Abstract for IAS Quantum Forum on Altermagnetism and Beyond (August 10-13, 2026)

Anomalous Transport Responses in Metallic Odd-parity Magnets

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Antiferromagnetic states with anisotropic spin splitting have recently attracted great interest as platforms for spintronic responses without large net magnetization. While altermagnets realize even-parity spin splitting, recent theory and experiments have extended this concept to odd-parity spin splitting, including *p*-wave magnets [1]. Here, we report the experimental realization of a metallic *p*-wave magnet in the rare-earth helical magnet $Gd_3(Ru_{0.95}Rh_{0.05})_4Al_{12}$ [2]. By tuning the band filling, we stabilize a coplanar spin helix with an even commensurate magnetic period, satisfying the spin-space-group symmetry conditions for *p*-wave magnetism. Transport measurements reveal characteristic anisotropic conductivity associated with the *p*-wave spin-splitting axis. In addition, a tiny spontaneous magnetization and spin–orbit coupling induce a giant anomalous Hall effect, demonstrating that metallic odd-parity magnets provide a fertile platform for exploring unconventional transport responses and electrically controllable spin-split states.

References:

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[1] A.B. Hellenes, *et al*., arXiv:2309.01607v3 (2024) / Q. Song *et al*., Nature **642**, 64–70 (2025).

[2] R. Yamada, *et al*., Nature **646**, 837-842 (2025)