Finite Difference Micromagnetics

Michael J. Donahue

National Institute of Standards and Technology
Gaithersburg, Maryland

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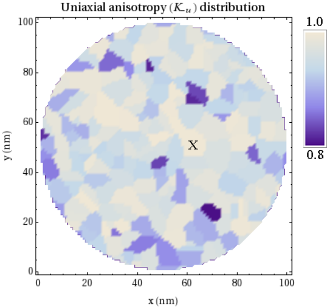
OOMMF is an experimental system. NIST assumes no responsibility whatsoever for its use by other parties, and makes no guarantees, expressed or implied, about its quality, reliability, or any other characteristic.

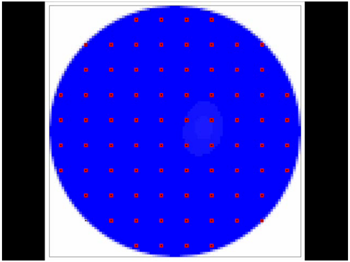
Portable, extensible, public domain programs & tools for micromagnetics

http://math.nist.gov/oommf

- Finite difference code
- Rectangular elements
- FFT-base demag
- Fully 3D
- Landau-Lifshitz & energy minimization solvers
- Time varying applied fields
- All parameters ptwise adj.

Contacts: Michael Donahue, Donald Porter





Movie credit: June Lau

Finite difference methods

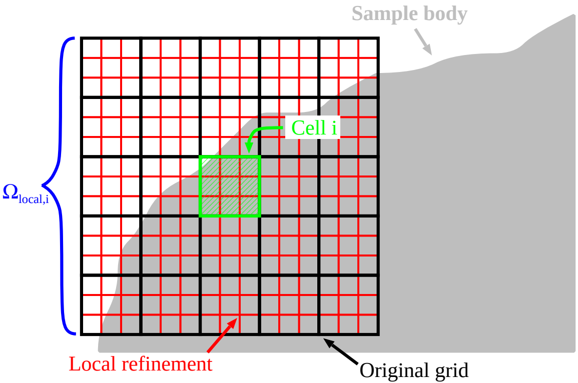
Advantages:

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

Disadvantages:

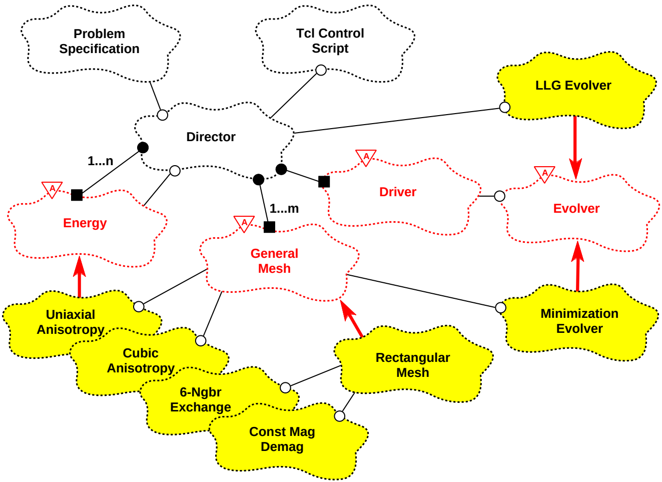
- "Stairstep" edges on curved boundaries

Curved boundary corrections



M.J. Donahue and R.D. McMichael, *IEEE Trans Magn*, **43**, 2878–2880 (2007).

