

Doping evolution of thermodynamic properties across the antiferromagnetic endpoint in Mott insulator $\text{Sr}_2(\text{Ir,Rh})\text{O}_4$



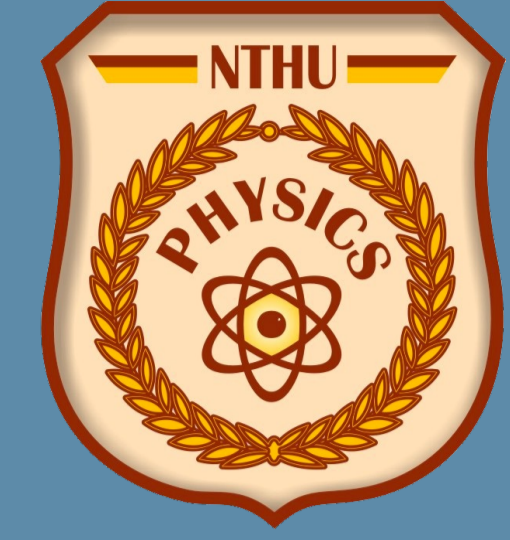
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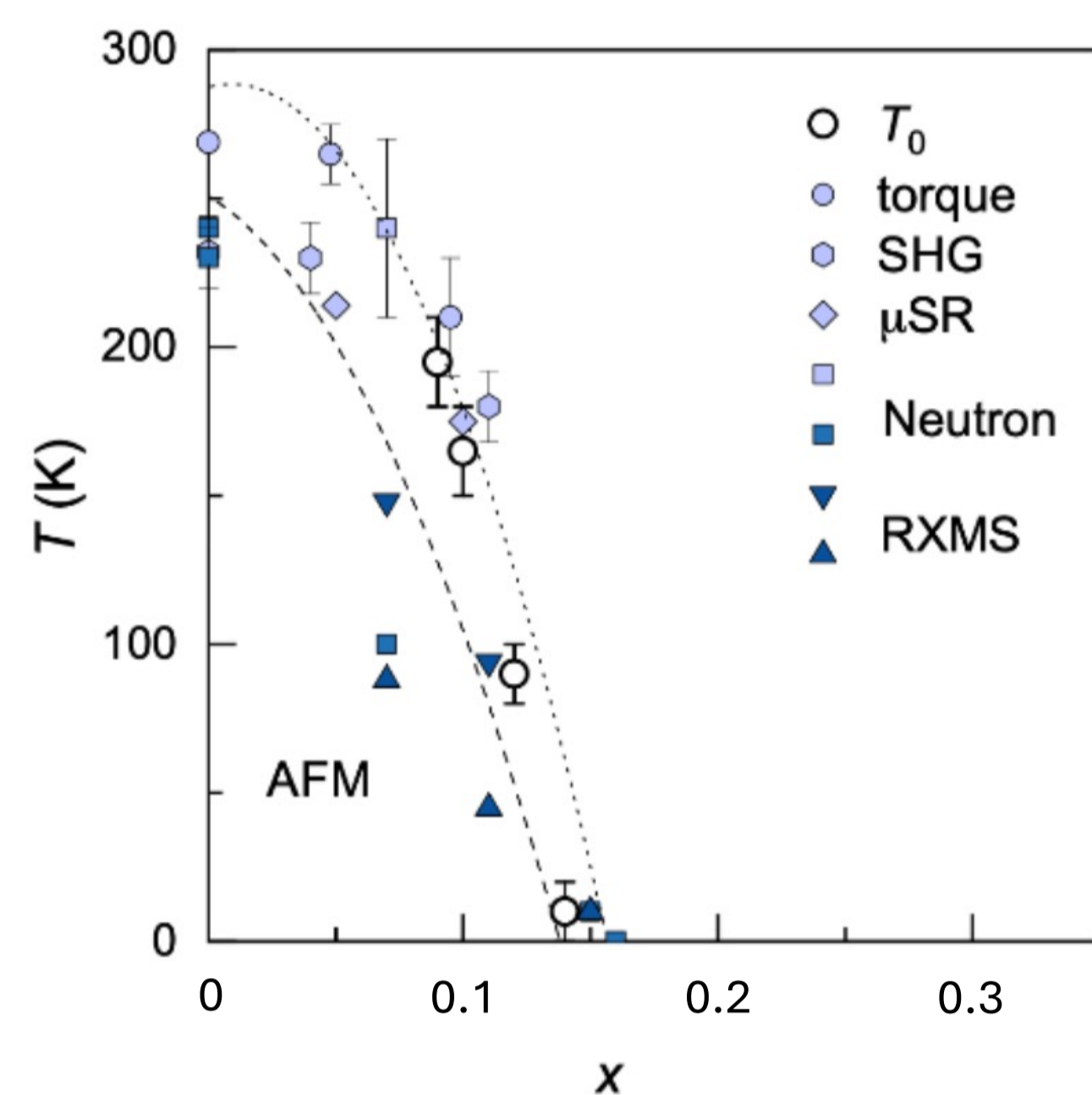


