Minimal loop currents and strong pairing in doped Mott insulators

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Novel pairing mechanism is revealed by studying dilute holes doped into an antiferromagnetic spin background using density matrix renormalization group (DMRG) and wavefunction variational Monte Carlo (VMC) methods. Strong correlation effects manifest as follows: A single unpaired hole generally exists in a "cat" state—a quantum superposition of a Landau quasiparticle and a non-quasiparticle component accompanied by minimal loop currents. When two holes are introduced, they bind into a tightly bound pair that suppresses the loop currents, forming a "cat" state superposition of a d-wave Cooper pair and a non-Cooper-pair component. This exotic picture remains valid up to a finite doping level, provided the antiferromagnetic correlation length exceeds the characteristic lattice scale (~4×4) for both the single-hole and two-hole cat states. We argue that the latter constitutes a minimal superconducting block in understanding the high-Tc cuprate. The asymmetry between the hole-doping and electron-doping in the t-t'-J model will be also briefly mentioned.