

# Quantum skyrmions and antiskyrmions in monoaxial chiral magnets

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Skyrmions are topological solitons with particle-like properties holding potential for applications in magnetic and quantum technologies. Recently, the quantum properties of skyrmions have garnered significant attention [1,2]. Unlike their classical counterparts, quantum skyrmions exhibit novel physical phenomena arising from their entanglement properties of the underlying spin system – spin-1/2 particles [3,4]. We investigate quantum skyrmions in so-called monoaxial chiral magnets, which are a class of materials with Dzyaloshinskii-Moriya interaction (DMI) present in just one crystallographic direction, while the Heisenberg exchange interaction remains isotropic. Classical monoaxial chiral magnets represent a unique magnetic system that allows for the stabilization of both skyrmions and antiskyrmions of equal energy [5]. Unlike a similar situation in frustrated magnets, the energy landscape here is much simpler, consisting of only four states: the saturated ferromagnetic state, spin-spiral, skyrmion and antiskyrmion. This simplicity makes such systems interesting for potential applications that rely on manipulating these states. We study the quantum analogue of the established classical theory by investigating the low-excitation spectra of a spin-1/2 quantum Heisenberg model with monoaxial DMI. We find that such a model supports the existence of skyrmion and antiskyrmion states of equal energy using density matrix renormalization group (DMRG) methods. This degeneracy allows for the existence of a mesoscopic superposition state exhibiting properties of both skyrmion and antiskyrmion. Interested in the experimental observation of this superposition, we calculate two-point spin correlations, which can be measured in neutron scattering experiments. Finally, we introduce a perturbation in the form of a magnetic gradient field to induce a non-trivial time evolution. We study this time evolution both using a numerical variational approach and the collective coordinates method [6].

## References:

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