Motion-induced inertial effects and topological phase transitions in skyrmion transport

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Abstract
When the skyrmion dynamics beyond the particle-like description is considered, this topological structure can deform due to a self-induced field. In this work, we perform Monte Carlo simulations to characterize the skyrmion deformation during its steady movement. In the low-velocity regime, the deformation in the skyrmion shape is quantified by an effective inertial mass, which is related to the dissipative force. When skyrmions move faster, the large self-induced deformation triggers topological transitions. These transitions are characterized by the proliferation of skyrmions and a different total topological charge, which is obtained as a function of the skyrmion velocity. Our findings provide an alternative way to describe the dynamics of a skyrmion that accounts for the deformations of its structure. Furthermore, such motion-induced topological phase transitions make it possible to control the number of ferromagnetic skyrmions through velocity effects.

Author keywords
deformation; effective mass; Monte Carlo; skyrmions; topological transition