Electromagnetic response in kinetic energy driven superconductivity: the Meissner effect

Ryszard Gonczarek[2], Shiping Feng[1], and Mateusz Krzyzosiak[1,2]

[1]Department of Physics, Beijing Normal University, 100875 Beijing, China
[2] Institute of Physics, Wrocław University of Technology,
Wybrzeże Wyspiańskiego 27, 50-370 Wrocław, Poland.
Email: mateusz.krzyzosiak@pwr.wroc.pl

The response of cuprate superconductors to a weak magnetic field is studied within the kinetic energy driven d-wave superconductivity formalism. Employing the linear response method the kernel of the response function for a vector potential in the transversal gauge is found. Quantitative characteristics of the in-plane electromagnetic response such as the local magnetic field profile, temperature dependence of the penetration depth and doping dependence of the zero-temperature superfluid density are discussed within the two-dimensional specular reflection model. It is shown that the local magnetic field decays exponentially inside the sample in agreement with experimental observations. The magnetic field penetration depth is found to follow the linear temperature dependence as expected for a nodal d-wave superconductor, except for a nonlinear behavior at extremely low temperatures, which is attributed to nonlocal effects. Moreover, it is shown that in the underdoped regime the zero-temperature superfluid density decreases linearly with decreasing doping. The problem of gauge invariance is addressed and an approximation for the dressed current vertex not violating the generalized Ward identity is proposed.