A CSE Sampler

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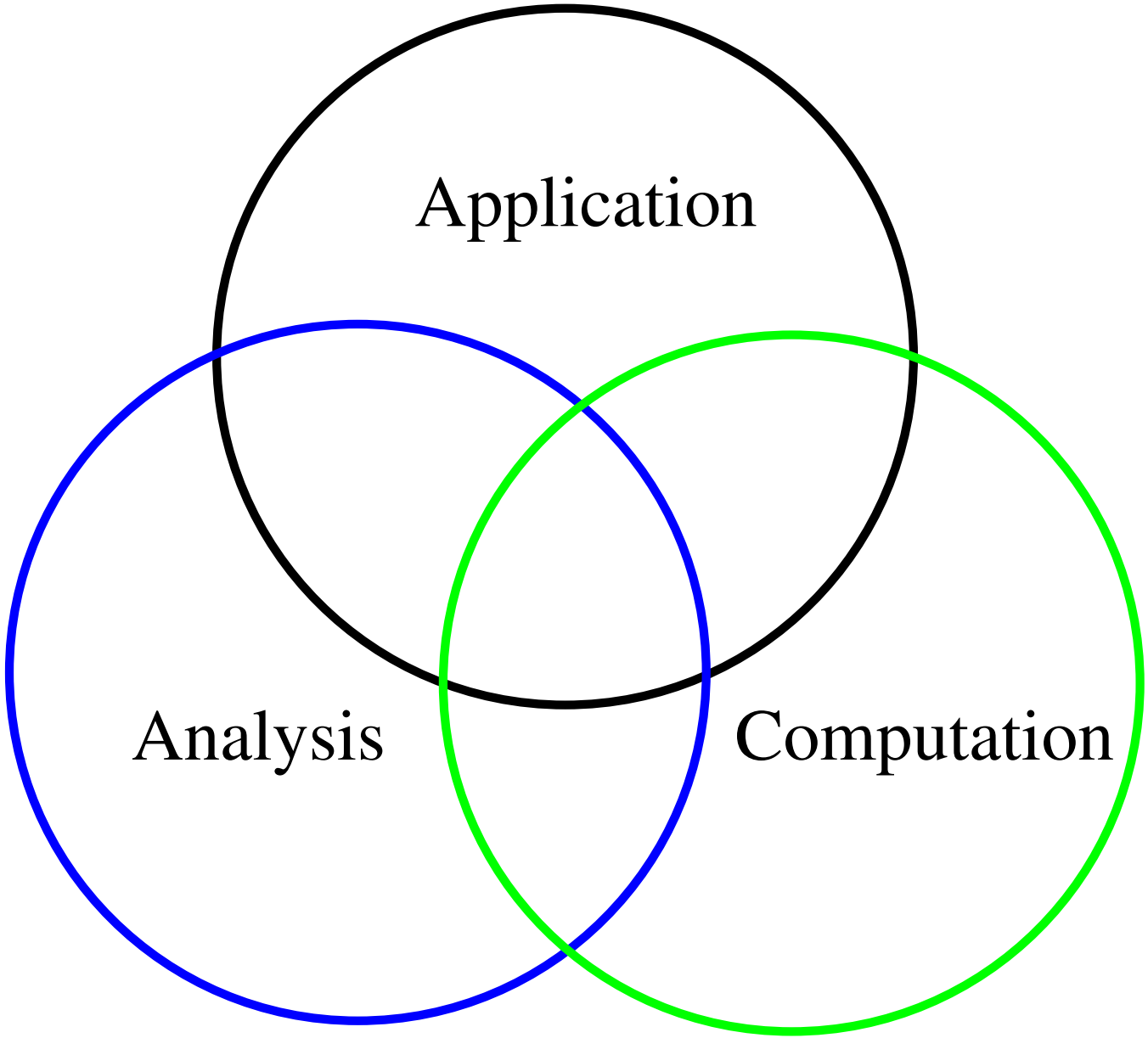
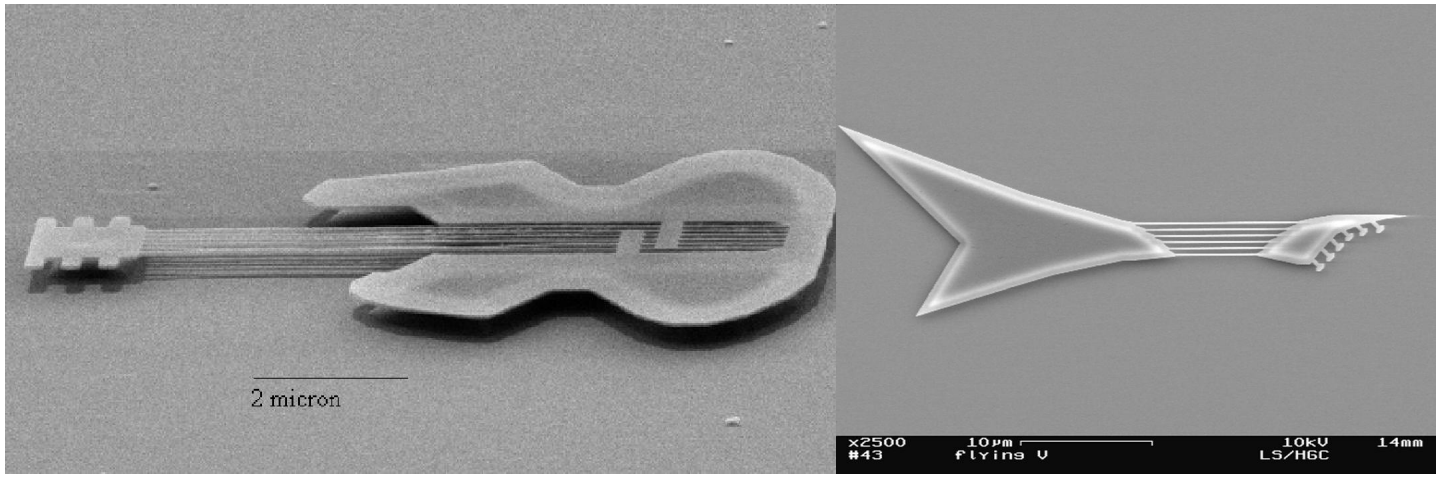
8 Mar 2011

The Computational Science & Engineering Picture



