Universal properties of high-temperature superconductors from real-space pairing: Comparison with experiment

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One of the pivotal challenges in high-temperature superconductivity is the designation of a consistent interpretation framework within which one describes quantitatively their universal features. Here we analyze the principal experimental data and compare them quantitatively with the approach based on a single-band model of strongly correlated electrons supplemented with strong antiferromagnetic (super)exchange interaction (the t-J-U model). We use our original full Gutzwiller wave-function solution going beyond the renormalized mean-field theory (RMFT) in a systematic manner. Our approach reproduces very well the observed hole doping (δ) dependence of the kinetic-energy gain in the superconducting phase, one of the principal non-BCS features of the cuprates. The calculated Fermi velocity in the nodal direction is practically δ-independent and its universal value agrees very well with that determined experimentally. A weak doping dependence of the Fermi wave vector leads to an almost constant value of the effective mass, which is observed in experiment [1-2].

References:

[1] J. Spałek, M. Zegrodnik, J. Kaczmarczyk, Phys. Rev. B **95**, 024506 (2017).
[2] M. Zegrodnik, J. Spałek, arXiv 1705.06038.