Science Advances
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Supplementary Materials for

Correlation between scale-invariant normal-state resistivity and superconductivity in an electron-doped cuprate

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Published 17 May 2019, *Sci. Adv.* **5**, eaav6753 (2019)
DOI: 10.1126/sciadv.aav6753

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SUPPLEMENTARY MATERIALS

High-temperature MR

Figure S1 shows the magnetoresistance for doping x=0.15 and x=0.16 at temperatures above the linear-in-H regime. The magnetoresistance is measured from 50 K to 80 K. The magnitude of the magnetoresistance decreases with increasing temperatures, which is similar to conventional metals.

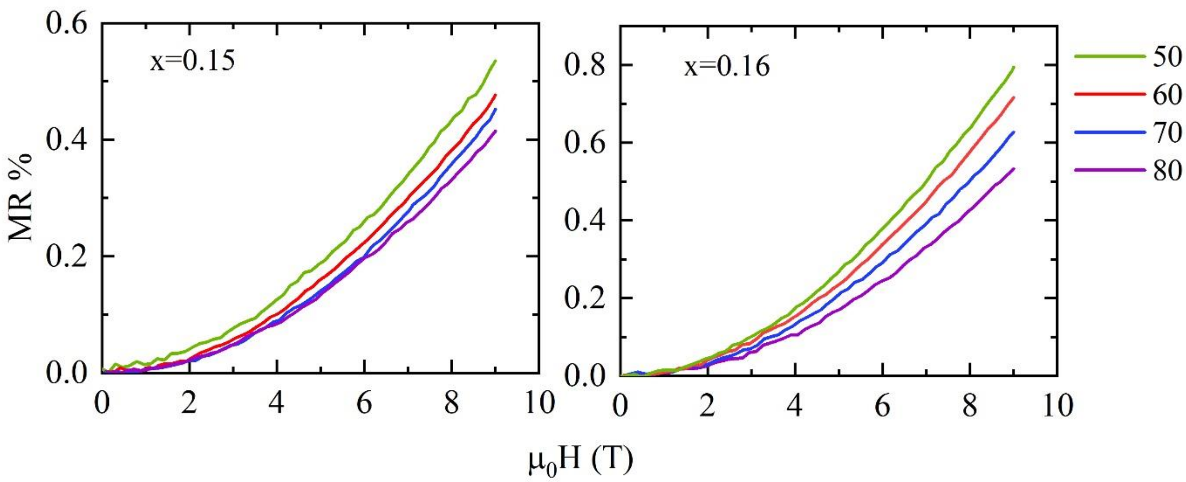

Fig. S1. MR versus doping at high temperatures. (a), (b) transverse *ab* plane magnetoresistance $MR\% = ((\rho(H) - \rho(0))x100/\rho(0)$ for sample x=0.15 and 0.16 for dc field up to 9T for temperature 50 K to 80 K.

Temperature-dependent resistivity

Figure S2 shows the 1st derivative of the normal state zero field resistivity for two representative samples x=0.15 and x=0.17. The change in the slope indicates the temperature where linear-in -T resistivity crosses over to quadratic-in-T resistivity. Here we have shown the cross over temperature (T_ρ) for x=0.15 and 0.17 samples. The evolution of the crossover temperature as a function of doping is shown in the figure 5b inset.

