Edge-Soliton-Mediated Vortex-Core Reversal Dynamics

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Magnetic topological solitons play the crucial roles in magnetization reversal dynamics of micrometer-size (or smaller) magnetic elements[1]. For example, vortex-core reversals are known to occur through the creation and annihilation of a pair of a vortex and an antivortex bulk topological soliton[2-4]. Recently, we have explored a new reversal mechanism of single vortex cores in magnetic disks driven by currents flowing perpendicular to the disk plane, as found from micromagnetic simulations. In the mechanism, vortex core switching occurs through serial dynamic transformations from an initial vortex to a pair of two edge solitons, again back to a newly created vortex of reversed core orientation. The transformation from the vortex state to an edge-soliton pair takes place spontaneously whenever a single vortex core arrives at the disk boundary, but the returning process requires a driving force overcoming a certain energy barrier. We found that this driving force is strongly localized out-of-plane gyrotropic fields induced by the fast motion of coupled edge-solitons. This gyrotropic fields form a magnetization dip between the two edge solitons and as the results, the vortex corewith reversed core orientation creates from the maximum magnetization dip. This mechanism is totally different from the well-known vortex-antivortex pair mediated vortex core reversals in terms of the associated topological solitons, energies, and spin-wave emissions. In this presentation, we are going to report not only a comprehensive understanding of edge-soliton mediated vortex corereversals but also physical insights into the dynamic transformations of magnetic topological solitons in nanoelements. This work was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (No. 20110000441).

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