Magnon squeezing in conical spin spirals

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We investigate squeezing of magnons [1] in a conical spin spiral configuration [2] forming due to competing Heisenberg and Dzyaloshinsky–Moriya interaction. Performing a Bogoliubov transformation we calculate the energy of magnons propagating along the $\vec{k}$ and the $-\vec{k}$ directions which can differ due to the nonreciprocal dispersion [3].

These two modes are connected by the squeezing, hence can be described by the same squeezing parameter showing reciprocal properties under wave vector inversion. The squeezing parameter diverges at the center of the Brillouin zone due to the translational Goldstone mode of the system, but the squeezing also vanishes for certain wave vectors.

As an example system we regard a two-dimensional square lattice magnet on a substrate in the C_{4v} symmetry class, as shown in Fig. 1, with nearest-neighbour and next-nearest-neighbour exchange interactions J_1, J_2 and nearest-neighbour Dzyaloshinskii-Moriya interactions $\vec{D}$. Further, an uniaxial anisotropy K_z and a magnetic field $\vec{B}$ along the cone opening direction are considered. We derive possible ground state configurations and two are discussed in depth. First a spin spiral forming along the diagonal of the x-y-plane, second a spin spiral forming along the x-axis are investigated. For both configurations the squeezing parameter respects a C_{2v} symmetry and decreases towards the Brillouin zone boundary while showing curves of vanishing squeezing inside the Brillouin zone .

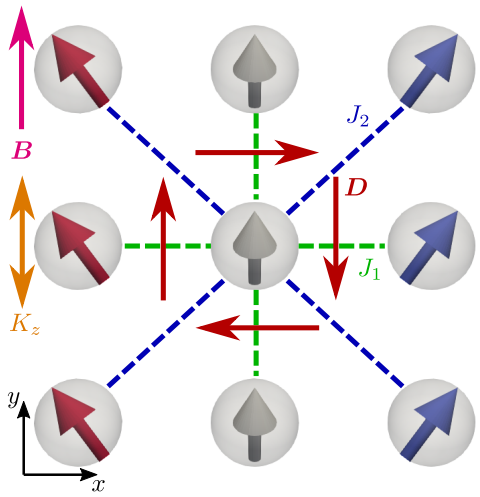

Figure 1: *Directions of the Dzyaloshinsky–Moriya vectors ($\vec{D}$) in a square-lattice magnet on a substrate in the C_{4v} symmetry class. The interaction J_1 acts between the middle site and the neighbouring sites along the x (y) direction (green line). The interaction J_2 acts between the middle site and the next neighbouring sites along the diagonals (blue line)*

References

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