Large-angle Scattering as the Origin of Transport Anisotropy in Antiferromagnetic $BaFe_2As_2$: a Shubnikov-de Haas study

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Introduction

The anisotropic properties of electrons of unconventional superconductors is rapidly becoming a ubiquitous property of correlated systems near a quantum critical point, including the iron-based superconductors, strontium ruthenate or the cuprate based superconductors. These anisotropic properties could be a manifestation of an exciting new ground state - the electronic nematic, and so understanding the origin of this anisotropy is of considerable significance. In this work, we use the Shubnikov-de Haas effect to understand the origin of the transport anisotropy in pnictide superconductors by uniquely identifying the response of each Fermi surface pocket to small changes in the transport scattering rate.

Experimental

The magnetoresistance and Shubnikov-de Haas effect was measured in high magnetic field up to 35 T using resistive magnets at the High Magnetic Field Lab, Tallahassee. This was measured in two configurations, one with the field pointed parallel to the crystalline c-axis (labeled B//c), and the other with the field pointed in-plane along [100] Tet of the tetragonal unit cell (labeled B$\perp$ c).

Results and Discussion

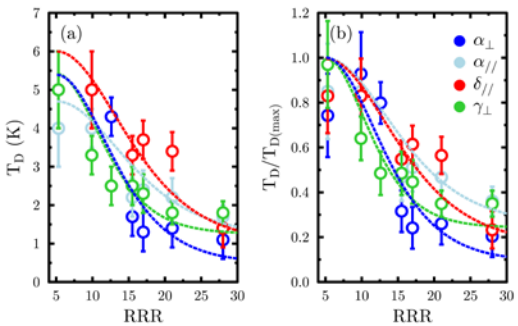

Figure 1: (a) Dingle temperature TD as a function of RRR as extracted from the fit in Figure 4 for each Fermi pocket α, γ and δ for each orientation of the magnetic field. Lines are guides to the eye. (b) The same data shown in (a) but with normalized by the maximum value of TD, illustrating that the response of the orbitally averaged scattering rate of each Fermi surface pocket to disorder (as measured by RRR) is remarkably similar.

Conclusions

The origin of the anisotropic transport in Fe-based superconductors defines the nature of the electron nematic state with which it is thought to be associated. As a function of doping, the magnitude of this anisotropy and its response to strain fields varies in a manner that echoes a quantum critical transition. Our data shows that this anisotropy finds its origins in an anomalous large-angle scattering mechanism which enhances the anisotropy, and not exclusively due to the average anisotropy of the Fermi velocity about any particular Fermi surface. The present, work is consistent with this interpretation, but we have been able to assign this mechanism unambiguously to a large-angle scattering effect.

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