How to describe anomalous under-doped cuprate physics by Hubbard model and Composite Operator Method

Abstract:
The two-dimensional Hubbard model is studied within the composite operator method (COM) with the self-energy computed in the Non-Crossing Approximation (NCA). The COM describes interacting electrons in terms of the new elementary excitations that appear in the system owing to strong correlations; residual interactions among these excitations are treated within the NCA. On decreasing the doping (from the overdoped to underdoped region), anomalous features develop in the spectral function, the Fermi surface, the momentum distribution function, the dispersion, and the density of states in the intermediate-coupling regime (U=8) at low temperatures (T=0.01--0.02).
At high doping (n=0.7), the system resembles an ordinary weakly interacting metal. At low doping (n=0.92), a pseudogap opens, hot and cold spots appear, and non-Fermi-liquid features develop. This behavior, together with the presence of kinks in the calculated electronic dispersion, is in very good qualitative agreement with angle-resolved photoemission spectroscopy data for high- Tc cuprates superconductors.