Supplementary Information for "Experimental evidence of Kondo effect induced by oxygen-vacancy in IrO_2 crystals"

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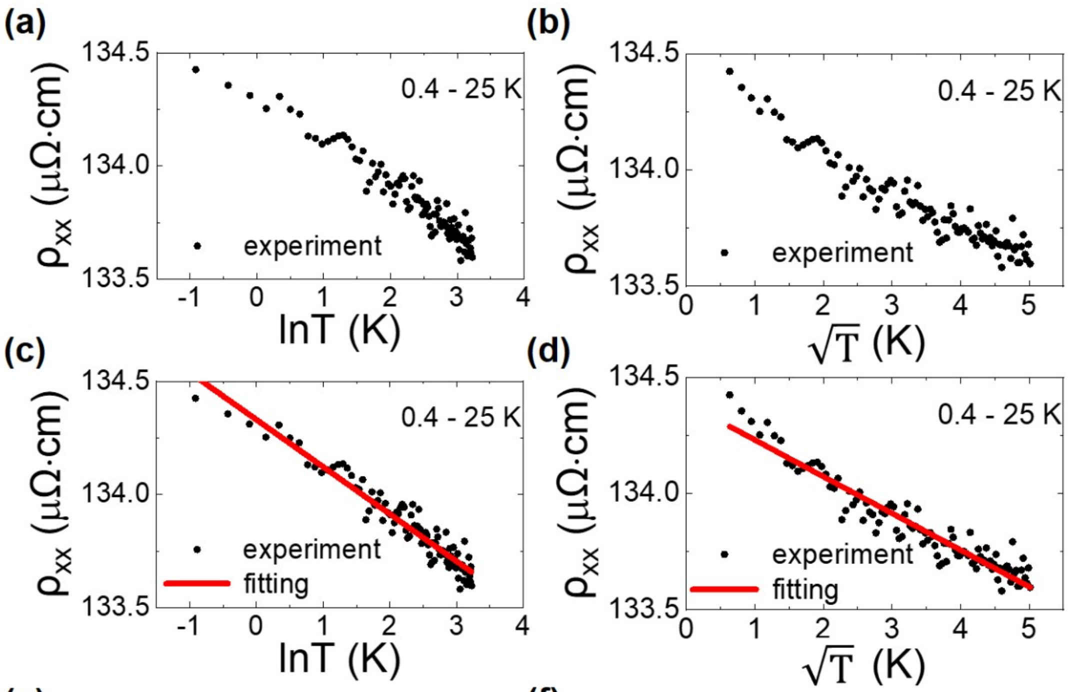
Section 1: Comparison of the low-temperature resistivity fitting of the IrO_2 crystal using ln T and $\sqrt{T}$ forms.



(e)

Equation	y = a + b*x
Plot	G
Weight	No Weighting
Intercept	134.33028 ± 0.013
Slope	-0.20855 ± 0.0056
Residual Sum of Squar	0.24221
Pearson's r	-0.9657
R-Square (COD)	0.93258
Adj. R-Square	0.93189

(f)

Equation	y = a + b*x
Plot	G
Weight	No Weighting
Intercept	134.38949 ± 0.017
Slope	-0.15796 ± 0.0048
Residual Sum of Squar	0.30043
Pearson's r	-0.95727
R-Square (COD)	0.91637
Adj. R-Square	0.91551

Fig. S1. Comparison of the low-temperature resistivity fitting of the IrO_2 crystal using ln T and $\sqrt{T}$ forms in the temperature range of 0.4-25 K. (a) and (b) show the experimental ρ_{xx} data by linear functions against ln T and $\sqrt{T}$, respectively. (c) and (d) show the fitted ρ_{xx} data by linear functions against ln T and $\sqrt{T}$, respectively. while (e) and (f) summarize the corresponding fitting parameters and goodness-of-fit statistics. The ln T fitting gives a higher R^2 value than the $\sqrt{T}$ fitting.

Section 2: Rule out the 3D weak localization.

In 3D weak localization scenario, resistivity change due to 3D weak localization is proportional to $-T^{\alpha/2}$, α is dependent on the scattering mechanism. For example, α is 3.0 for electron-phonon scattering, while α is 2.0 for electron-electron scattering (see chapter 9, E. N. Economou, *Green's Functions in Quantum Physics*, Springer, 2006, 3th edition). Using this criterion, we fitted the temperature-dependent resistivity. The fitting results are shown in Fig. S2, one can see that the fitting quality is significantly worse. Based on these new data, we think that the 3D weak localization still can be ruled out.

