Theoretical investigation of superconductivity and antiferromagnetism in trilayer cuprate superconductors

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Recent ARPES experiment on the optimally doped trilayer cuprate superconductors Bi2223 has revealed a layer variation of both doping density and d-wave gap. In particular, the two outer layers are overdoped with a gap which is larger than the gap for optimally doped single layer cuprates while the inner layer is underdoped with an even larger gap. Here we propose a minimal model composed of three layer t-J model, single particle interlayer tunneling as well as Cooper pair tunneling terms. By using renormalized mean field method, both the superconducting and antiferromagnetic properties are theoretically investigated. Both tunneling effects may influence the phase configurations of both d-wave superconducting and antiferromagnetic order parameters on each layer which plays a crucial role in determining the electronic structures of trilayer cuprate superconductors. The inphase state for both superconducting and antiferromagnetic phases is found to be relevant to the Bi2223 trilayer system. In such a state, the superconducting order parameter of inner plane will be further enhanced due to the constructive proximity effect from the two outer planes and the hole density of inner plane will be much suppressed.

*This work is in collaboration with Chun Chen and A. Fujimori.