Supplementary Information

Anomalous quantum criticality in the electron-doped cuprates

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Thermopower measurements technique

The thermopower has been measured using two heater-two thermometer technique (1). It is a steady state method where the temperature gradient is reversed to cancel out the Nernst effect and other possible background contributions. The sample is mounted on two copper blocks which are thermally insulated from a temperature controlled base. Two small chip resistor heaters are attached to the copper blocks and two tiny Lakeshore Cernox bare chip thermometers are on the two ends of the sample to monitor the temperature gradient (0.7-1 K) continuously. The temperature gradient is developed by applying power to each heater and the temperature gradient direction is switched by turning on or off the heaters. The electric voltage was measured using a Keithley 2001 multimeter with a sensitivity of several nanovolts in a Physical Property Measurement System (PPMS) when the gradient was stable. The data were averaged for many times to reduce the random error. To reduce the contribution from the voltage leads we have used phosphor bronze wire which has a small thermopower even at high field in the temperature range of our measurements (2). The measurements were performed under high vacuum and the magnetic field was applied perpendicular to the *ab* plane of the films. The sample temperature is

www.pnas.org/cgi/doi/10.1073/pnas.1817653116

taken as the average of hot and cold end temperatures. The Hall coefficient for the film x=0.13 was measured by applying a magnetic field (11 T) perpendicular to the film plane in the PPMS and averaging up and down field directions to eliminate any ab-plane magnetoresistive component.

Hall coefficient

Figure S1 shows the Hall coefficient, R_H (T) of LCCO film as a function of temperature with x = 0.13 at an applied magnetic field of 11 T measured from 100 to 1.8 K. The Hall coefficient is found to drop below T ≃ 15 K and becomes negative below T ≃ 8 K. The Hall coefficient for x=0.11 shows similar behavior and is also negative at lower temperature. The data are in good agreement with prior data for x=0.11 and 0.13 (3). This drop is closely linked to the onset of spin density wave order. $T_{R_{Hmax}}$ is the temperature below which Hall coefficient starts to fall at lower temperature to reach negative values (arrow). This is another signature of the FSR. The prior Hall data of LCCO as a function of doping shows that the normal-state Hall coefficient suddenly drops and changes sign between 0.13 and 0.14 (3).

Reference

1. Li P, et al. (2007) Evidence for a quantum phase transition in electron-doped $Pr_{2-x}Ce_xCuO_{4-\delta}$ from thermopower measurements. *Phys. Rev. B* 75:020506(R).

2. Wang Y, et al. (2003) Spin entropy as the likely source of enhanced thermopower in $Na_xCo_2O_4$. *Nature* (London) 423:425.

3. Sarkar T, et al. (2017) Fermi surface reconstruction and anomalous low-temperature resistivity in electron-doped $La_{2-x}Ce_xCuO_4$. Phys. Rev. B 96:155449.

Supplementary Figure captions

Figure S1: Hall coefficient versus temperature for $La_{2-x}Ce_xCuO_4$ films with x=0.13 measured at a magnetic field of 11 T.

Figure

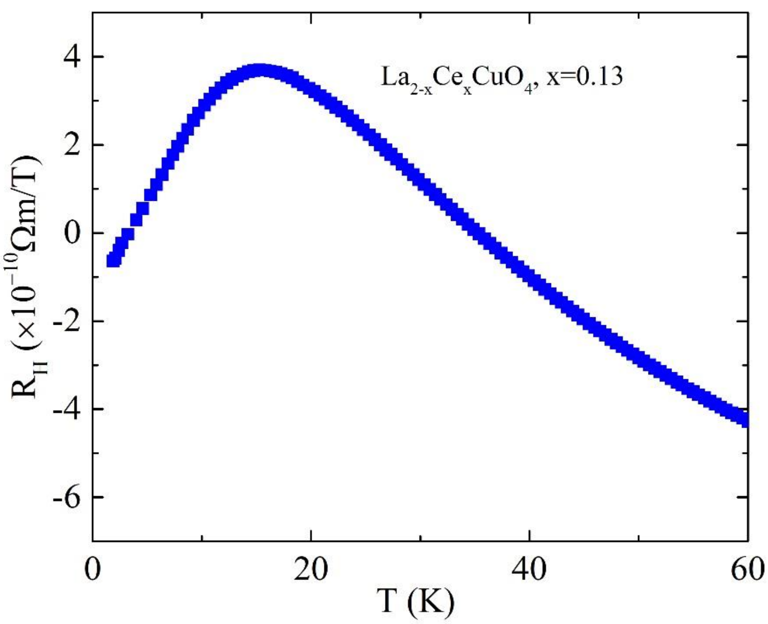

Figure S1