Clues about unconventional superconductivity from high-field Hall data

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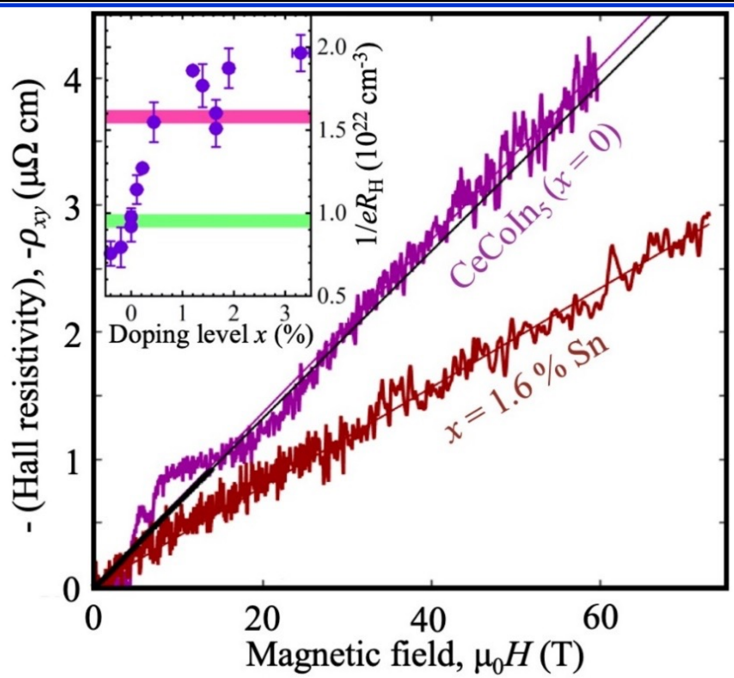
Funding Grants: J.G. Analytis (NSF DGE-1752814; Gordon and Betty Moore Foundation GBMF9067), G.S Boebinger (NSF DMR-1644779); P. Oppeneer (Swedish Research Council; K. and A. Wallenberg Foundation Award 2015.006).

$CeCoIn_5$ has many similarities to the high-temperature superconducting cuprates, including crystal structure, transport properties, and unconventional superconductivity. *Here, intense pulsed magnetic fields up to 73T reveal another common feature of the two systems, providing a vital clue to the mechanism for the unconventional superconductivity*. Ultra-high magnetic fields are essential in these Hall effect measurements of pure and doped $CeCoIn_5$ to reach the high-field limit in which the gradient of the Hall resistivity – the Hall coefficient R_H – can be demonstrated to be field-independent over a wide range of magnetic fields.

When plotted as a function of doping (Figure inset), the carrier densities extracted from the high-field Hall coefficient reveal the delocalization of electrons at a transition between Fermi surfaces of different volume. This is a *quantum phase transition* (QPT) driven by carrier concentration. Other measurements suggest that the change in Fermi-surface volume is not accompanied by broken symmetry. *A model invoking fractionalization of spin and charge is able to account for the phenomena manifested in the high-magnetic-field Hall effect*.

QPTs without a broken symmetry are proposed to be the mechanism of high-temperature superconductivity. This experiment is the first in a material closely related to the cuprates, for which existing magnetic fields are able to unambiguously access the high-field regime, a situation that is not achievable in measurements on the cuprates.



A quantum phase transition detected using pulsed fields: On one side of the transition (purple curve) the Hall resistivity grows steeply with field, once the linear regime has been accessed in high magnetic fields; on the other side (red curve), the increase is slower. Inset: the quantum phase transition is evidenced by the steep jump with increasing electron concentration in data from a dozen samples.

Facilities used: 73T and 65T magnets at the Pulsed Field Facility; SCM1 dilution refrigerator at the DC Magnet Facility

Citation: Maksimovic, N.; Eilbott, D.H.; Cookmeyer, T.; Wan, F.; Rusz, J.; Nagarajan, V.; Haley, S.C.; Maniv, E.; Gong, A.; Faubel, S.; Hayes, I.M.; Bangura, A.; Singleton, J.; Palmstrom, J.C.; Winter, L.; McDonald, R.; Jang, S.; Ai, P.; Lin, Y.I.; Ciocys, S.; Gobbo, J.; Werman, Y.; Oppeneer, P.M.; Altman, E.; Lanzara, A.; Analytis, J.G., *Evidence for a delocalization quantum phase transition without symmetry breaking in $CeCoIn_5$,* **Science**, eaaz4566 (2021) doi.org/10.1126/science.aaz4566