Finite Difference Micromagnetics

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OOMMF is an experimental system. NIST assumes no responsibility whatsoever for its use by other parties, and makes no guarantees, expressed or implied, about its quality, reliability, or any other characteristic.
Portable, extensible, public domain programs & tools for micromagnetics

http://math.nist.gov/oommf

Contacts: Michael Donahue, Donald Porter

Movie credit: June Lau
Finite difference methods

Advantages:
- Easy to implement
- Simple meshing
- FFT for demagnetizing field
- Accessibility of higher order methods

Disadvantages:
- “Stairstep” edges on curved boundaries
Curved boundary corrections

OOMMF 3rd party extensions

- thetaevolve: Finite temperature
- oommf_pbc: Periodic boundaries
- Southampton_UniaxialAnisotropy4
- Southampton_CubicAnisotropy8
- anv_spintevolve: Spin torque
Parallel processing

2500 nm x 1250 x 40 nm sample
5 nm cubic cells => $10^6$ spins

2.2 GHz Opteron 848, 4 processors
2.4 GHz Core2, quad core

Time/demag field eval (seconds)
Number of cores
2.2 GHz Opteron 848, 4 processors
2.4 GHz Core2, quad core
OMPMP
M.J. Donahue

Parallel processing

2.2 GHz Opteron 848, 4 processors
2.4 GHz Core2, quad core
2.8 GHz Opteron 8220, 8 dual-core

Speed-up (normalized)
Number of cores

2  4  6  8  10  12  14  16
Edge study

Edge study

![Graph showing applied in-plane field vs. writing dose](image)

**A**

- **Mean nucleation field, $H_n$**
- **Nucleation field distribution, $\sigma_n$**

**B**

- Equation: $H_n = 5.4 \text{ mT}$
- Equation: $\sigma_n = 8.5 \text{ mT}$

**C**

- Equation: $p(H) = \frac{1}{2} \text{Erfc} [0.084(H - 5.418)]$
Mode simulations

50 nm CoPd disk, 12 nm thick:

Credits: J. Shaw, J. Lau, R. McMichael; see also poster FT-03
Mode simulations
Defect spectroscopy

Applied field (T) vs. Resonance frequency (GHz)

- No defect
- Center defect
- Edge defect

Graph showing the relationship between applied field and resonance frequency for different defect types.
Spin torque on pinned domain walls

(Pure translation: $\epsilon'_L = 0$ or $\epsilon'_G = \alpha \epsilon$)

Ni$_{80}$Fe$_{20}$ strip, 300 nm wide, 12 nm thick.
Spin torque on pinned domain walls
("Pure translation")

\[ \langle m_x \rangle \]

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure}
\caption{Graph showing the trend of \( \langle m_x \rangle \) with respect to current (mA).}
\end{figure}

\begin{axis}[
    xlabel=Current (mA),
    ylabel=\( \langle m_x \rangle \),
    xmin=0, xmax=5,
    ymin=-0.036, ymax=-0.030
]\end{axis}