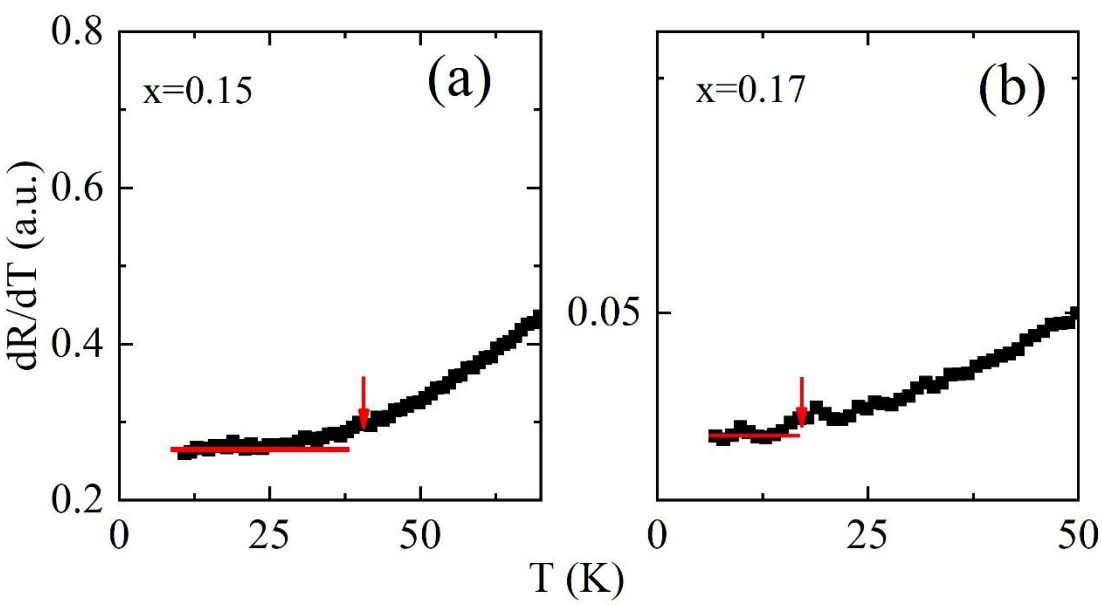

Fig. S2. Derivative of normal-state resistance. dR/dT of the resistance vs temperature, red arrow indicates the change in the slope for x=0.15 and 0.17 at H=0.

Scaling between temperature and magnetic field

The figure S3 shows the scaling between temperature and field for doping x=0.16 and x=0.17. The resistivity, $\rho\ (T, H)$ is a linear function of T and H. This indicates the slope of linear-in-H is independent of temperatures in the quantum critical (QC) region. So, in the QC region magnetoresistance is temperature independent (see main text Fig.3). This anomalous low temperature scattering behavior cannot be explained by any orbital magnetotransport mechanism, which will strongly depend on temperature and be quadratic in field (and decreases with increasing temperature). We attribute this anomalous scattering to excitations associated with the QCP or excitations of unknown origin. The high temperature MR is quadratic with field. The scaling works only at low temperatures where the magnetoresistance is linear-in-H. In the inset it is seen that for the x=0.17 samples the scaling is not working above 4 K where the magnetoresistance is deviating from linear-in-H. In contrast the scaling works to a much higher temperature for x=0.15 as linear-in-H exists to a higher temperature.

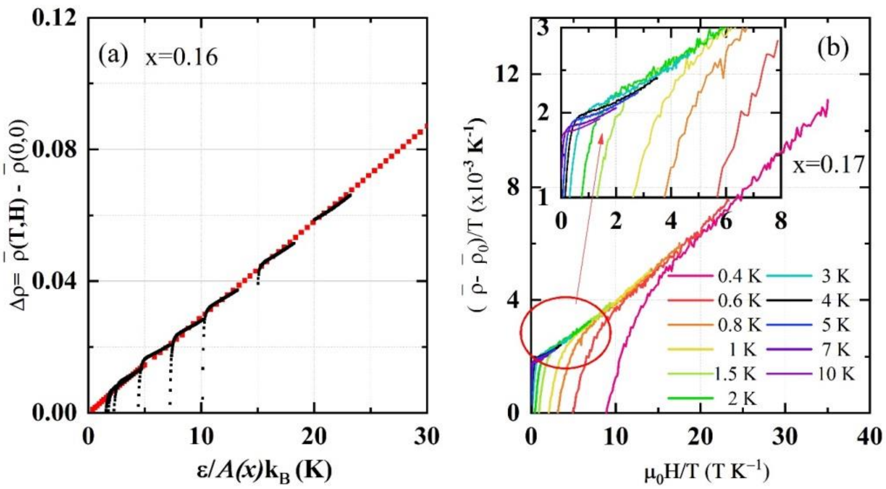

Fig. S3. Scaling between field and temperature. (a) for x=0.16 $\bar{\rho}(\mathrm{T,H}) - \bar{\rho}(0,0)$ vs $T + \frac{C(x)\mu_B}{A(x)k_B}\mu_0 H \equiv \varepsilon\ (T,H)/A(x)k_B$. $\bar{\rho}(0,0)$ is taken from extrapolating the zero field resistivity data down to T=0. Resistivity data (red) is the data with 7 T field after subtracting the $\bar{\rho}(0, 7\mathrm{T})$. (b) for x=0.17 $(\bar{\rho} - \bar{\rho}(0)\ )/\mathrm{T}$ (where $\bar{\rho} = \rho(T)/\rho(200K)$, $\bar{\rho}(0) = \frac{\rho(0,\ \ 0.4)}{\rho(0,200)}$ taken from figure 2a) vs

$\mu_0 H/T$ is been deduced with varying temperature at fixed field as well as varying field at fixed temperature) (color solid lines) for doping x=0.17. Scaling plot of the transverse magneto resistivity is fitted with $\Delta\rho = \alpha + \beta(\mu_0 H/T)^m$ (m=1.09) (dashed line).

