Fermi surface transforms at the onset of the pseudogap state in a cuprate superconductor

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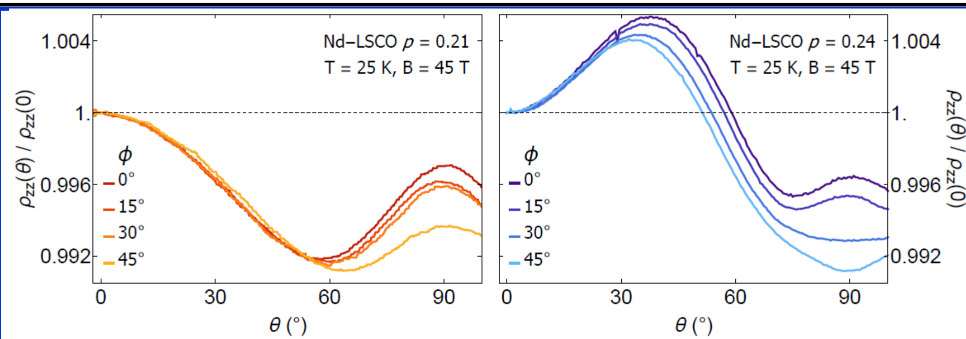
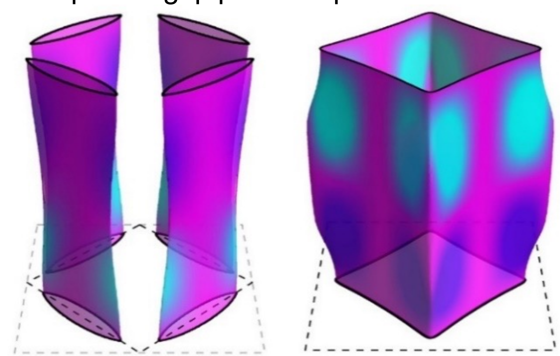
The nature of the pseudogap phase remains an unsolved problem in cuprate high-temperature superconductivity. The topology of the Fermi surface of the pseudogap state remains an open question of fundamental importance to determining whether this metallic phase might be defined by any of a number of reported broken symmetries.

MagLab users measured the angle-dependent magneto-resistance (ADMR) to calculate the Fermi surface of a superconducting cuprate crystal both inside and outside the pseudogap phase. Outside the pseudogap phase, the ADMR reveals a complete Fermi surface consisting of a single large pocket, as one expects in the absence of long-range order. Within the pseudogap phase, however, the ADMR data are qualitatively different, revealing a transformation of the Fermi surface in the pseudogap state. The ADMR data are most consistent with a pseudogap Fermi surface that consists of four small hole pockets, thereby accounting for the drop in carrier density across the pseudogap transition that has been found in several cuprates.

The Fermi surface transformation at the onset of the pseudogap phase suggests that antiferromagnetism plays a role in the physics of the pseudogap phase, an idea long expressed but never demonstrated. This may ultimately hold the secret to how electrons pair in cuprate superconductors.



Angle-Dependent Magneto-Resistance (ADMR) data at a temperature of *T*=25K and at a magnetic field of *B*=45T from the cuprate superconductor Nd-LSCO as a function of magnetic field angle *θ*. The data were taken (**left**) inside the pseudogap phase at carrier concentration p = 0.21, and (**right**) outside the pseudogap phase at p=0.24.



Fermi surfaces calculated from ADMR data (**left**) inside the pseudogap phase at p=0.21, showing four small pockets (resembling those that would be created by antiferromagnetism) and (**right**) outside the pseudogap phase at p=0.24, showing the single large pocket of a simple metal.

Facility used: 45T Hybrid magnet in the DC Field Facility.

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