Doping and Magnetic Field Dependence of Superfluid Density in Cuprate Superconductors

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Within the kinetic energy driven superconducting mechanism[1], the doping and temperature dependence of the Meissner effect in cuprate superconductors is studied in the linear response approach. The electromagnetic response kernel is evaluated by considering both couplings of the electron charge and electron magnetic momentum with an external magnetic field and employed to calculate the local magnetic field profile, the magnetic field penetration depth, and the superfluid density, based on the specular reflection model for a purely transverse vector potential, then the main features of the doping dependence of the Meissner effect and the weak magnetic field induced reduction of the low-temperature superfluid density in the Meissner state are well reproduced[2]. The theory also shows that the striking behavior of the weak magnetic field induced reduction of the low-temperature superfluid density in the Meissner state is intriguingly related to both depairing due to the Pauli spin polarization and nonlocal response in the vicinity of the d-wave gap nodes on the Fermi surface to a weak magnetic field.

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