Application: Resonating MEMS



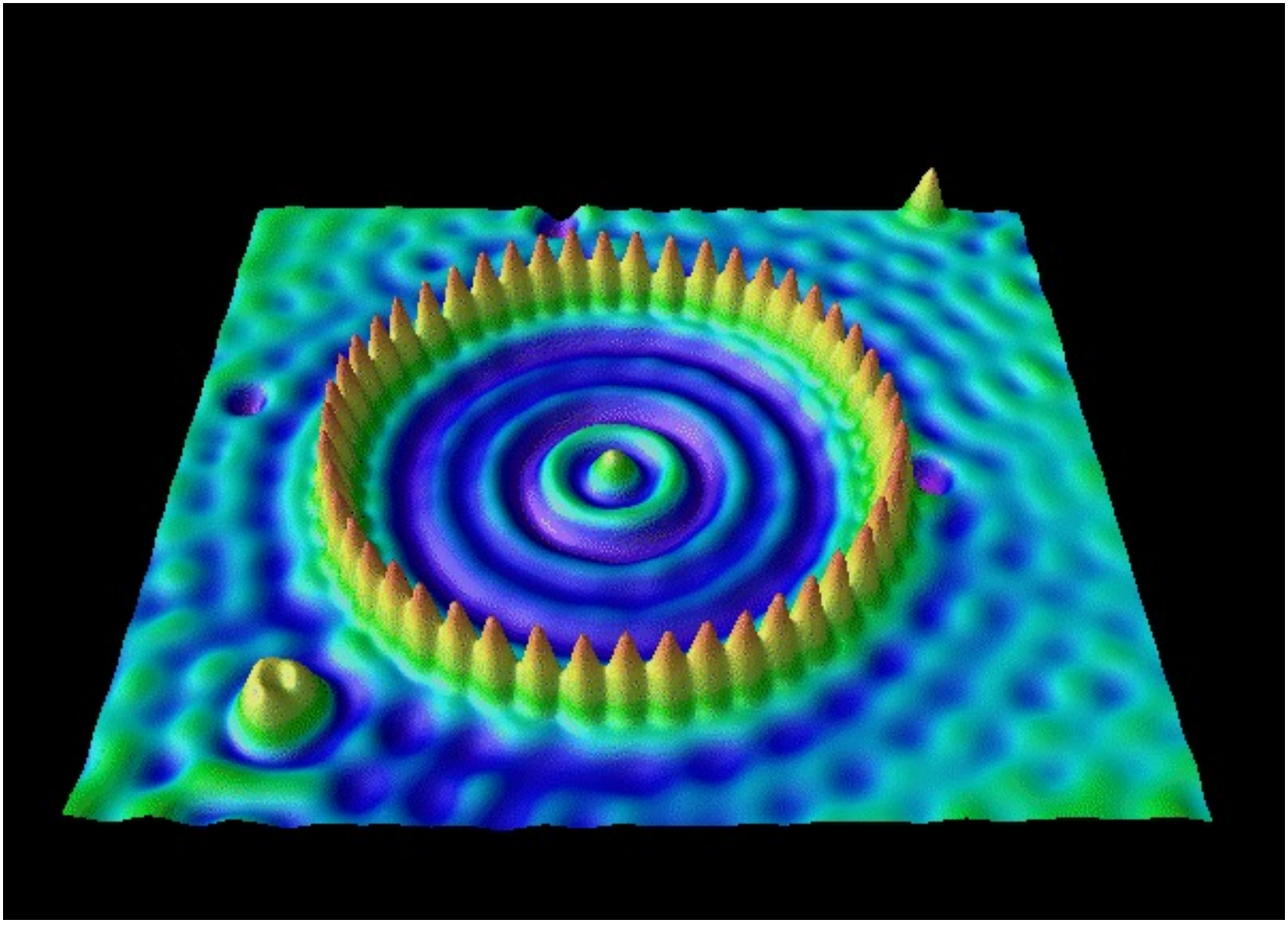
Microguitars from Cornell University (1997 and 2003)

- MEMS = Micro-Electro-Mechanical Systems
- Micron-scale *mechanical* structures with IC fab technology
