Vortex switching in nanomagnetic structures

How to control the position, circulation, and polarity of a magnetic vortex in a nanomagnet?

--voids or holes?
--applied fields, currents?
--optical impulses?

Theory: computer simulations of spin energetics & dynamics to study vortex motion and spin reversal.

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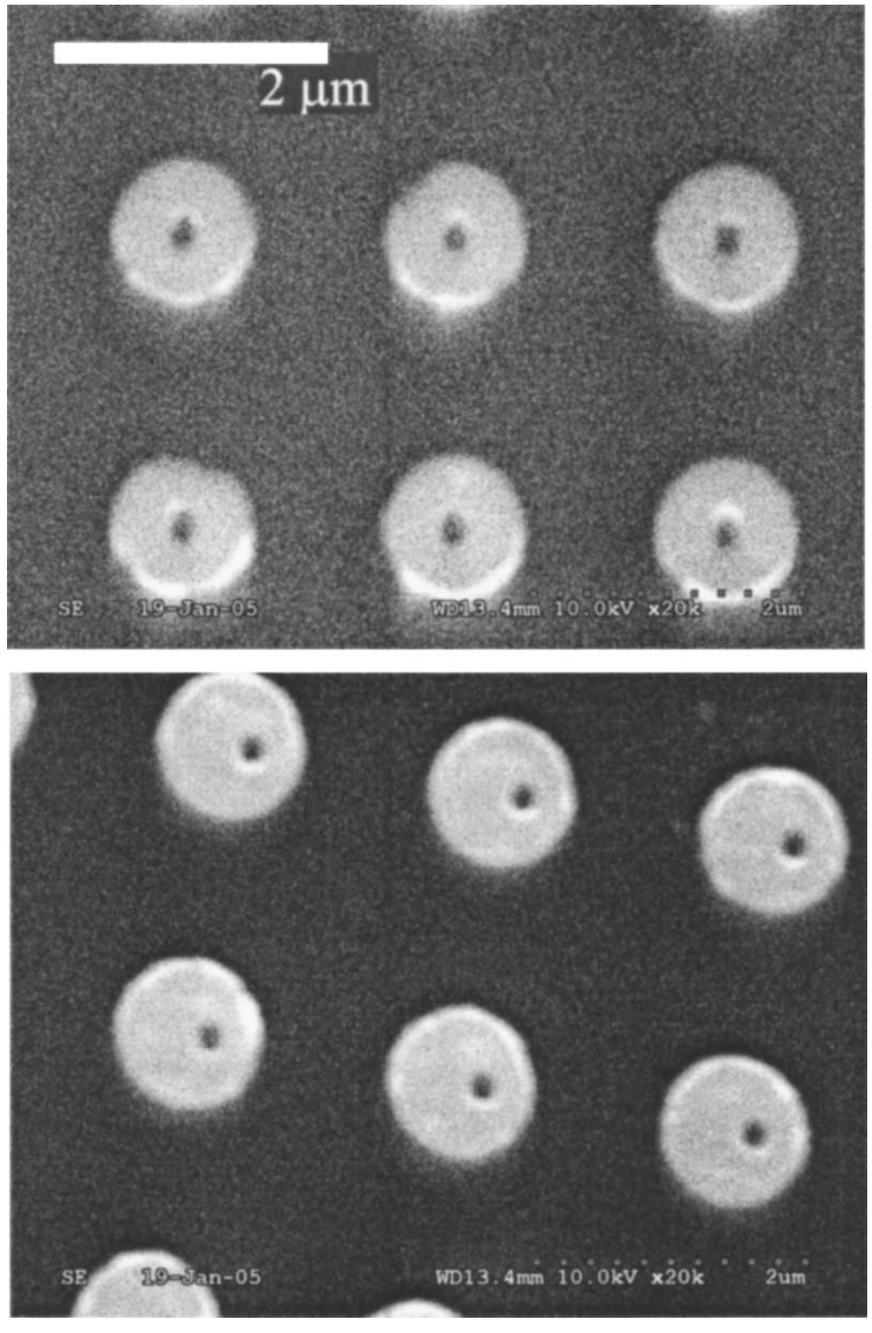


FIG. 1. Scanning electron images of a portion of the two patterns: symmetric rings (upper panel) and asymmetric rings (lower panel).