Resistivity below the FSR

The Figure-S4 shows the resistivity and MR for a doping just below the FSR (x<0.14). In electron-doped cuprates the AFM order (long range or short range) vanishes at a critical doping x_c, where the low temperature normal state resistivity upturn also ends (x=0.14 in LCCO). In this study we find that the resistivity minimum is associated with negative transverse magnetoresistance as shown in Figure S4b. Once doping increases above x_c , the field driven normal state magneto resistivity is positive and linear-in-H (see main text).

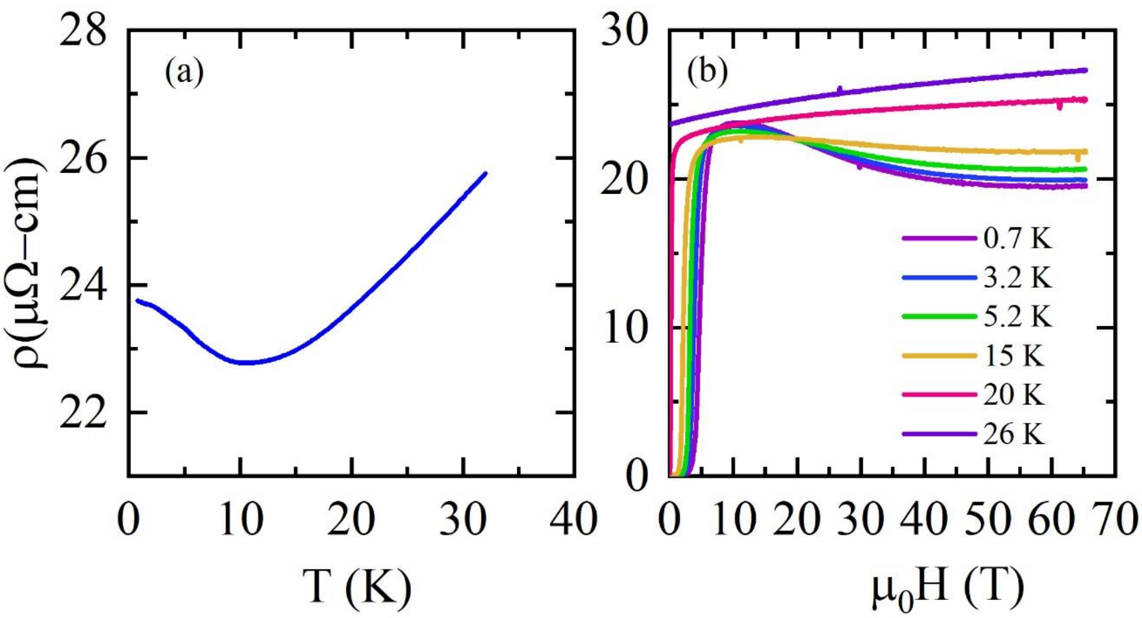

Fig. S4. Resistivity versus temperature and field for x = 0.13. The normal-state ab-plane resistivity versus temperature in a magnetic field of $10\ T\ > H_{c2}$ applied parallel to the c axis. b) ab-plane resistivity vs magnetic field measured up to 65 T (pulsed field) down to 700 mK.

Pulsed field MR

The figure S5 shows magnetoresistance (MR) for x=0.15 doping measured in pulsed field up to 65 T. The magnetoresistance at low temperatures is linear up to field 65 T as shown in figure S5 (right panel). This high field MR extends the low field (14T) linear-in-H behavior.