- Widely used for sensing and signal processing ...
- ... and sometimes really high-pitch guitars!

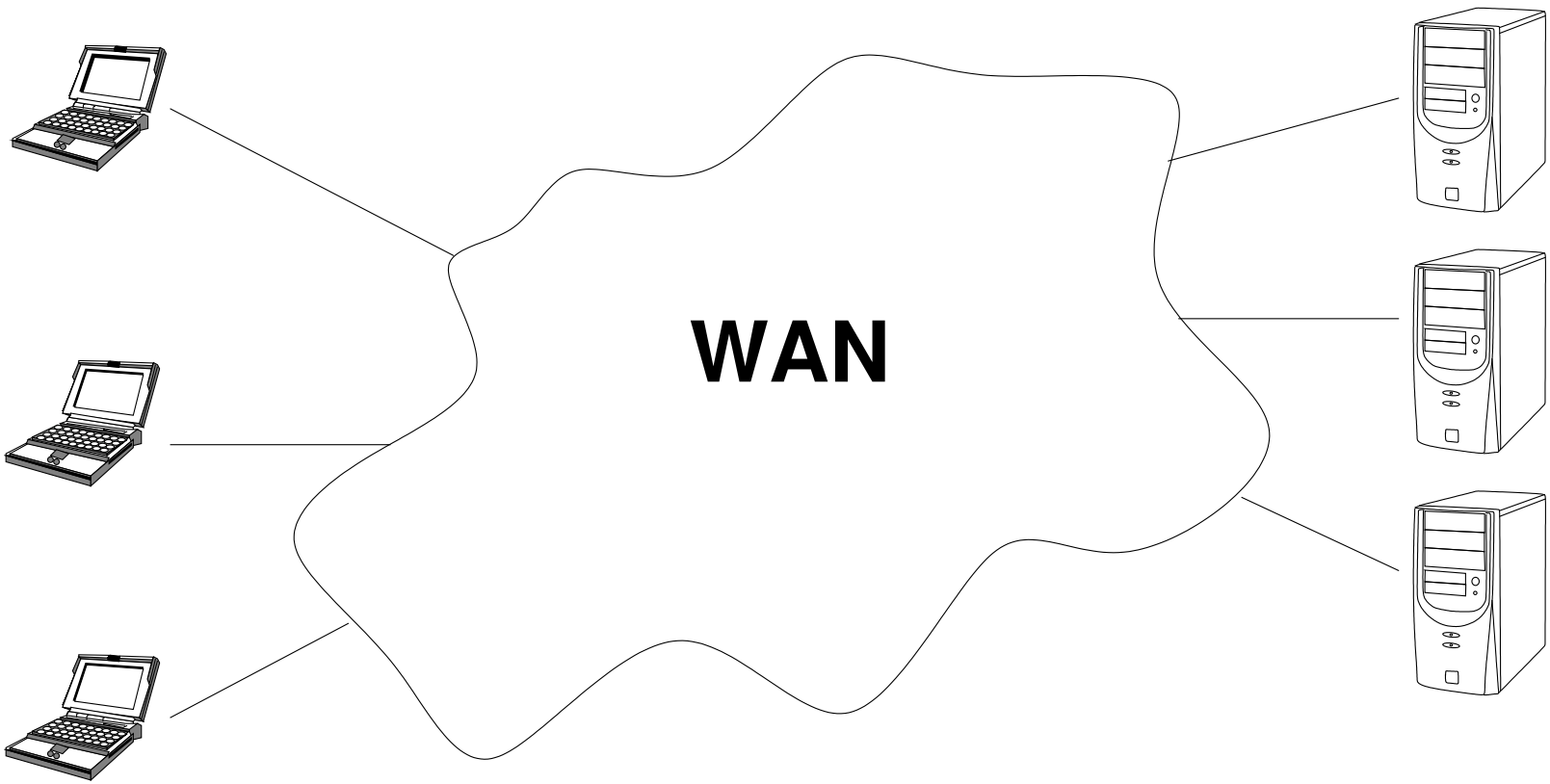
Current example: Micro-HRG / GOBLiT / OMG

- This is a gyroscope!