Polarity Switching:

APPLIED PHYSICS LETTERS **89**, 262507 (2006)

(Xiao et al.)

Dynamics of vortex core switching in ferromagnetic nanodisks

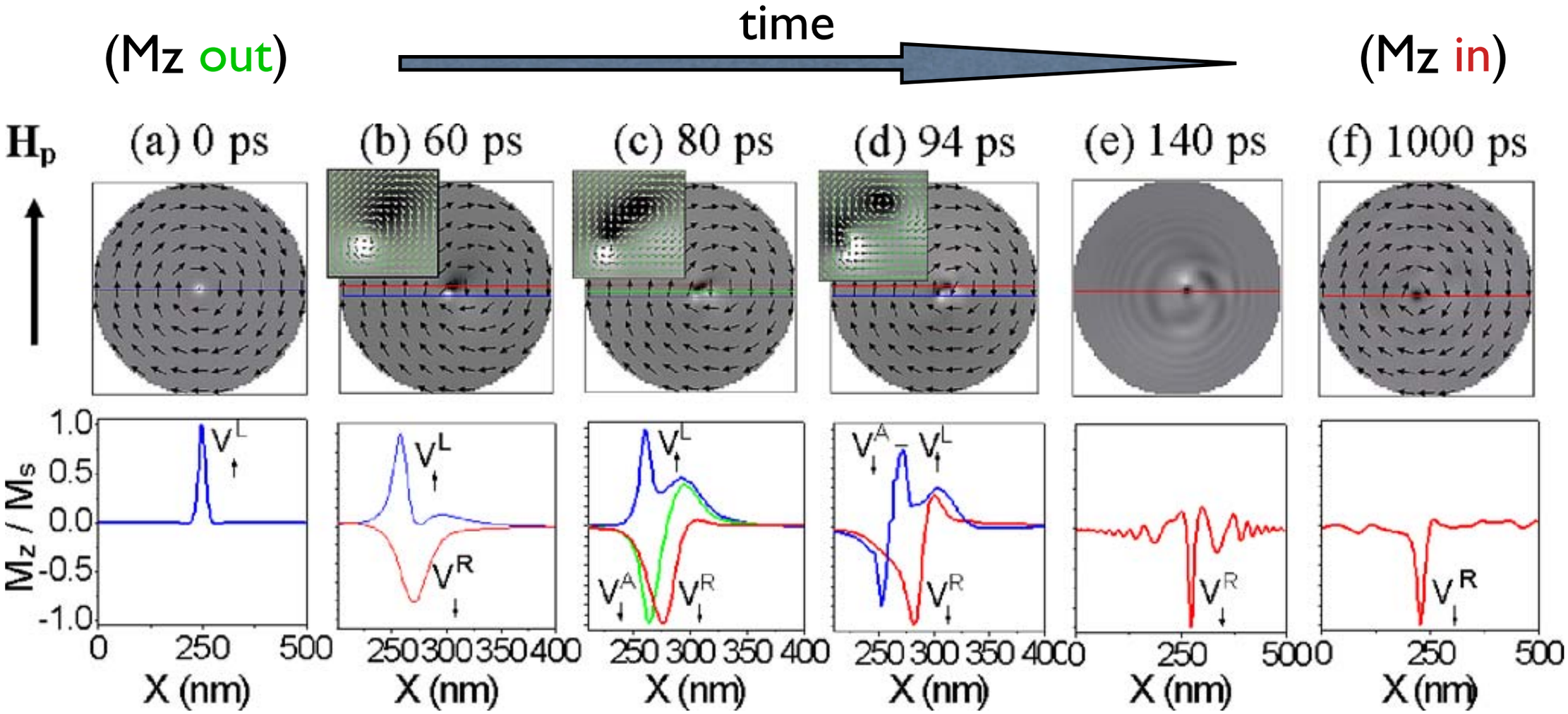


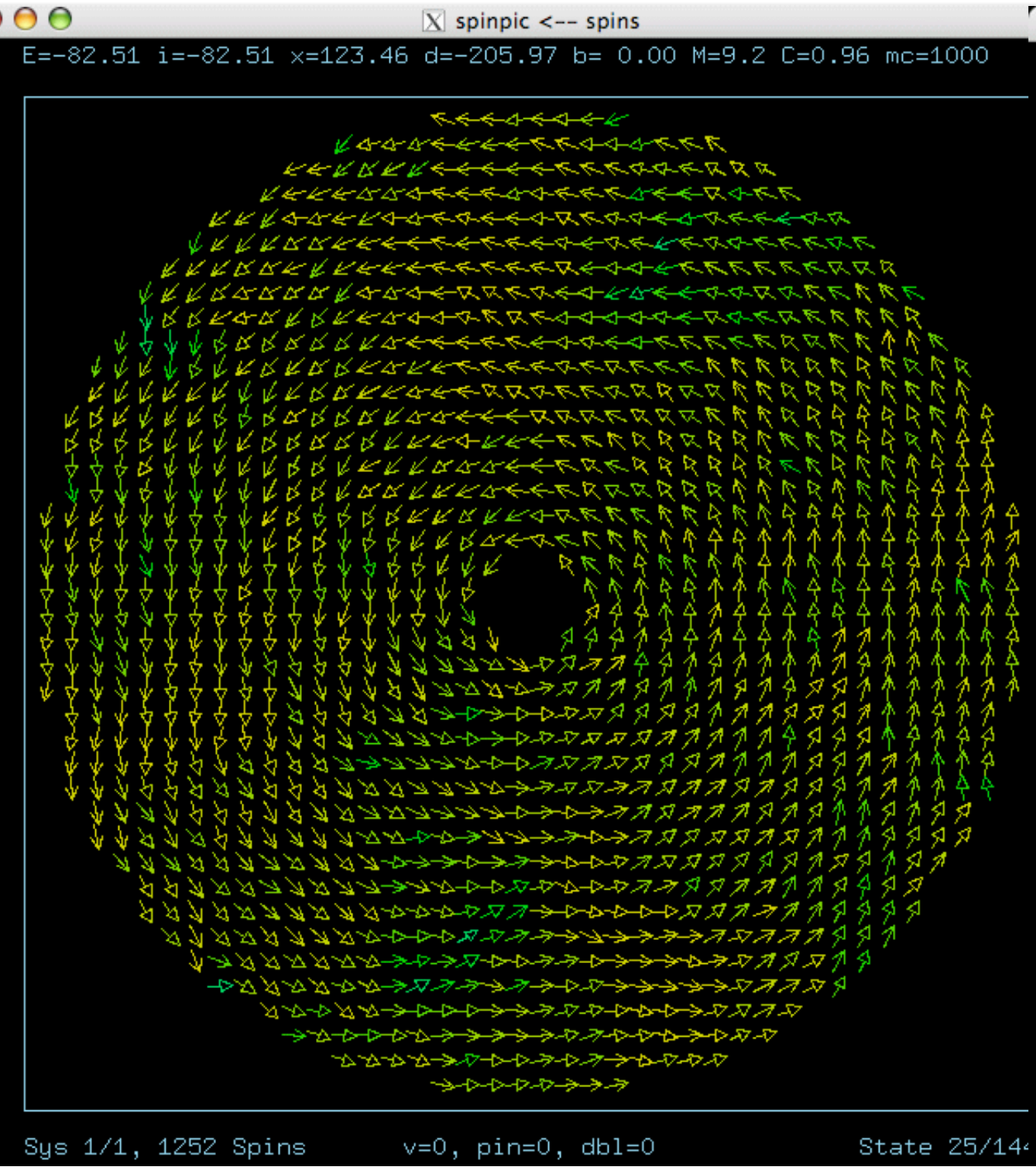
FIG. 1. (Color online) Temporal evolution of M_z/M_s of the Py disk excited by $H_{\mathrm{Py}}=290$ Oe (cut off at 80 ps). The arrows are the in-plane component of the magnetization. Below each image are the M_z/M_s profiles through the center of each vortex core along the lines in the x direction, respectively. Note that the profiles in (b)–(d) are enlarged in the x axis direction.

