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Effect of strong correlations on transport properties of disordered cuprates[1]

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The theory of thermal transport in a d-wave superconductor predicts a universal T-linear term κ_0 at low temperatures. Measurements on several cuprate families down to the 50 milliKelvin range indicate that the linear term decreases with underdoping, from which a substantial increase of the slope of the order parameter near the nodes is usually deduced by comparison with the standard theory. We discuss ways in which low-T universal transport can break down, and in particular focus on the importance of strong correlations, which can induce local magnetism in the presence of disorder or other spatial perturbations. Static magnetism coexisting with superconductivity has been detected in some but not all cuprate families, particularly at low temperatures and for strongly underdoped samples, We present an interpretation of this superconducting "spin glass" state as local antiferromagnetic order driven by dopant atoms, particularly in the LSCO and BSCCO systems. Within this framework, recent NMR experiments on Zn-doped YBCO can also be quantitatively explained, down to detailed description of the lineshapes. Both the strong correlations and the quantum interference of impurity states appear to be vital to understand these results. In either more disordered or more underdoped systems, the tendency towards static magnetism is enhanced. Numerical solutions of the Bogoliubov-de Gennes equations of a disordered d-wave superconductor with Hubbard-like correlations show that in this case κ_0 is in fact strongly suppressed, universality of quasiparticle transport is violated and κ_0 may no longer be used to extract the size of the gap near the node directly. [2]

[2]B.M. Andersen and P.J. Hirschfeld, cond-mat/0607682, J.W. Harter et al., cond-mat/0609721