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

Chiral Magnons and Switchable Altermagnetic Order in MnTe: Neutron Scattering Insights into Nonrelativistic Spin Splitting

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Altermagnetism has recently emerged as a new class of collinear magnetism characterized by momentum-dependent spin splitting despite zero net magnetization. Unlike conventional ferromagnets or antiferromagnets, altermagnets exhibit alternating spin polarization in reciprocal space, leading to unconventional electronic and magnonic properties governed by symmetry rather than relativistic spin–orbit coupling. In particular, the existence of chiral magnons arising from nonrelativistic exchange interactions has been theoretically predicted, offering a novel platform for dissipationless spin transport without stray magnetic fields.

In this talk, we present a comprehensive neutron-scattering study of the prototypical altermagnet MnTe, integrating results from unpolarized and polarized neutron techniques to establish both the microscopic origin and controllability of altermagnetic excitations and order. First, using inelastic neutron scattering, we directly observe magnon band splitting in MnTe, providing clear experimental evidence of altermagnetic magnon splitting. The lifting of magnon degeneracy is quantitatively reproduced by a spin-wave model based solely on symmetric exchange interactions, demonstrating that the splitting originates from a nonrelativistic mechanism. Furthermore, detailed analysis of the momentum dependence reveals the characteristic g-wave symmetry of the underlying altermagnetic state [1].

Next, we address the domain-dependent nature of altermagnetic order. Because altermagnetic domains with opposite Néel vectors can coexist, their contributions tend to cancel in macroscopic measurements, making direct detection of the altermagnetic order nontrivial. By employing polarized neutron diffraction, we directly probe the nuclear–magnetic interference terms and demonstrate the presence of a net Néel vector in bulk MnTe. We further show that a weak ferromagnetic moment, induced by relativistic spin–orbit coupling, is coupled to the altermagnetic order. Importantly, both the Néel vector and the associated weak ferromagnetism can be controlled via milli-Tesla-scale magnetic-field cooling, enabling deterministic switching of the altermagnetic domain state [2].

Finally, combining polarized inelastic neutron scattering with domain control, we directly observe chiral magnons in MnTe and demonstrate that their chirality can be reversibly switched by external magnetic fields. This establishes a direct link between the altermagnetic order parameter and magnon chirality, providing the first experimental realization of switchable chiral magnons in a bulk altermagnet. These results not only confirm the existence of nonrelativistic chiral magnon splitting but also highlight the feasibility of controlling magnonic degrees of freedom via weak magnetic fields in compensated magnetic systems [3].
Our findings establish MnTe as a model system for altermagnetic magnonics and open a pathway toward symmetry-driven spintronic functionalities that do not rely on net magnetization or strong spin–orbit coupling. The combination of neutron scattering and symmetry-based analysis provides a powerful framework for exploring emergent excitations in altermagnets and related compensated magnetic materials.

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References:
[1] Z. Liu et al., Phys. Rev. Lett. 133, 156702 (2024).
[2] Z. Liu et al., . Phys. Rev. Lett. 136, 236705 (2026).
[3] Z. Liu et al., Phys. Rev. Lett. in press; arXiv:2605.21616.