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Interaction-stabilized topological magnon insulator in ferromagnets

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Condensed matter systems admit topological collective excitations above a trivial ground state, an example being Chern insulators formed by Dirac bosons with a gap at finite energies. However, in contrast to electrons, there is no particle-number conservation law for collective excitations. This gives rise to particle number-nonconserving many-body interactions whose influence on single-particle topology is an open issue of fundamental interest in the field of topological quantum materials.

Taking magnons in honeycomb-lattice ferromagnets as an example, we uncover topological magnon insulators that are stabilized by interactions through opening Chern-insulating gaps in the magnon spectrum. This can be traced back to the fact that the particle-number nonconserving interactions break the effective time-reversal symmetry of the harmonic theory. Hence, magnon-magnon interactions are a source of topology that can introduce chiral edge states, whose chirality depends on the magnetization direction. Importantly, interactions do not necessarily cause detrimental damping but can give rise to topological magnons with exceptionally long lifetimes. We identify two mechanisms of interaction-induced topological phase transitions and show that they cause unconventional sign reversals of transverse transport signals, in particular of the thermal Hall conductivity. Our results demonstrate that interactions can play an important role in generating nontrivial topology.

Reference: Alexander Mook, Kirill Plekhanov, Jelena Klinovaja, Daniel Loss, arXiv:2011.06543 (2020)

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