Domain wall rectification in thin magnetic films with arrays of asymmetric holes

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Modern techniques in nanotechnology provide a very versatile tool to fabricate thin films with a well controlled pinning potential for magnetic domain walls. This system rises basic physical questions which are relevant for technological applications such as the dynamical magnetic response under an applied external field for different pinning geometries. We study both experimentally and theoretically, the magnetic wall dynamics on thin films patterned with an asymmetric array of holes under an external magnetic field applied along the easy direction. We observe for first time rectification effects of Néel walls in conventional continuous thin films with defects. Moreover a rectification reversal effect induced by the asymmetric wall kinks motion is obtained at low applied magnetic fields (see Fig.1).

A simple phenomenological ϕ^4-model succesfully explain the observed phenomena, suggesting that the interplay among the driving force, elasticity and pinning of domain walls is at the root of the observed macroscopic phenomena.

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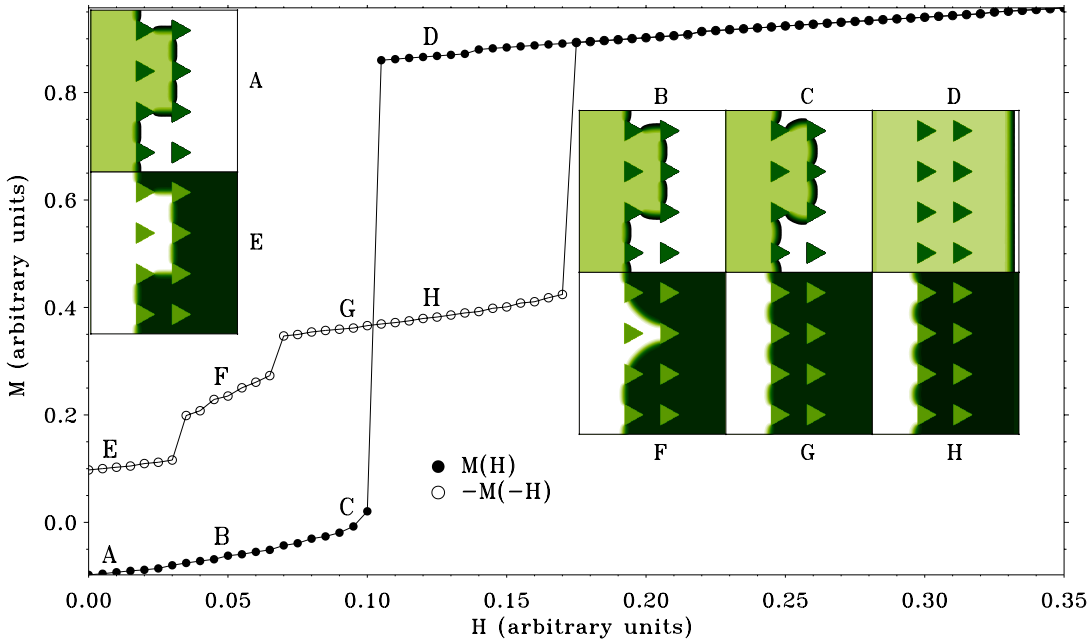

FIG. 1: Magnetization vs applied magnetic field. Results obtained using a ϕ^4-model. The initial state at $H = 0$ is a wall with a kink-antikink pair (A,E) which evolves asymmetrically with respect to H and $-H$. Insets are ϕ snapshots corresponding to the points, A,B,C,D,E,F,G and H marked in $M(H)$ and $M(-H)$ curves. The curves show clearly that is easier to move a straight wall to the right than to the left but on the contrary a wall with a kink-antikink pair is harder to move to the right than to the left.