Clues about unconventional superconductivity from high-field Hall data

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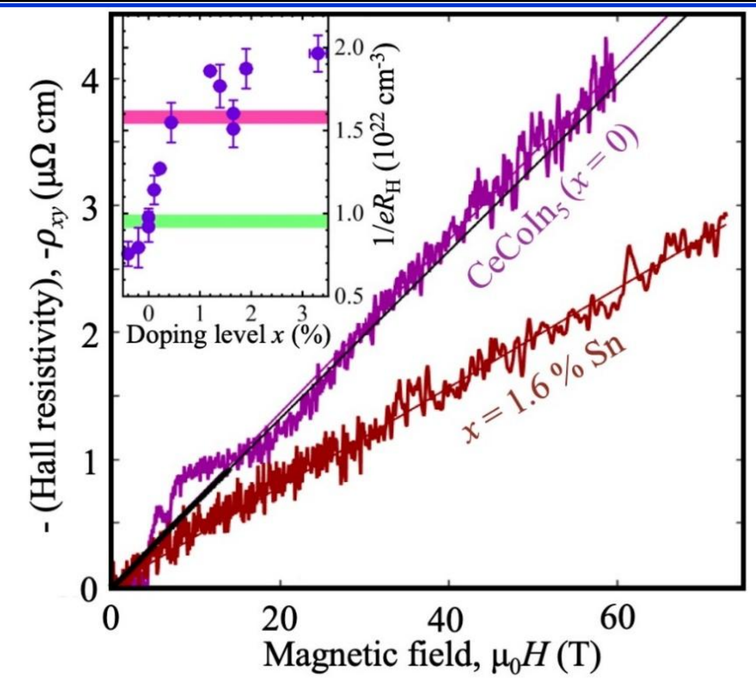
$CeCoIn_5$ has many similarities to the high-temperature superconducting cuprates, including crystal structure, transport properties, and unconventional superconductivity. *Here, intense pulsed magnetic fields up to 73T reveal another common feature of the two systems, providing a vital clue to the mechanism 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

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