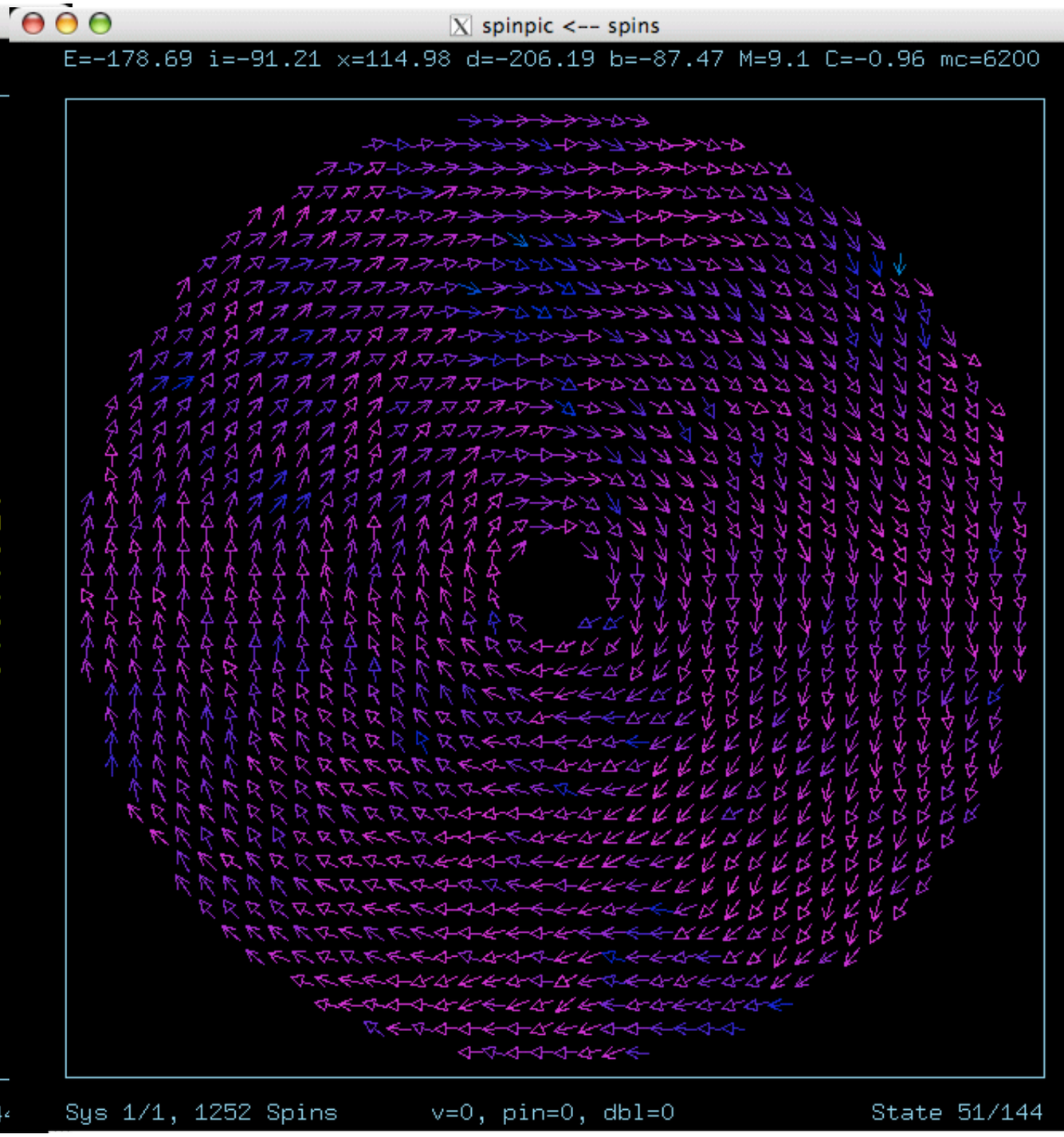
Circulation switching:

Influence of a perpendicular current on the circulation of a pinned magnetic vortex (Wysin 2008)

