Poster-2-7

Ferron Hall Effect

Daniel Bustamante[1,2] and Dominik Juraschek[2]

[1] *Department of Physics, Boston University, Boston, Massachusetts 02215, USA*
[2] *Department of Applied Physics and Science Education, Eindhoven University of Technology, 5612 AP Eindhoven, Netherlands*

Hall physics in solids has expanded far beyond its charge-transport setting and now includes transverse responses of neutral excitations such as magnons and phonons. An example is the phonon Hall effect, in which broken time-reversal symmetry causes lattice vibrations to deflect, generating a transverse heat current. More recently, nonequilibrium lattice dynamics have been extended to Hall-type responses, including transverse currents of phonon angular momentum [1,2]. Motivated by these developments, we ask whether the lattice can carry and deflect not only heat or angular momentum, but also structural order parameters. Ferroelectrics provide a natural platform to explore this possibility because their soft polar modes encode the ferroelectric distortion and carry electric polarization, giving rise to the ferron quasiparticle [3].
In this presentation, I introduce the ferron Hall effect as a Hall-type response of the polarization-carrying soft-mode sector in a ferroelectric. Under a longitudinal thermal gradient and broken time-reversal symmetry, the driven soft-mode dynamics acquires a transverse component that is odd in the magnetic field, producing a transverse ferron current and an edge accumulation of polarization [4]. I present microscopic results for ferroelectric $BaTiO_3$, where the effect appears as a transverse nonequilibrium polarization signal, suggesting a route toward thermal and magnetic control of ferroelectric order.

[1] S. Park and B.-J. Yang, "Phonon Angular Momentum Hall Effect," Nano Lett. 20, 7694–7699 (2020). DOI: 10.1021/acs.nanolett.0c03220.
[2] D. A. Bustamante Lopez, V. Brehm, and D. M. Juraschek, "Atomistic theory of the phonon angular momentum Hall effect," arXiv:2604.01899 (2026). DOI: 10.48550/arXiv.2604.01899.
[3] P. Tang, R. Iguchi, K.-i. Uchida, and G. E. W. Bauer, "Excitations of the ferroelectric order," Phys. Rev. B 106, L081105 (2022). DOI: 10.1103/PhysRevB.106.L081105.
[4] D. A. Bustamante Lopez and D. M. Juraschek, "Ferron Hall effect," in preparation.