Chiral crossroads in Ho_3ScO_6: a tale of frustration in the maple leaf lattice

Pratyay Ghosh
Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland

Abstract:

Motivated by the recent observation of a uniform vector chirality (UVC) magnetic order in the maple-leaf lattice (MLL) realization Ho_3ScO_6 via powder neutron scattering experiments, we investigate the classical antiferromagnetic Heisenberg model on the maple-leaf lattice. The MLL features three symmetry-inequivalent nearest-neighbor couplings, J_d, J_t, and J_h. Previous studies, primarily focused on the case where $J_t = J_h$, identified a staggered vector chirality (SVC) order. Extending beyond this limit, we demonstrate that the SVC order remains stable across a broad parameter regime. However, we also find that the UVC order cannot emerge from the nearest-neighbor model alone. By introducing a further-neighbor antiferromagnetic interaction, J_x, we demonstrate that even a weak J_x can cause a first-order phase transition from SVC to UVC order. Using linear spin wave theory, we compute the dynamical spin structure factor, revealing distinct signatures for SVC and UVC orders that can be probed through inelastic neutron scattering experiments. Additionally, we calculate the specific heat, which exhibits qualitative agreement with the experimental data for Ho_3ScO_6. Our findings provide a minimal framework for understanding Ho_3ScO_6 and related MLL systems, like $MgMn_3O_7 \cdot 3\,H_2O$, suggesting avenues for further experimental and theoretical investigations.