Monte Carlo evolution

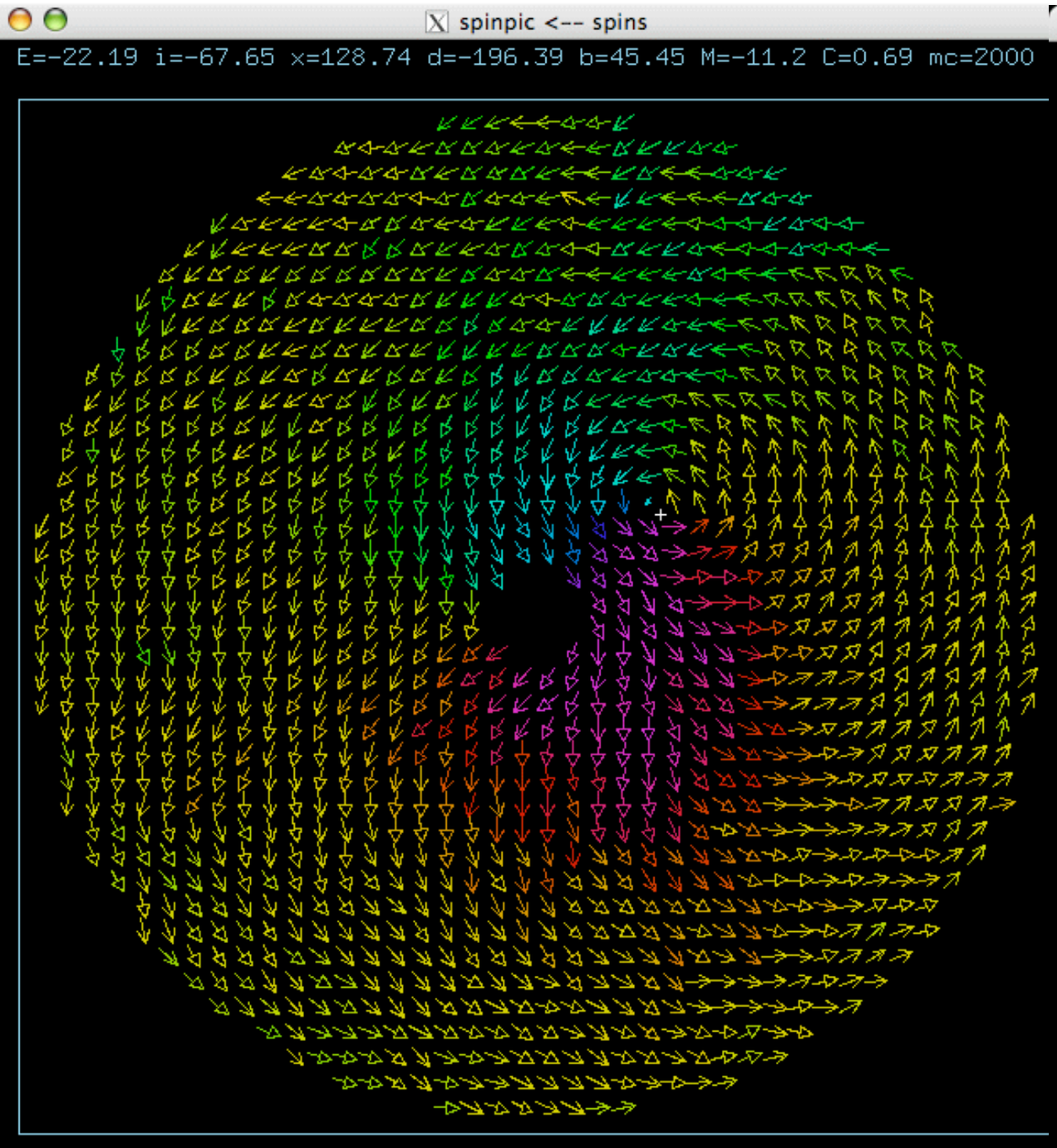
start: C=+1 → 6200 mc steps, C=-1