ABSTRACT

We conducted magnetic susceptibility, specific heat, and Hall effect measurements on doped spin-orbit coupled Mott insulator $\text{Sr}_2\text{Ir}_{1-x}\text{Rh}_x\text{O}_4$ crystals with x between 0.08 and 0.32. Across $x \approx 0.15$, we found a clear qualitative change in susceptibility and Hall effect, supporting the existence of an antiferromagnetic endpoint there. However, we do not observe a clear enhancement in electronic specific heat at $x = 0.15$, contrasting the expectation of strong mass enhancement near a putative quantum critical point.

INTRODUCTION

- Sr_2IrO_4 is a 5d Mott insulator with strong spin-orbit coupling and a long-range antiferromagnetic (AFM) order with $T_N = 240$ K
- Rh doping in Sr_2IrO_4 introduces hole-like carriers, suppresses $T_N = 0$ at $x \approx 0.15$, and drives the toward a metallic state [1]



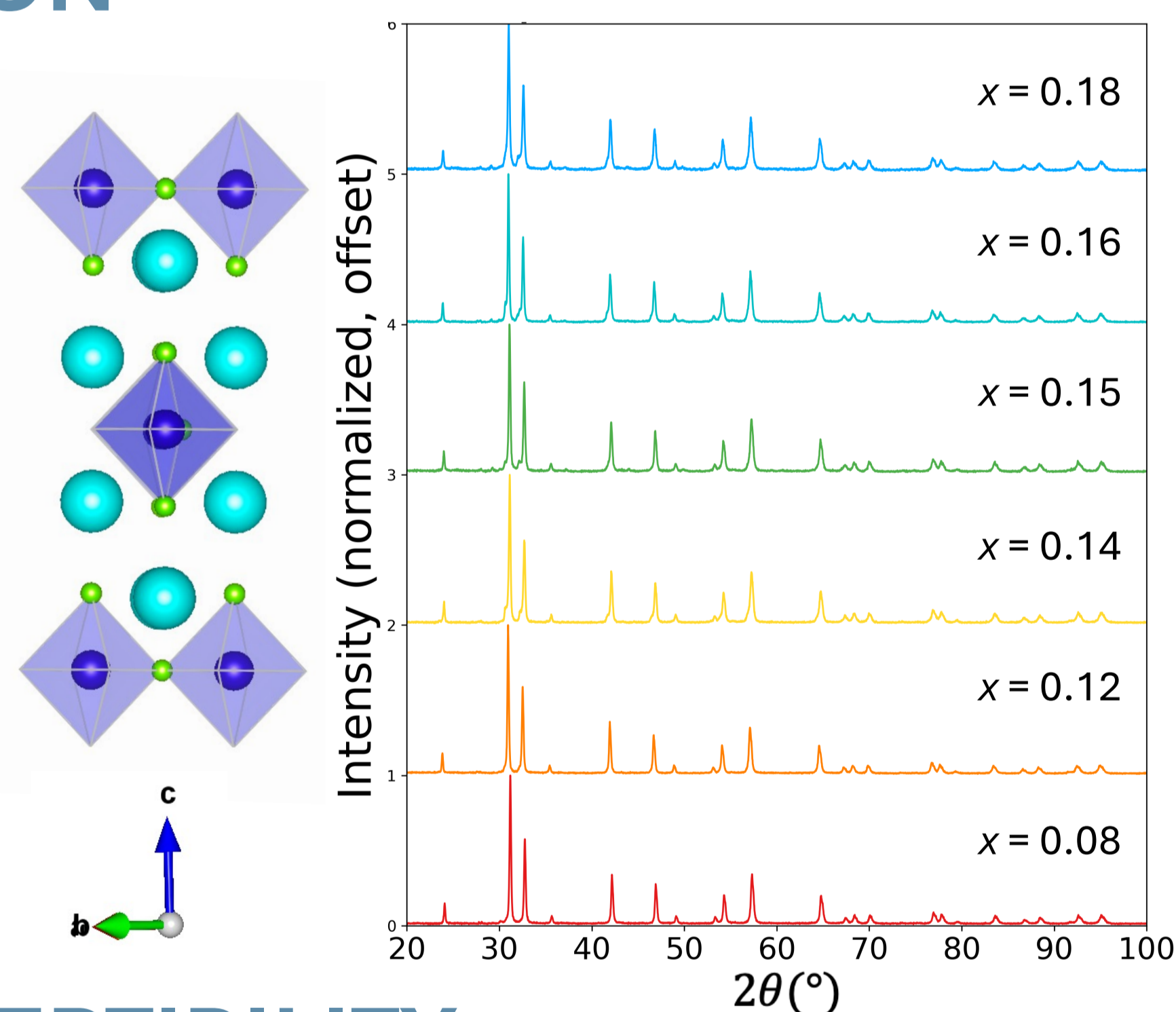
SYNTHESIS

- Polycrystalline $\text{Sr}_2\text{Ir}_{1-x}\text{Rh}_x\text{O}_4$ samples ($x = 0.08, 0.12, 0.14, 0.15, 0.16, 0.18, 0.22, 0.26$) were synthesized using solid-state reaction: stoichiometric powders were grounded and calcined at 1050 °C, followed by regrounding, pelletization, and 2nd sintering at 1150 °C
- Single crystals of $\text{Sr}_2\text{Ir}_{1-x}\text{Rh}_x\text{O}_4$ over a similar doping range were grown using a flux method as previously described [2]

RESULTS

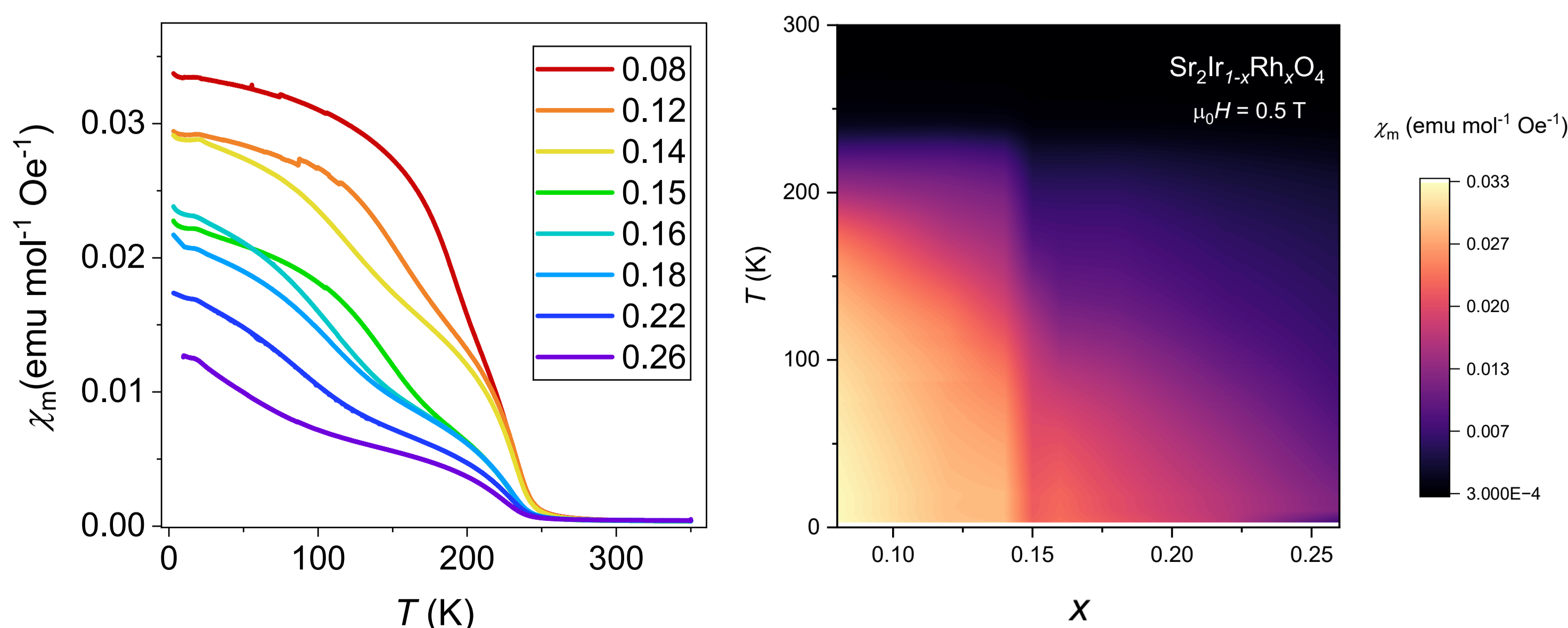
X-RAY DIFFRACTION

- Measured XRD spectra of the $\text{Sr}_2(\text{Ir,Rh})\text{O}_4$ polycrystals can be fully accounted for using known structure of Sr_2IrO_4
- Rh substitution does not alter the crystal structure or introduce impurity phases