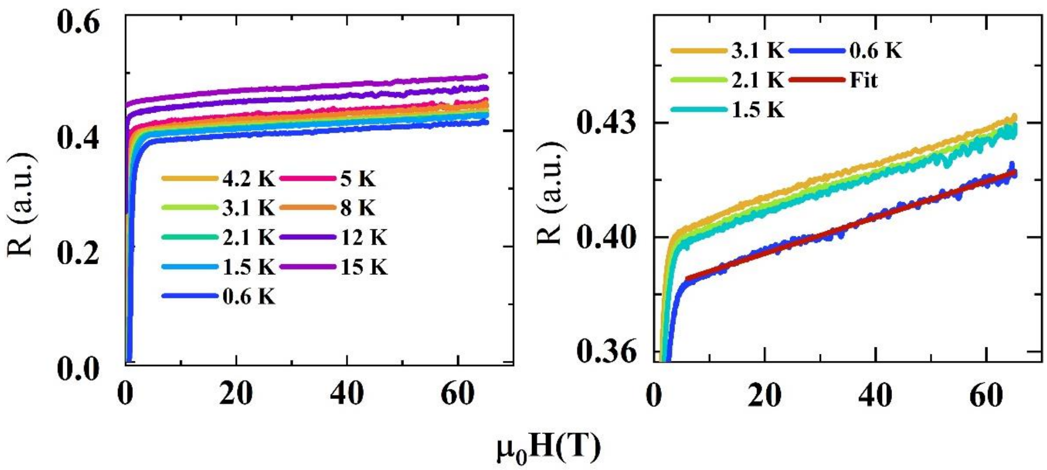

Fig. S5. High-field MR of *x* = 0.15. resistance vs magnetic field up to 65T for x=0.15 as a function of temperature (color solid line) with a fit (red solid line), $R(H) = R(0) + \mu_0 H$ at the lowest temperature 600 mK.

MR of an overdoped, non-SC, sample

The figure S6 shows the magnetoresistance at 5 K and the temperature dependent resistivity for doping x=0.18. The resistivity follows a T^2 behavior as shown in the figure S6 inset with a T^2 linear fit. The magnetoresistance is quadratic in H. The quadratic in H and T resistivity behaviors for a non-superconducting sample strongly supports the correlation of the linear-in-H and linear-in-T resistivity with the superconductivity as claimed in the main text.

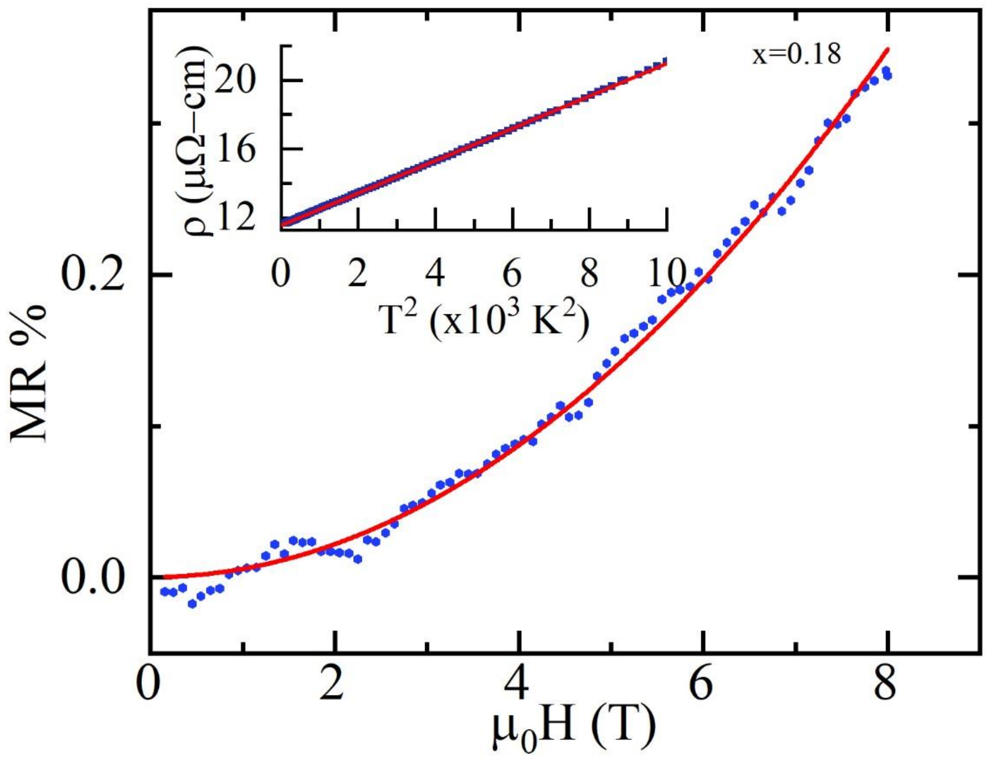

Fig. S6. MR for *x* = 0.18. Magnetoresistance at 5 K (H//ab plane) fitted by $\mathrm{MR\%} = (\frac{\rho(\mathrm{H})-\rho(0)}{\rho(0)}100) \propto (\mu_0\mathrm{H})^2\ (red)$; Inset: resistivity ρ(T) vs T^2 (blue).