Magnon quantum geometry in one-dimensional chiral magnets

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We develop a theoretical framework for magnon dynamics in a quasi-one-dimensional Heisenberg spin chain that includes a nearest-neighbour Dzyaloshinskii-Moriya interaction (DMI) and a magnetic field applied along both the hard and easy axes. Depending on the field's direction and strength, the system hosts various ground states, including ferromagnetic and conical spiral phases, as well as a chiral soliton lattice. Using the Holstein-Primakoff transformation, we derive a quadratic magnon Hamiltonian. We diagonalize the Hamiltonian via the Bogoliubov transformation and show that the quantum geometric tensor of magnons fundamentally inherits a symplectic structure. This geometric structure yields corrections to the semiclassical equations of motion for magnon wave packets, resulting in a metric-driven longitudinal contribution in one dimension. Overall, the framework provides a systematic route for incorporating geometric effects and symplectic structure into magnon dynamics, where no particle-number-conserving framework exists, offering new insights into the interplay between topology and transport in nonlinear spin textures.