Ninety teslas peek under the superconducting dome of a high-temperature superconductor

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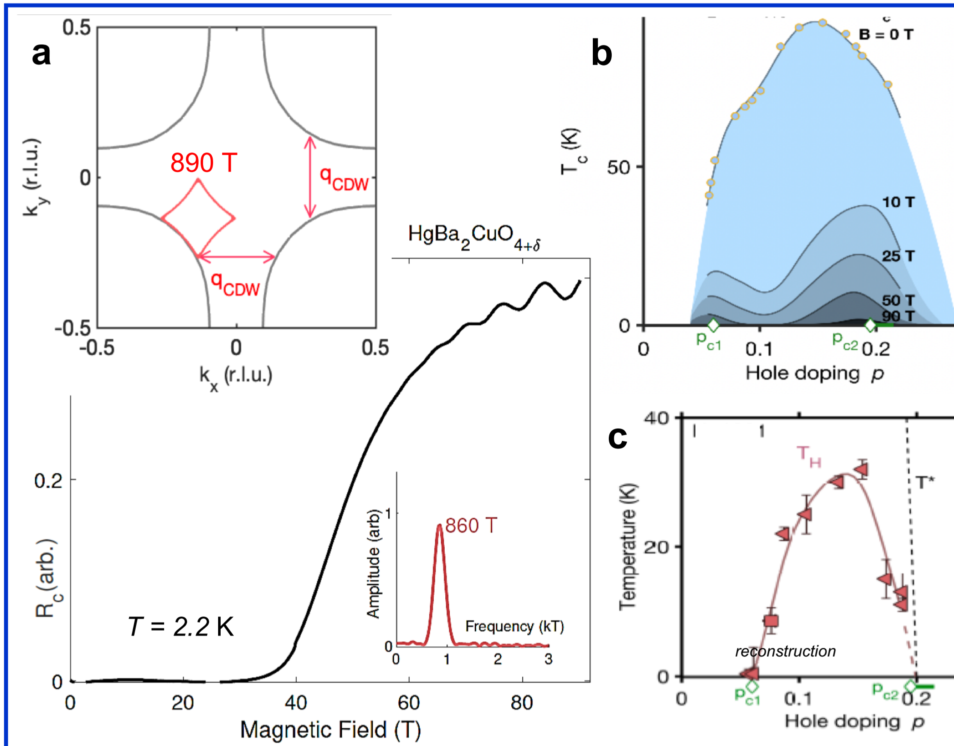
A prevalent theoretical paradigm of unconventional superconductivity posits that the superconductivity results from quantum critical fluctuations associated with a zero-temperature phase transition. Termed a quantum critical point, these phase transitions are "hidden" by the strength of the superconducting phase that surrounds it.

Recent experiments utilized extreme magnetic fields up to 90 teslas to suppress superconductivity in the high-temperature superconductor $HgBa_2CuO_{4+\delta}$. The MagLab's extreme fields were required to suppress superconductivity down to low temperatures over a broad range of hole-doping. Electrical transport revealed a Fermi-surface undergoing reconstruction: likely a signature of a charge-density-wave phase transition. *The Fermi-surface reconstruction was discovered to terminate at zero temperature coincident with hole concentrations where the superconductivity is most robust to magnetic fields.* These results link the reconstructed Fermi surface phase to two quantum critical points that were heretofore hidden by the superconducting dome in the cuprate phase diagram.

This work was made possible by the MagLab's unique 1.43GW generator, which delivers 600 MJ electrical pulses to generate magnetic fields of up to 100T repeatedly, thus permitting a systematic doping and temperature mapping of the Fermi surface reconstruction near quantum critical points.



(a) Superconductivity is suppressed in underdoped $HgBa_2CuO_{4+\delta}$, revealing quantum oscillations above 65T whose frequency (lower inset) reflects the reconstructed Fermi-surface area resulting from a charge-density-wave phase (upper left inset). **(b)** Superconducting temperature (*Tc*) in magnetic field reveals two regions of robust superconductivity near 0.07 and 0.19 doping, coinciding with the dopings at which the Fermi-surface reconstruction temperature (T_H) approaches zero in **(c)**, indicating two revealed quantum critical points.

Magnets used: 65T short pulse and 100T multi-shot magnets

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