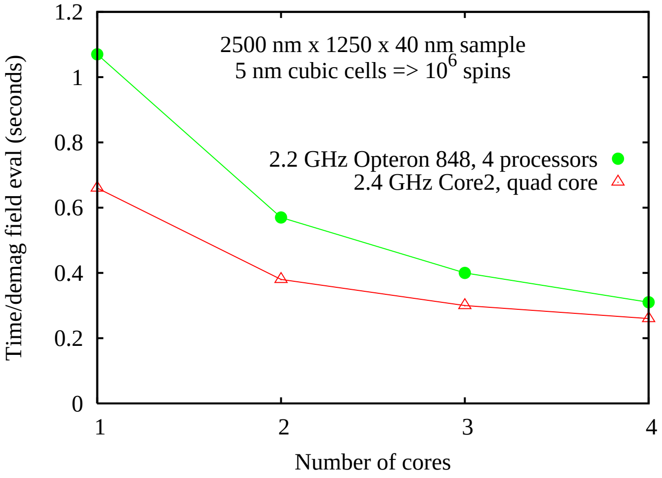
OOMMF class structure

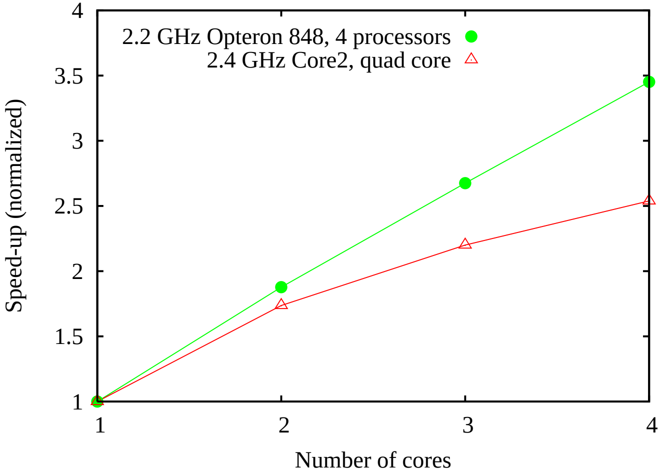


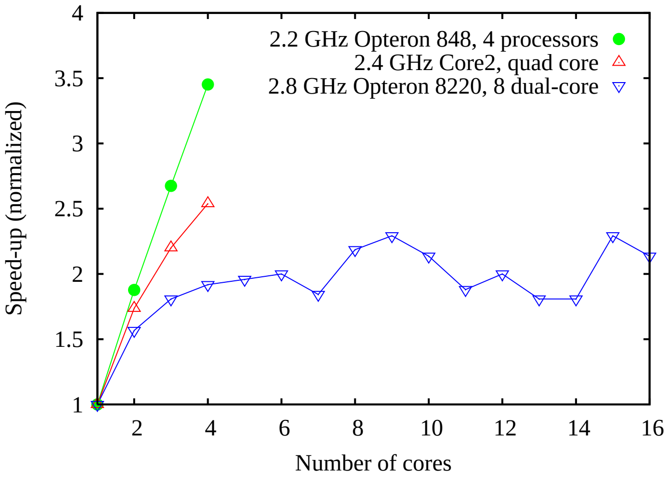
OOMMF 3rd party extensions

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

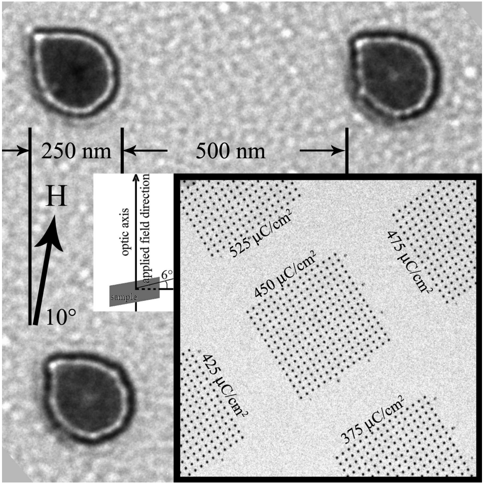
Parallel processing




2.2 GHz Opteron 848, 4 processors
2.4 GHz Core2, quad core
Speed-up (normalized)
Number of cores
4
3.5
3
2.5
2
1.5
1
1
2
3
4

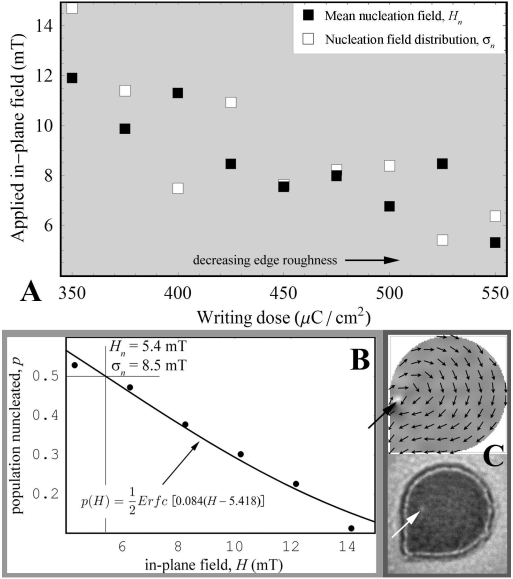

2.2 GHz Opteron 848, 4 processors
2.4 GHz Core2, quad core
2.8 GHz Opteron 8220, 8 dual-core
Speed-up (normalized)
Number of cores
1
1.5
2
2.5
3
3.5
4
2
4
6
8
10
12
14
16

Edge study



J.W. Lau, R.D. McMichael, M.A. Schofield and Y. Zhu, JAP **102**, 023916 (2007).

