

# Nonreciprocal transport effects in FeSe superconducting films

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Nonreciprocal transport effects, which refer to different transport responses to forward and backward stimuli, have been observed in various noncentrosymmetric superconductors under an external magnetic field (for example, [1-3]).

In this study, we focus on simpler materials, specifically, centrosymmetric FeSe thin films. We grew FeSe films with a thickness of 22 nm on a LaAlO<sub>3</sub> substrate by pulsed laser deposition (PLD) and subsequently deposited amorphous Si as a protective capping layer. Through detailed measurements of the  $I$ - $V$  characteristics under magnetic fields below the transition temperature, while carefully avoiding heating effects, we have demonstrated that nonreciprocal resistance arises in these simple structures owing to symmetry breaking at the interfaces. A plausible mechanism behind these effects is the vortex ratchet motion caused by asymmetric surface barriers.

In addition, we successfully observed nonreciprocal signals along the transverse (Hall) direction when magnetic fields are applied parallel to the electric current. The emergence of the nonreciprocal transverse response is counterintuitive, since vortex motion is not expected in this configuration. Our results provide new insights into the control of vortex dynamics in superconductors.

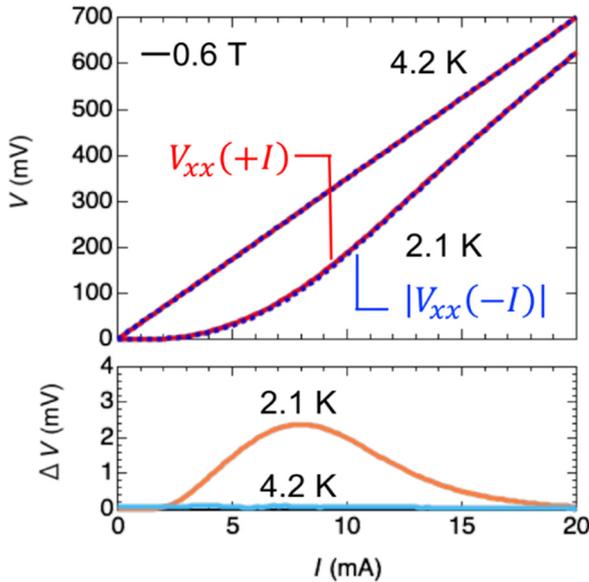


Figure caption: Examples of experimental results for nonreciprocal longitudinal signals. As shown in the upper panel, the voltage magnitude is different for opposite current directions, and the difference is plotted in the lower panel. The nonreciprocal signals are only observed at 2.1 K below the superconducting transition temperature ( $T_c=2.8$  K).

## References

- [1] R. Wakatsuki et al., *Sci. Adv.* 3, e1602390 (2017).
- [2] E. Zhang et al., *Nat. Commun.* 11, 5634 (2020).
- [3] M. Masuko et al., *npj Quantum Mater.* 7, 104 (2022).