物理学科談話会

「Evidence for spin-fluctuation-mediated superconductivity in electron-doped cuprates」

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In conventional, phonon-mediated superconductors, the transition temperature T_c and normal-state scattering rate $1/\tau$ – deduced from the linear-in-temperature resistivity $\rho(T)$ – are linked through the electron-phonon coupling strength λ_{ph}. In cuprate high-T_c superconductors, no equivalent λ has yet been identified, despite the fact that at high doping, α – the low-T T-linear coefficient of $\rho(T)$ – also scales with T_c. Here, we use high-field magnetoresistance to extract $1/\tau$ in electron-doped $La_{2-x}Ce_xCuO_4$ (LCCO) as a function of x from near-optimal doping to beyond the superconducting dome. A highly anisotropic inelastic component to $1/\tau$ is revealed whose magnitude diminishes tenfold across the doping series. Using known Fermi surface parameters and subsequent modelling of the Hall coefficient, we demonstrate that the form of $1/\tau$ in LCCO is consistent with scattering off commensurate antiferromagnetic spin fluctuations of variable strength λ_{sf}. The clear correlation between α, λ_{sf} and T_c then identifies low-energy spin-fluctuations as the primary pairing glue in electron-doped cuprates. The contrasting magnetotransport behaviour in hole-doped cuprates suggests that the higher T_c in the latter cannot be attributed solely to an increase in λ_{sf}. Indeed, the success in modelling LCCO serves to reinforces the notion that resolving the origin of high-temperature superconductivity in hole-doped cuprates will require more than a simple extension of BCS theory.

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