Nanophotonic Modeling
Lecture 3.4: MEEP: An FDTD Solver

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FDTD Stability

- Stiff solvers: for ODEs with a rapid harmonic oscillation, use backward differentiation formulae:
  \[
  \sum_{i=0}^{M} c_i y_{n+i} = \Delta t \cdot f(t_{n+M}, y_{n+M})
  \]
- Convergence can be orders of magnitude better
- Implemented with ode15s in MATLAB
Special Features of MEEP

- Arbitrary dimensionality, boundary conditions
- Perfectly matched layers
- Subpixel averaging
- Symmetry and parallelization
- Fully programmable
- Nonlinear and saturable gain media
- Frequency-domain solver
Perfectly Matched Layers

Subpixel Averaging

Symmetry and Parallelization

Using the Scheme Interface

```
(set! geometry-lattice (make lattice (size 16 8 no-size)))
(set! geometry (list
  (make block (center 0 0) (size infinity 1)
    (material (make dielectric (epsilon 12)))))))
(set! pml-layers (list (make pml (thickness 1.0))))
(set! sources (list
  (make source
    (src (make continuous-src (frequency 0.15)))
    (component Ez)
    (center -7 0))))
(set! resolution 10)
(run-until 200
  (at-beginning output-epsilon)
  (at-end output-e-field-z))
```

HDF5 file → plotting program