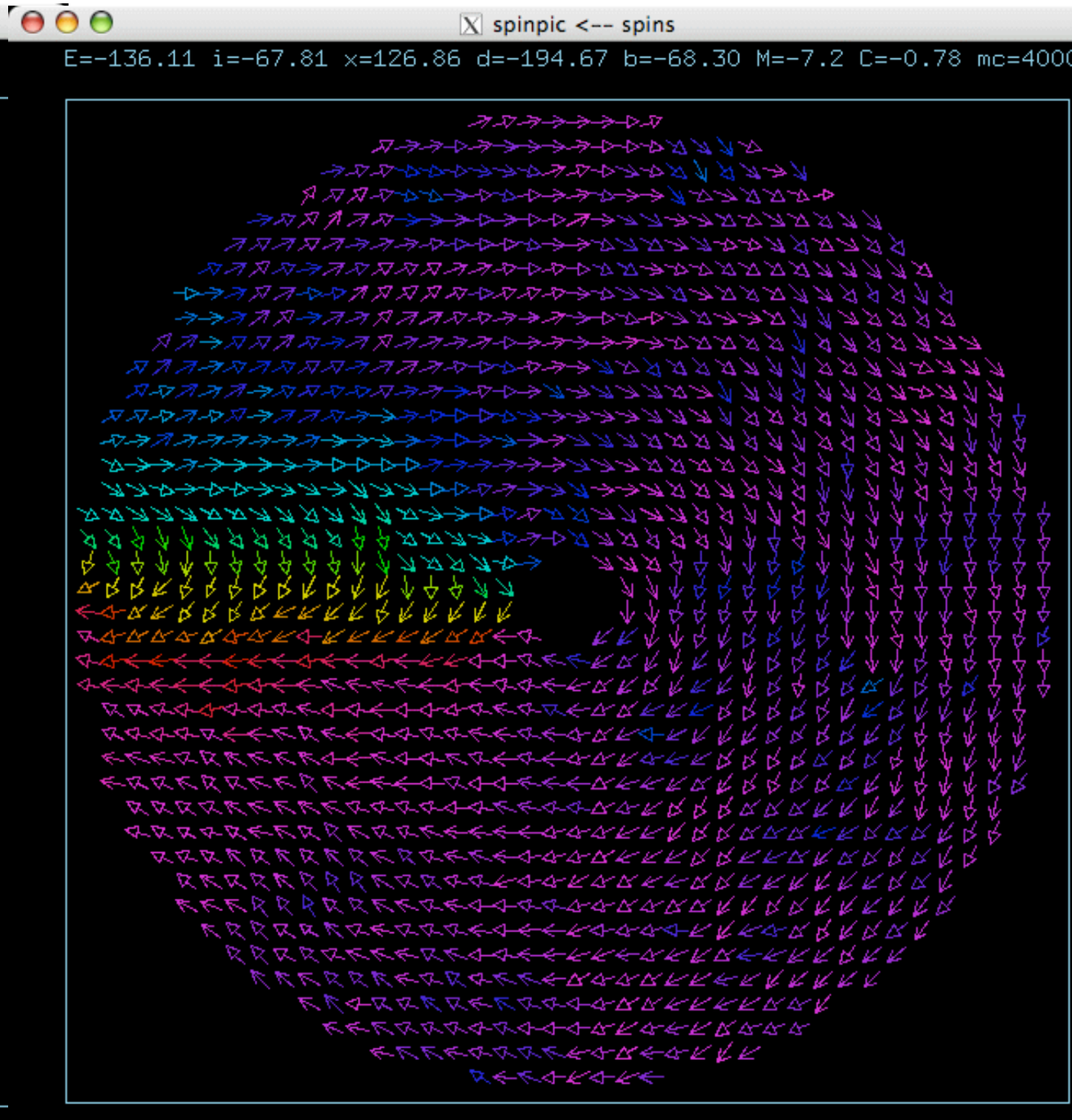


reversal via: <u>emergent +vortex</u>, <u>domain wall</u>, emergent -vortex.

