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Symmetry and magnon band topology

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Abstract: In a crystalline ordered magnet, coherent excitations called spin waves, or magnons, propagate in the material forming band structures in an analogous way to electrons. Spin waves can possess non trivial topology associated with novel response functions of fundamental and potential technological interest. One of the central issues in this area is to establish the conditions under which band topology can arise in magnons and explore its variety. In this work we harness the full power of symmetry as applied to magnetism, to facilitate the discovery of new topological magnon models and materials.

We show how to efficiently identify such systems by adapting the electronic topological quantum chemistry scheme to magnons, using constraints imposed by time reversal and crystalline symmetries to determine possible gapped and nodal topology in magnon models. Further, we explore enhanced symmetries beyond this paradigm, which are nevertheless natural for magnons: the spin-space groups. Exploring spin-space symmetry, which has wholly or partially decoupled magnetic and lattice degrees of freedom, reveals a proliferation of nodal points, lines, and planes beyond the standard crystalline symmetries.