- We want to make it 1mm across.
- Collaborator roles:
  - Basic design
  - Fabrication
  - Measurement
- Our part:
  - Detailed physics
  - Fast software
  - Sensitivity
  - Design optimization

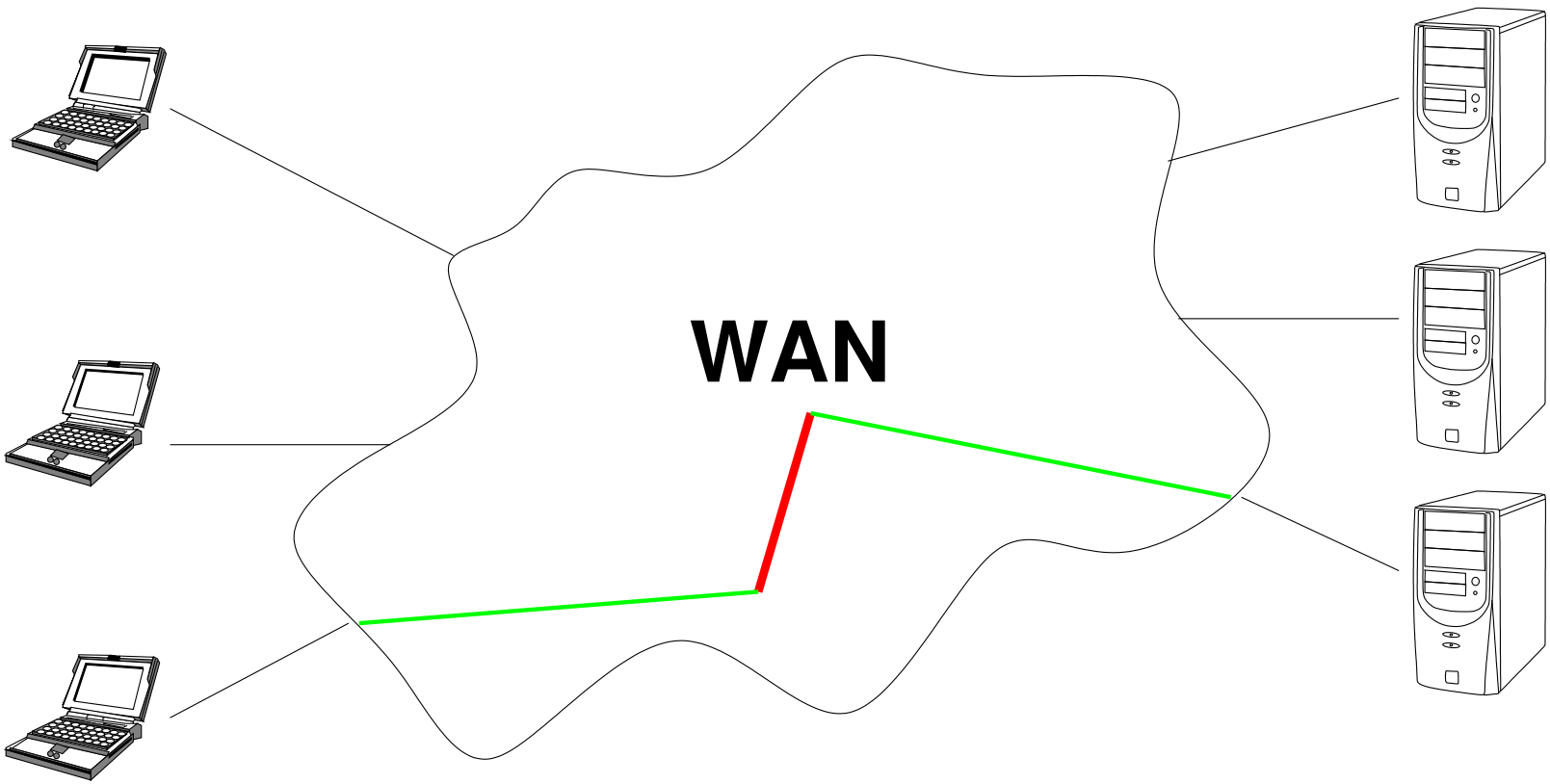
Application: Resonance and Metastable Behavior