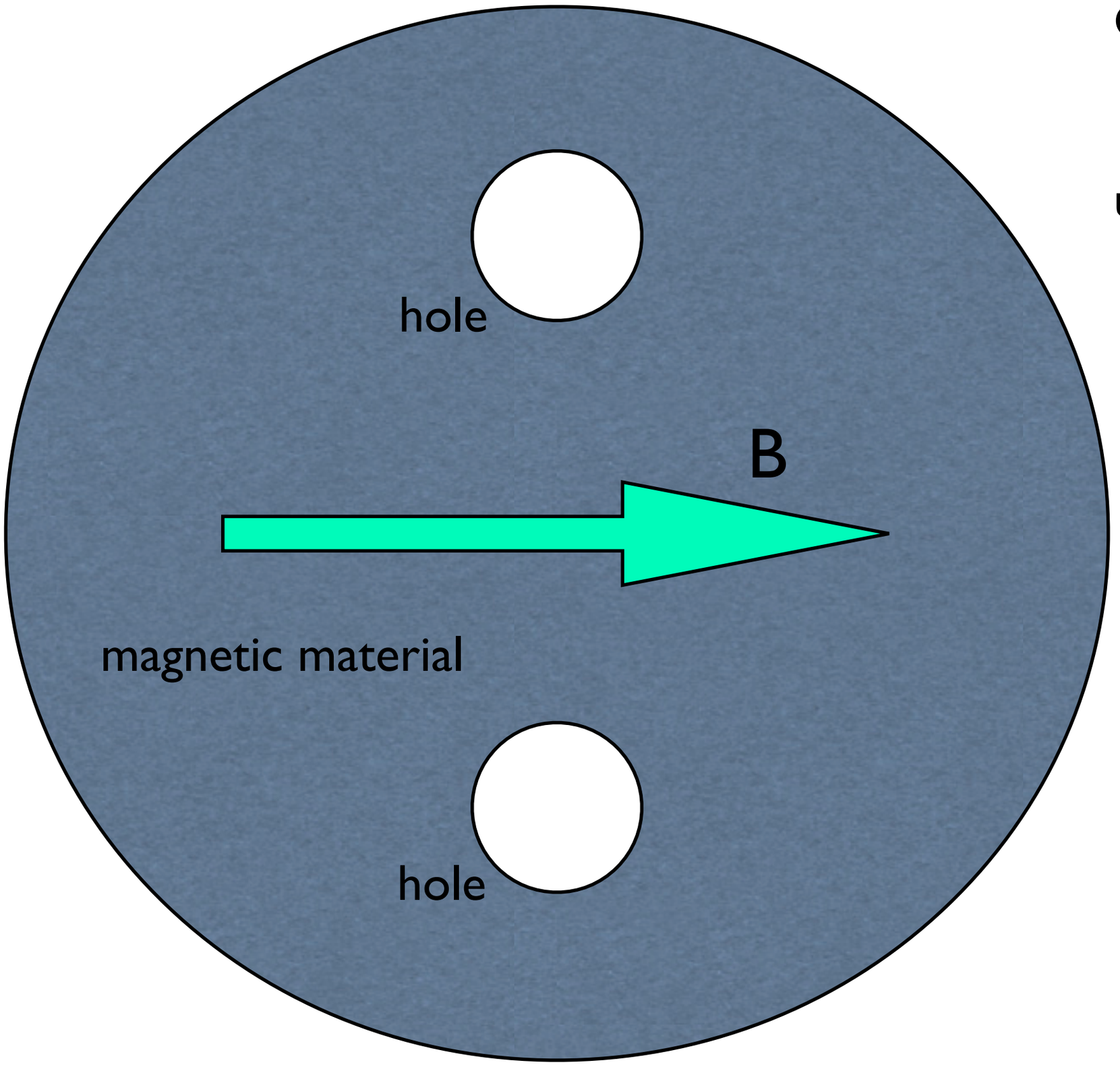
2000 mc steps, C=+0.69



4000 mc steps, C=-0.78



Proposed project: A bistable nanomagnetic switch



Can an applied magnetic field control whether a vortex surrounds the upper hole or the lower hole?

Approach:

Energy minimization for the metastable states.

Monte Carlo simulation for including thermal fluctuations and seeing the switching process.

Some References

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