

Emergent Topological Transitions of Dirac Magnons Beyond Linear Spin-Wave Theory

Chien-Te WU

Department of Electrophysics, National Yang Ming Chiao Tung University

Email: chientewu@nycu.edu.tw

Topological magnons in two-dimensional honeycomb ferromagnets offer a bosonic analogue of quantum Hall physics. I will discuss how magnon–magnon interactions and Dzyaloshinskii–Moriya coupling jointly drive temperature- and field-induced topological phase transitions characterized by Dirac-gap closings and sign reversals of the magnonic thermal Hall conductivity. Extending these ideas, I will present a self-consistent renormalized spin-wave theory (SRSWT) that incorporates higher-order Holstein–Primakoff corrections to capture both magnetic and topological transitions near the Curie temperature. The analysis clarifies when SRSWT remains thermodynamically stable and shows that small Zeeman fields or antiferromagnetic next-nearest-neighbor exchange can render topological transitions experimentally accessible in materials such as CrI_3 .

Finally, I will outline ongoing extensions to finite systems, including exact-diagonalization and nanoribbon studies that probe edge-state evolution across interaction-driven transitions. Preliminary results indicate that magnonic edge modes persist but acquire finite-size quantization signatures, offering new avenues to explore magnon topology in confined geometries.