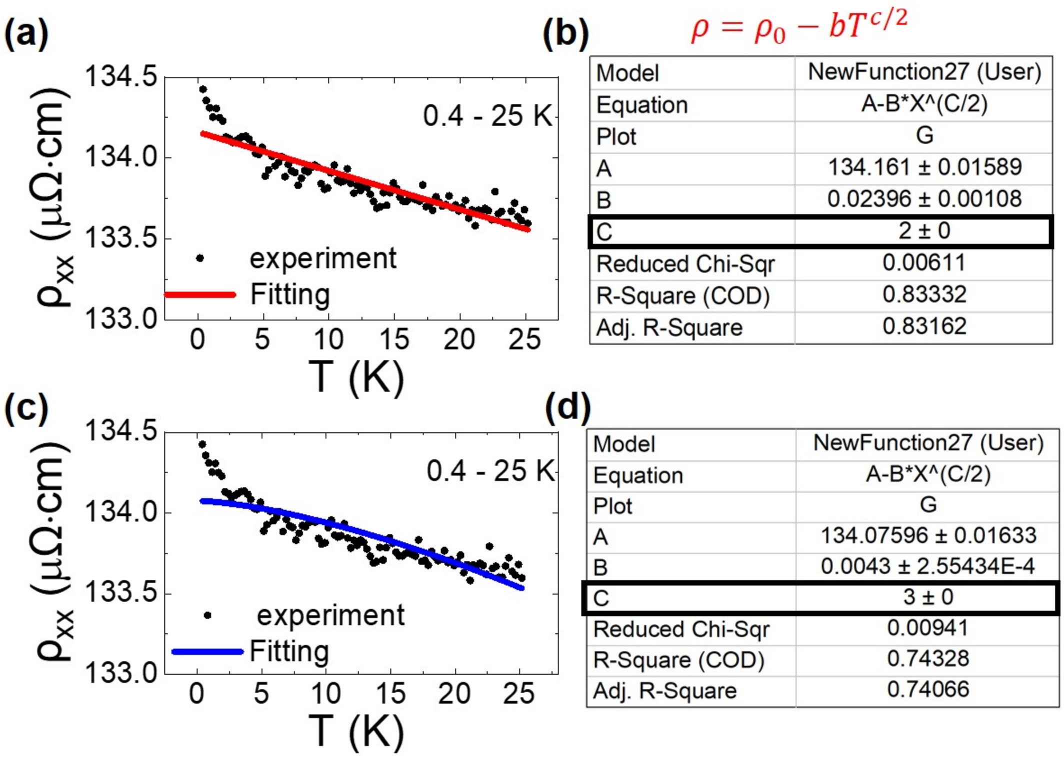


Fig. S2. Comparison of the low-temperature resistivity fitting of the IrO_2 crystal using $-T^{\alpha/2}$ forms in the temperature range of 0.4-25 K. α is dependent on the scattering mechanism. For example, α is 3.0 for electron-phonon scattering, while α is 2.0 for electron-electron scattering. one can see that the fitting quality is significantly worse.

Section 3: Fitted the M-B curves by Brillouin- and Lagevin functions.

We tested both Langevin and Brillouin functions for the nonlinear part of the $M(B)$ response. It is noted that the difference between the fits is not very pronounced in the main $M(B)$ plot because both functions reproduce the overall nonlinear trend rather well (see Figs. S3(a) and (c)). Therefore, our comparison is based mainly on the residuals (see Figs. S3(b) and (d)). For the nonlinear component, the best Brillouin fit gives a smaller root-mean-square error (RMSE) than the Langevin fit, indicating a somewhat better phenomenological description. But in the point of physical view, the fitted results are not reasonable. Because, as shown in the labels in Fig. S3(c), when J is larger than 1.0, the g-factor is smaller than 2. Generally, the magnetic moments in the systems comes from spins, rather than orbitals, because orbital moments are canceled by crystalline fields (see S. Blundell, *Magnetism in Condensed Matter*, Oxford University Press, 2001). g-factor of spin is exactly 2, that cannot smaller than 2. Based on this stringent constraint, we believe that the fitted results shown in Fig. S3(c) are not reasonable in physics.