MAGNETIC SUSCEPTIBILITY

- $\chi(T, x)$ measured using $\mu_0 H = 0.5$ T
- A pronounced suppression in $\chi(T)$ as x exceeds 0.15, indicative of a loss of long-range AFM order above $x = 0.15$



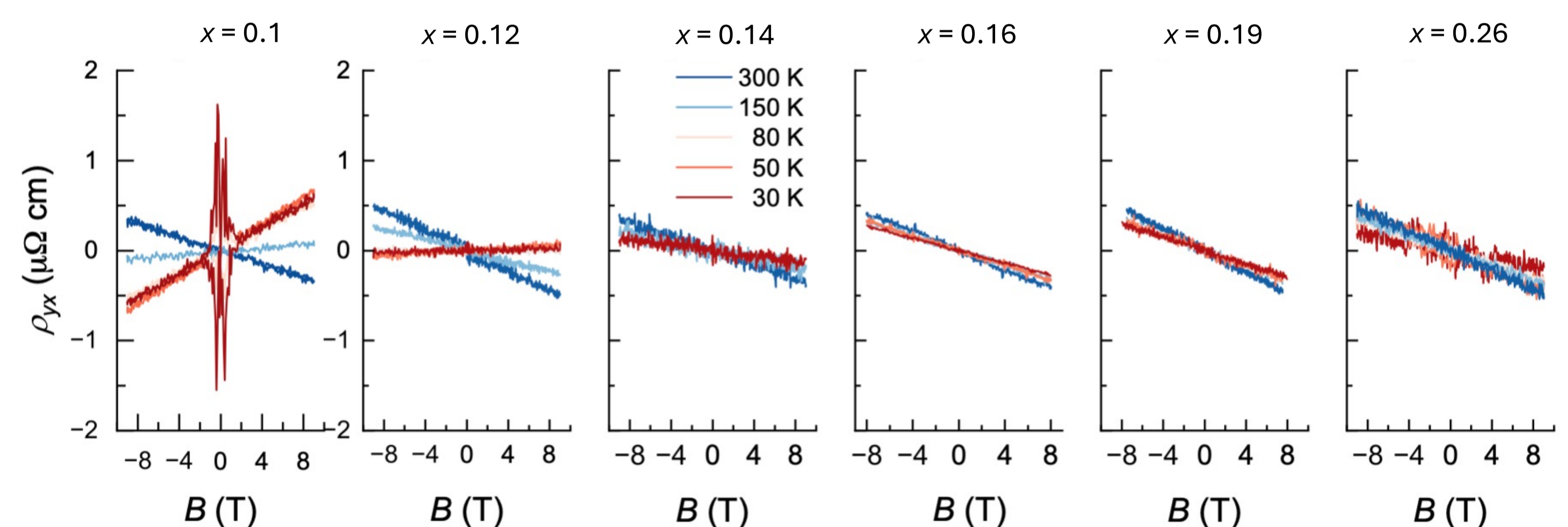
REFERENCE

[1] H. Murayama, et al., 2021, "Bond Directional Anapole Order in a Spin-orbit Coupled Mott Insulator $\text{Sr}_2\text{Ir}_{1-x}\text{Rh}_x\text{O}_4$," PHYSICAL REVIEW X 11, 011021.

