Interplay between charge order and superconductivity in cuprate superconductors

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One of the central issues in the recent study of cuprate superconductors is the interplay of charge order with superconductivity [1, 2]. Here [3] the interplay of charge order with superconductivity in cuprate superconductors is studied based on the kinetic-energy-driven superconducting mechanism by taking into account the intertwining between the pseudogap and superconducting gap [4, 5]. It is shown that the appearance of the Fermi pockets is closely associated with the emergence of the pseudogap [3]. However, the distribution of the spectral weight of the superconducting-state quasiparticle spectrum on the Fermi arc, or equivalently the front side of the Fermi pocket, and back side of Fermi pocket is extremely anisotropic, where the most part of the spectral weight is located around the tips of the Fermi arcs, which in this case coincide with the hot spots on the electron Fermi surface. In particular, as charge order in the normal-state [6], this electron Fermi surface instability drives charge order in the superconducting-state, with the charge-order wave vector that is well consistent with the wave vector connecting the hot spots on the straight Fermi arcs [3]. Furthermore, this charge-order state is doping dependent, with the charge-order wave vector that decreases in magnitude with the increase of doping. Although there is a coexistence of charge order and superconductivity, this charge order antagonizes superconductivity. The results from the superconducting-state dynamical charge structure factor indicate the existence of a quantitative connection between the low-energy electronic structure and collective response of the electron density. The theory also shows that the pseudogap and charge order have a root in common, they and superconductivity are a natural consequence of the strong electron correlation [3].

Keywords: charge order, Fermi arc, pseudogap, superconductivity, cuprate superconductor

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