Effects of Inhomogeneous Magnetic Correlations on the Penetration Depth in d-Wave Superconductors

WILLIAM ATKINSON, Trent University — The influence of static magnetic correlations on the temperature-dependent superfluid density $\rho_s(T)$ is calculated for $d$-wave superconductors. In self-consistent calculations, itinerant holes form incommensurate spin density waves (SDW) which coexist with superconductivity. In the clean limit, the density of states is gapped, and $\rho_s(T \ll T_c)$ is exponentially activated. In inhomogeneously-doped cases, the SDW are disordered and both the density of states and $\rho_s(T)$ obtain forms indistinguishable from those in dirty but pure $d$-wave superconductors, in accordance with experiments. We conclude that the observed collapse of $\rho_s$ at $x \approx 0.35$ in underdoped $\text{YBCO}$ may plausibly be attributed to the coexistence of SDW and superconductivity.

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