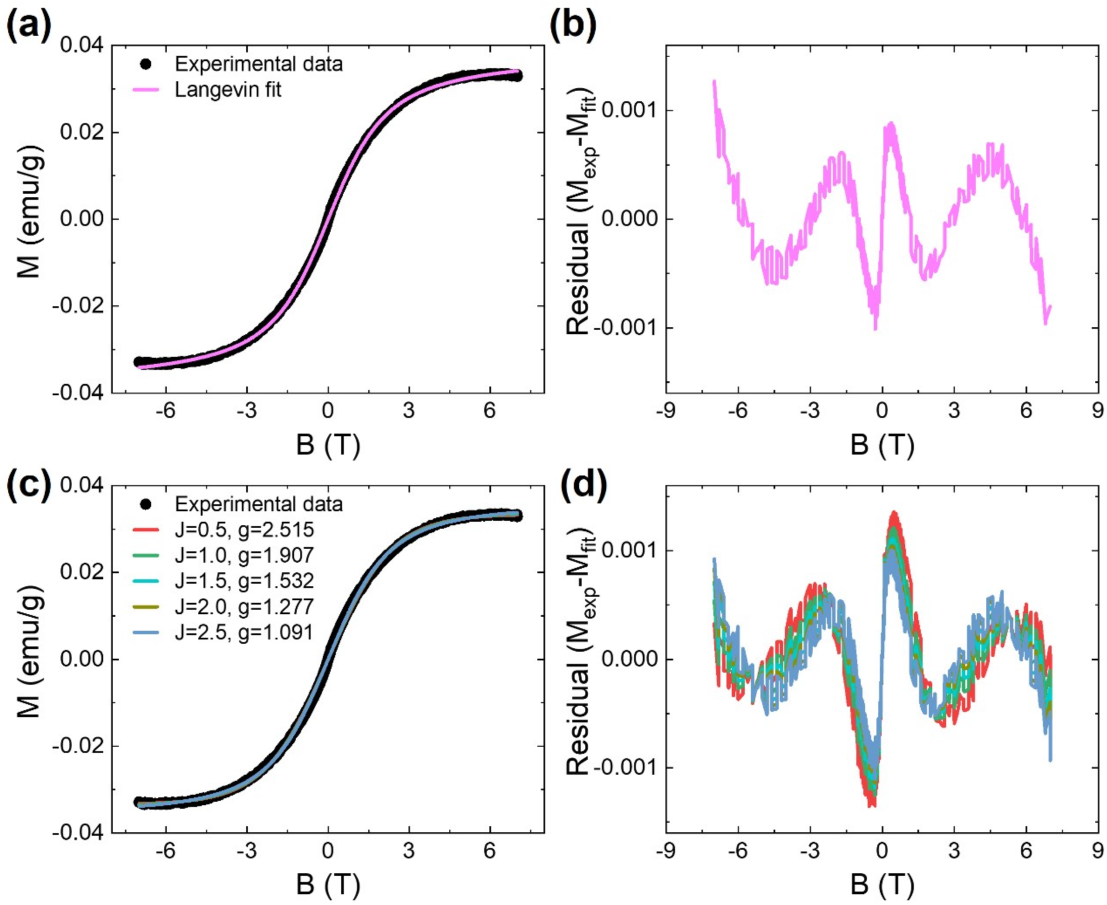


Fig. S3. Comparison between Langevin and Brillouin fits for the nonlinear component extracted from the 2 K $M(B)$ curve of IrO_2. (a) Experimental nonlinear component fitted by the Langevin function (pink line). (b) Residual plot for the fit, shown as $M_{\mathrm{exp}} - M_{\mathrm{fit}}$ as a function of magnetic field. (c) Experimental nonlinear component fitted by Brillouin functions with different discrete J values (0.5, 1.0, 1.5, 2.0, 2.5). (d) Corresponding residuals for the Brillouin fits with different J values. Although the difference among the fitting curves is not very pronounced in the main $M(B)$ plots, the residual analysis shows that the Brillouin description gives a somewhat better phenomenological fit to the nonlinear component than the Langevin form.