Magnetic Quantum Oscillations in $SrFe_2As_2$

2009 NHMFL Science Highlight for NSF

DMR-Award 0654118

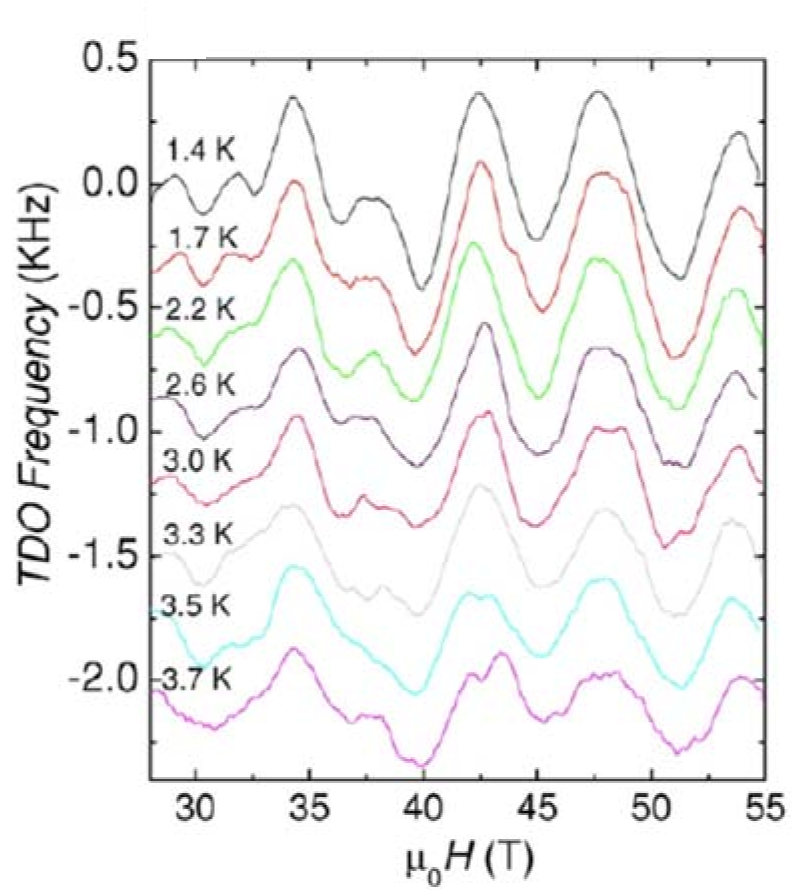
Pulsed Field Facility User Program

There has been considerable excitement concerning the recent discovery of high T_c superconductivity in FeAs-based layered materials. Like the CuO-based high T_c superconductors, superconductivity appears to develop out of a parent antiferromagnetic phase. One rather obvious question was whether the antiferromagnetic parent phase in the pnictides has an physical similarities to that in the cuprates. In particular, could the physics be related at all to a Mott insulator?

Last year in August, a team consisting of scientists at Los Alamos National Labs and the University of Cambridge (UK) eliminated all possibility of Mott-insulator physics applying in the pnictide materials by measuring the Fermi surface of the parent magnetic state. Examples of the magnetic quantum oscillations measured in $SrFe_2As_2$ are shown opposite, measured in the 60 tesla long-pulse magnet.

This work is having an enormous impact on the field of pnictide high T_c (having garnered more than 30 citations in less than a year). Follow-up quantum oscillation experiments on related pnictide antiferromagnets have since been performed on $BaFe_2As_2$ at Los Alamos (through a collaboration with Stanford) and on $CaFe_2As_2$ at Los Alamos (through a collaboration with the material science group, MPA-10).

S. Sebastian, J. Gillet, F.N. Harrison, P.H.C. Lau, D.J. Singh, C.H. Mielke, G.G. Lonzarich, **J.Phys.:Cond. Matt, 20, 422203 (2008).**



Magnetic quantum oscillations measured in $SrFe_2As_2$ in the long pulse magnet at Los Alamos using the TDO contactless conductivity technique.

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This work establishes rather clearly that the Fermi surface within the antiferromagnetic phase is reconstructed in the FeAs-based superconductors. Along with prior neutron scattering measurements, this provides rather concrete evidence that a spin-density wave is responsible for the magnetism in this family of compounds. The measurements also provide information on the strength of the electron-electron correlations, indicating that the strength is somewhere intermediate between that in the cuprates and that in conventional spin-density wave systems like chromium.

The figure shown opposite shows how the Fermi surface is reconstructed in $SrFe_2As_2$.The resulting reconstructed Fermi surface accounts for the small pockets and slow magnetic quantum oscillation frequencies observed in the experiment.

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The Fermi surface of $SrFe_2As_2$ before and after reconstruction due to spin-density wave order according to bandstructure calculations.