Linear-in temperature resistivity from isotropic Planckian scattering rate

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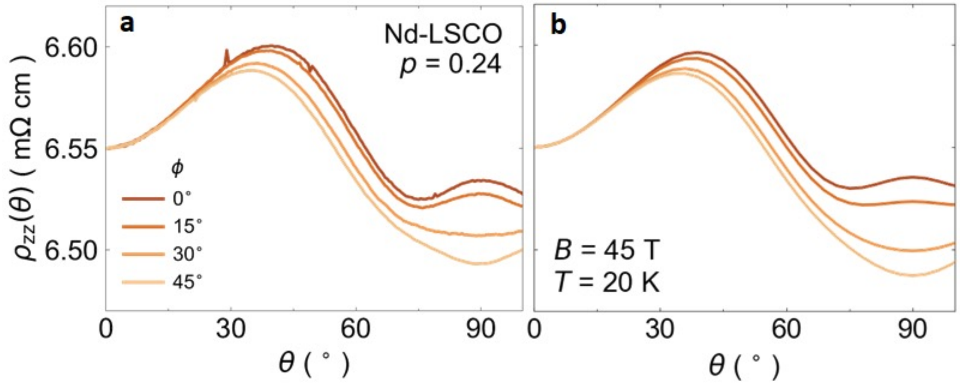
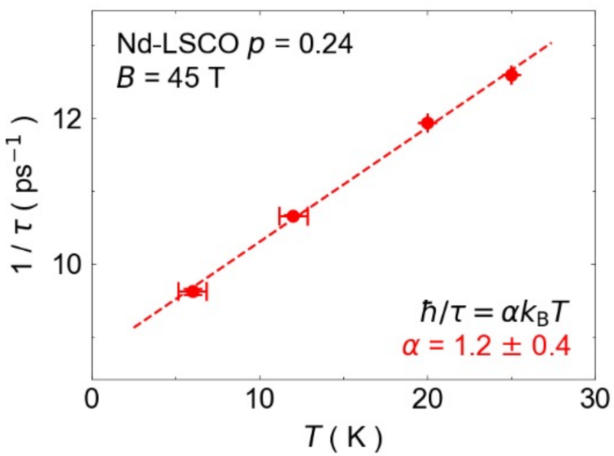
The "Strange Metals" are among the most fascinating of quantum materials, found in high temperature superconductors and twisted bilayer graphene. Yet, to date, they have resisted revealing their mysteries. *Recently, a new fundamental limit of nature was proposed—the Planckian bound—which puts a limit on how often electrons can collide with each other*.

To investigate the proposed Planckian bound, MagLab users studied Nd-LSCO, a superconducting cuprate crystal that exhibits this behavior down to low temperatures. With the sample in the world's strongest static magnetic field, the MagLab's 45T magnet, they measured resistivity as a function of applied magnetic field direction, a technique called angle dependent magnetoresistance (ADMR). The motion of the charged electrons is governed by the magnetic field in a way that depends on the collision time between electrons. Using ADMR and new algorithmic machinery that they developed, they not only measured the Planckian bound, but also demonstrated its impact on all directions of electron motion.

Understanding that the behavior of strange metals emerges from the Planckian bound stimulates a domain of research in which progress has stalled for decades. The intimate connection between strange metals, unconventional superconductivity, and magnetism suggests that the Planckian bound may ultimately hold the secret to how electrons pair in unconventional superconductors.



(**a**) ADMR of the cuprate Nd-LSCO with doping p = 0.24 as a function of magnetic field angle θ at a temperature of 20K and a magnetic field of 45T. (**b**) Simulations obtained from the new algorithmic machinery that can reproduce the behaviour of electrons in a metal from semi-classical theory, allowing researchers to measure the scattering rate.



(**left**) The Planckian bound ties the time τ between electron collisions to the temperature by the relation $\hbar/\tau = \alpha k_B T$, where α is a constant of order unity, $\hbar$ is Planck's constant and k_B is the Boltzmann constant. Note that τ for Nd-LCSO satisfies the Planckian bound with $\alpha = 1.2 \pm 0.4$

Facilities and instrumentation used: 45T Hybrid magnet, DCFF

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