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Deterministic and chaotic vortex dynamics in magnetic nanodots

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One of the effective ways of the magnetic vortex core reversal in a nanodisk can be realized under the action of ac magnetic field. Recently, the resonance switching of the vortex polarity under the action of ac perpendicular field was found numerically [1,2]: when the field frequencies are tuned to the eigenfrequencies of radial spin-wave modes, the threshold field amplitudes required for vortex-core switching are an order of magnitude smaller than those of static perpendicular fields. In this work we study such a switching in details both numerically and analytically. Different switching regimes are found when changing the field intensity H_0 and its frequency f. In particular, the vortex polarity demonstrates a chaotical dynamics with $1/f$ spectrum in a wide range of H_0 and f. We analyze the chaotic behavior of the system by means of autocorrelation functions, phase trajectories and Poincaré maps. We predict also a deterministic oscillations with resonance at the $f_0/3$ frequency which leads to polarity switching. We study the controlled vortex polarity switching under the influence of a short wave train: the controlled unidirectional switching takes place for low field amplitudes.
We present an analytical approach to describe simulations data using the vortex core model [3]. Our model is in a very good agreement with results of numerical simulations.

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