delta_{SC} < \Delta_{CO}$ with dominant $d_{x^2-y^2}$-wave pairing, and that Δ_{SC} decreases with decreasing p while Δ_{CO} increases. Both Δ_{SC} and Δ_{CO} exhibit long-range spatial homogeneity. For Ca-doped Y-123, the substitution of Y by Ca contributes to excess holes and disorder. For $p > 0.16$, both Δ_{SC} and Δ_{CO} decrease with increasing p, $\Delta_{CO} < \Delta_{SC}$ for $p > 0.23$, and the pairing symmetry becomes $(d_{x^2-y^2} + s)$ with increasing s-wave component, implying the diminishing Mott nature in overdoped cuprates. This work was supported by NSF through IQIM at Caltech.

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