Dynamics of Skyrmions in a Frustrated Magnetic Film Driven by Spin Currents

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The magnetic skyrmion is an exotic and versatile topological object in condensed matter physics, which promises novel applications in electronic and spintronic devices [1]. Recently, a rich phase diagram of an anisotropic frustrated magnet and properties of frustrated skyrmions with arbitrary vorticity and helicity were investigated [2]. Other remarkable physical properties of skyrmions in the frustrated magnetic system have also been studied theoretically [2-5]. Here, we explore the skyrmion dynamics in a frustrated magnet based on the J1-J2-J3 classical Heisenberg model explicitly by including the dipole-dipole interaction [6]. The skyrmion energy acquires a helicity dependence due to the dipole-dipole interaction, resulting in the current-induced translational motion with a fixed helicity. The lowest-energy states are the degenerate Bloch-type states, which can be used for building the binary memory. By increasing the driving current, the helicity locking-unlocking transition occurs, where the translational motion changes to the rotational motion. Furthermore, we demonstrate that two skyrmions can spontaneously form a bound state. The separation of the bound state forced by a driving current is also studied. In addition, we show the annihilation of a pair of skyrmion and antiskyrmion. Our results reveal the distinctive frustrated skyrmions may enable new applications.

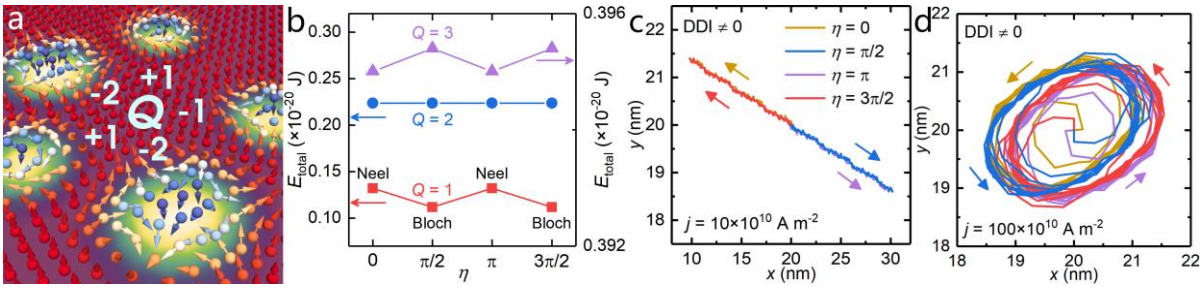

Figure 1. (**a**) Illustration of frustrated skyrmions with different topological number Q. (**b**) Total skyrmion energy as a function of helicity η. (**c**) Trajectories of skyrmions driven by a small spin current, where skyrmion helicities are locked. (**d**) Trajectories of skyrmions driven by a large spin current, where skyrmion helicities are unlocked.

References

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