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Doping-dependent vortex-state scanning tunneling spectroscopic (STS) studies of Ca-doped $YBa_2Cu_3O_{7-\delta}$(Y-123)[1] M.L. TEAGUE, C.-C. CHEN, N.-C. YEH, Dept. of Physics, Caltech, Pasadena, CA 91125, Z.J. FENG, Dept. of Physics, Shanghai University, Shanghai, China — We present STS studies of Ca-doped Y-123 as a function of magnetic field (H) and hole doping level (p). Our previous STS studies at $H = 0$ have shown that the origin of the pseudogap (PG) is due to competing orders (COs), and that the presence (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}. Moreover, Δ_{SC} and Δ_{CO} decrease with increasing p for $p >$0.16, and $\Delta_{CO} < \Delta_{SC}$ for $p >$0.23. The pairing symmetry also evolves from pure $d_{x^2-y^2}$ to $(d_{x^2-y^2} + s)$ for $p >$0.16, where the s-wave component increases with p. Here we investigate the evolution of vortex-state ($H >$0) STS with p. For $p =$ 0.21 and $H =$ 3T, STS reveal the presence of vortices with a vortex "halo" size $\xi \sim$ 8 nm, smaller than $\xi \sim$ 10 nm for $p = 0.16$. A PG with Δ_{CO} ($\sim$ 11 meV) $<\Delta_{SC}$ ($\sim$ 17 meV) is found inside the vortex core for $p = 0.21$, which is consistent with the value derived from Green function analysis of the STS in $H = 0$ and is in contrasts to the finding of an intra-vortex PG Δ_{CO} ($\sim$ 32 meV) $>\Delta_{SC}$ ($\sim$ 23 meV) for $p =$ 0.16. Fourier transformation of the STS also shows energy-independent wave-vectors Q_{CDW} and Q_{PDW} associated with the charge- and pair-density waves, where Q_{CDW} decreases with p and Q_{PDW} is p-independent.

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