Avalanches in Functional Materials with Magnus Force: Skyrmions and Vortices

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Abstract:

Topological excitations such as vortices in superconductors and skyrmions in magnetic materials are important not just for their fundamental physical properties but also for their potential as information carriers in high-density storage and logic devices. Skyrmions are nanoscale magnetic textures that enjoy topological stability and exhibit particle-like behavior. Just like domain walls, when vortices and skyrmions move through a crystal, they produce avalanches whose distribution depends on the Magnus force. The latter is a result of angular velocity of these excitations during their flow (linear velocity). The dynamics of skyrmions is dominated by the Magnus force; in contrast the dynamics of vortices is dominated by the dissipative force. This significant difference in dynamics is revealed in the corresponding avalanche distributions. Using a particle-based model derived from a mesoscopic, interacting spin model, we performed numerical simulations of skyrmions in the presence of quenched disorder. We .0present the results of our simulations and compare them to the known, similar case of superconducting vortices.

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