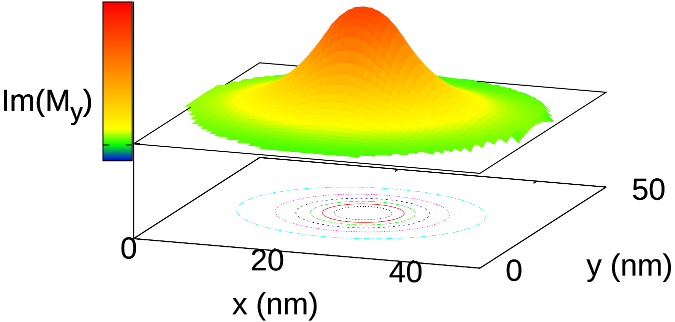
Edge study



Mean nucleation field, H_n
Nucleation field distribution, σ_n
Applied in−plane field (mT)
decreasing edge roughness
A
Writing dose (μC / cm^2)
350 400 450 500 550
6 8 10 12 14
H_n = 5.4 mT
σ_n = 8.5 mT
B
population nucleated, p
0.5 0.4 0.3 0.2
$p(H) = \frac{1}{2} Erfc\,[0.084(H - 5.418)]$
in-plane field, H (mT)
6 8 10 12 14
C

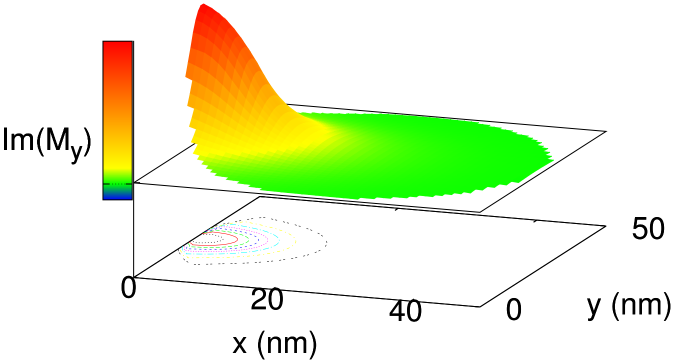
Mode simulations

50 nm CoPd disk, 12 nm thick:

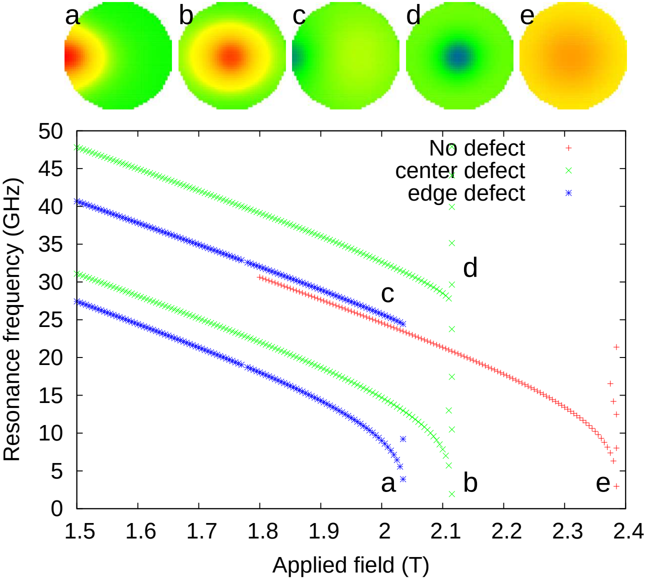


Credits: J. Shaw, J. Lau, R. McMichael; see also poster FT-03

Mode simulations

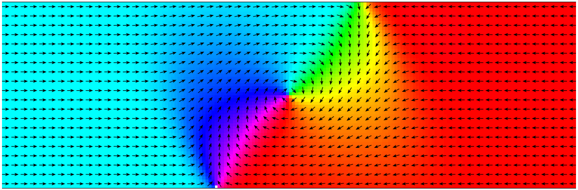


Defect spectroscopy

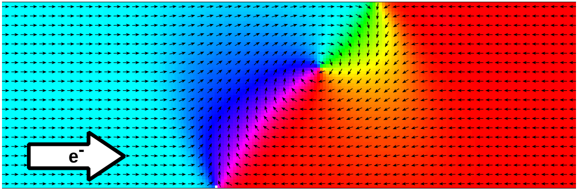


Spin torque on pinned domain walls

(Pure translation: $\epsilon'_{LL} = 0$ or $\epsilon'_{G} = \alpha\epsilon$)



(a)



(b)

$Ni_{80}Fe_{20}$ strip, 300 nm wide, 12 nm thick.

Spin torque on pinned domain walls

("Pure translation")