[2] T. F. Qi, et al., 2012 "Spin-orbit tuned metal-insulator transitions in single-crystal $\text{Sr}_2\text{Ir}_{1-x}\text{Rh}_x\text{O}_4$ (0 < x < 1)" PHYSICAL REVIEW B 86, 125105

HALL EFFECT

- For $x < 0.14$, Hall resistivity ρ_{yx} undergoes a sign change from negative to positive as T decreases below T_N
- For $x > 0.16$, Hall resistivity remains negative for all measured temperature with a similar magnitude for all x



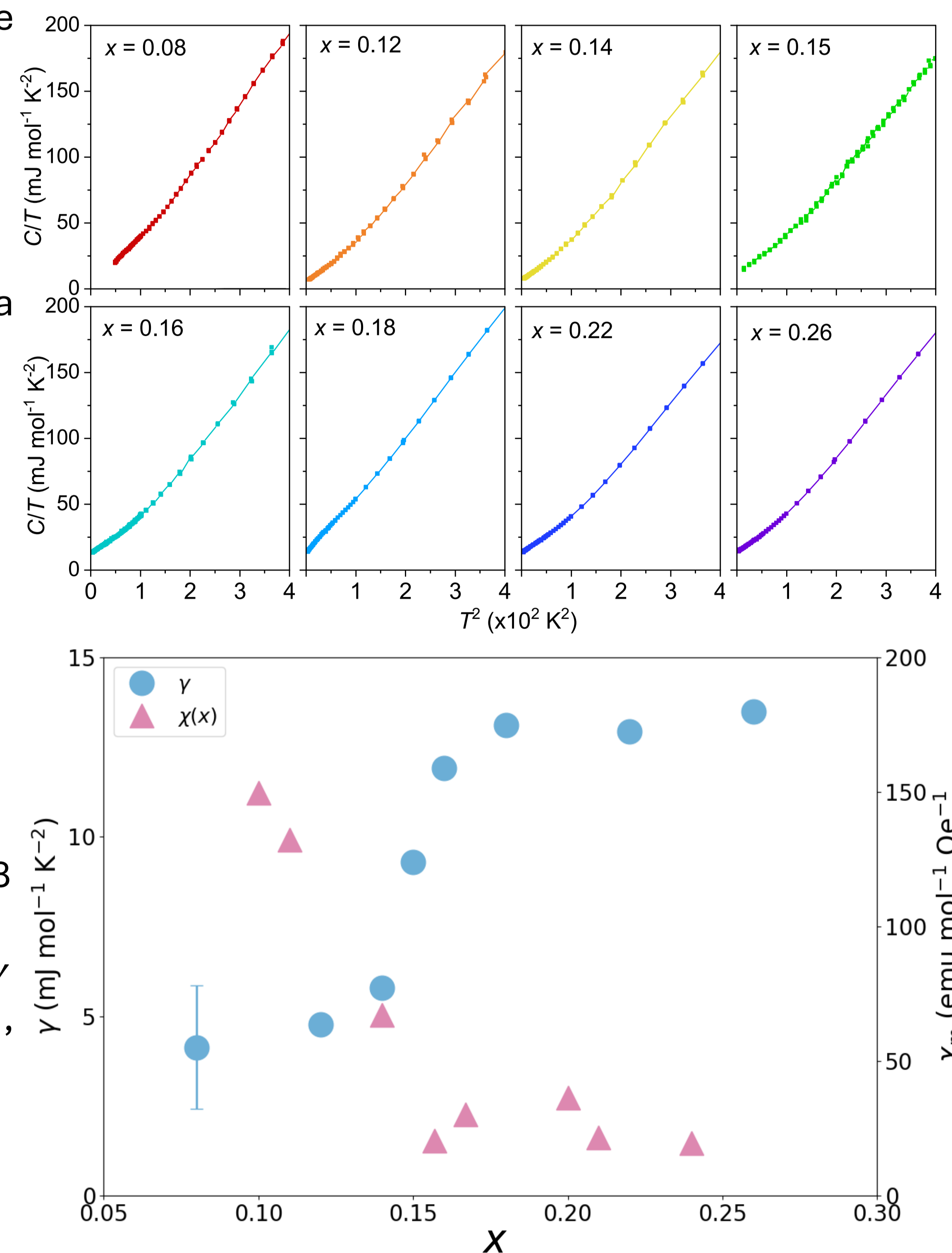
SPECIFIC HEAT

- Low-temperature specific heat follows:

$$C/T = \gamma + \beta T^2$$

- Linear fits to data below 60 K² to extract the electronic component γ

- The electronic specific heat γ shows a monotonic increase between $x = 0.08$ and 0.14
- Above $x = 0.15$, γ shows a plateau, rather than a strong enhancement near x_c



CONCLUSION

- 1) Near $x = 0.15$, clear anomalies in magnetic susceptibility and Hall resistivity are observed, supporting the presence of a quantum phase transition.
- 2) The precipitous suppression of magnetic susceptibility and sharp increase in electronic specific heat point to a discontinuous nature of the QPT.

ACKNOWLEDGEMENT

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