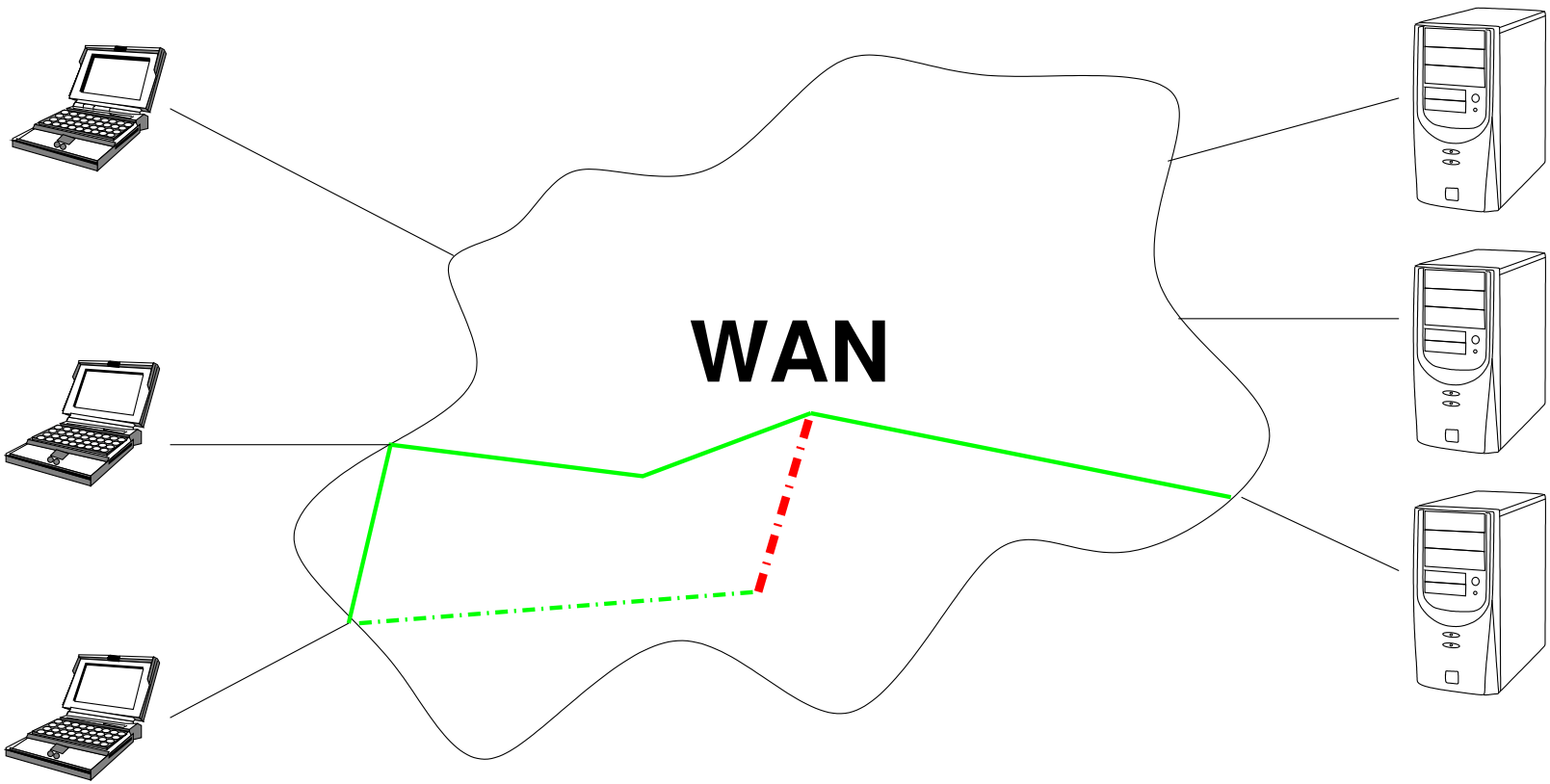
Application: Computer Network Tomography



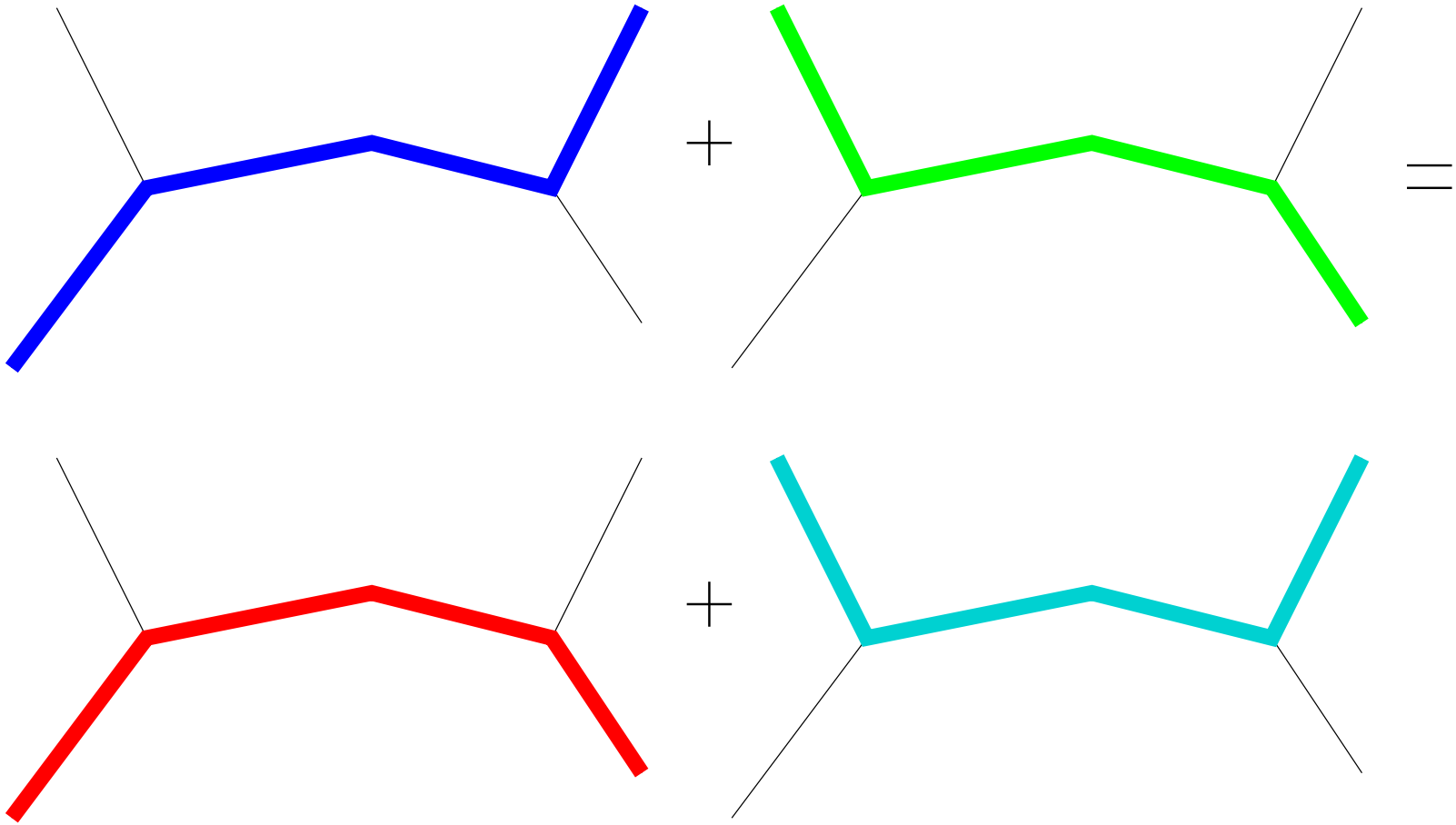
A Possible Problem



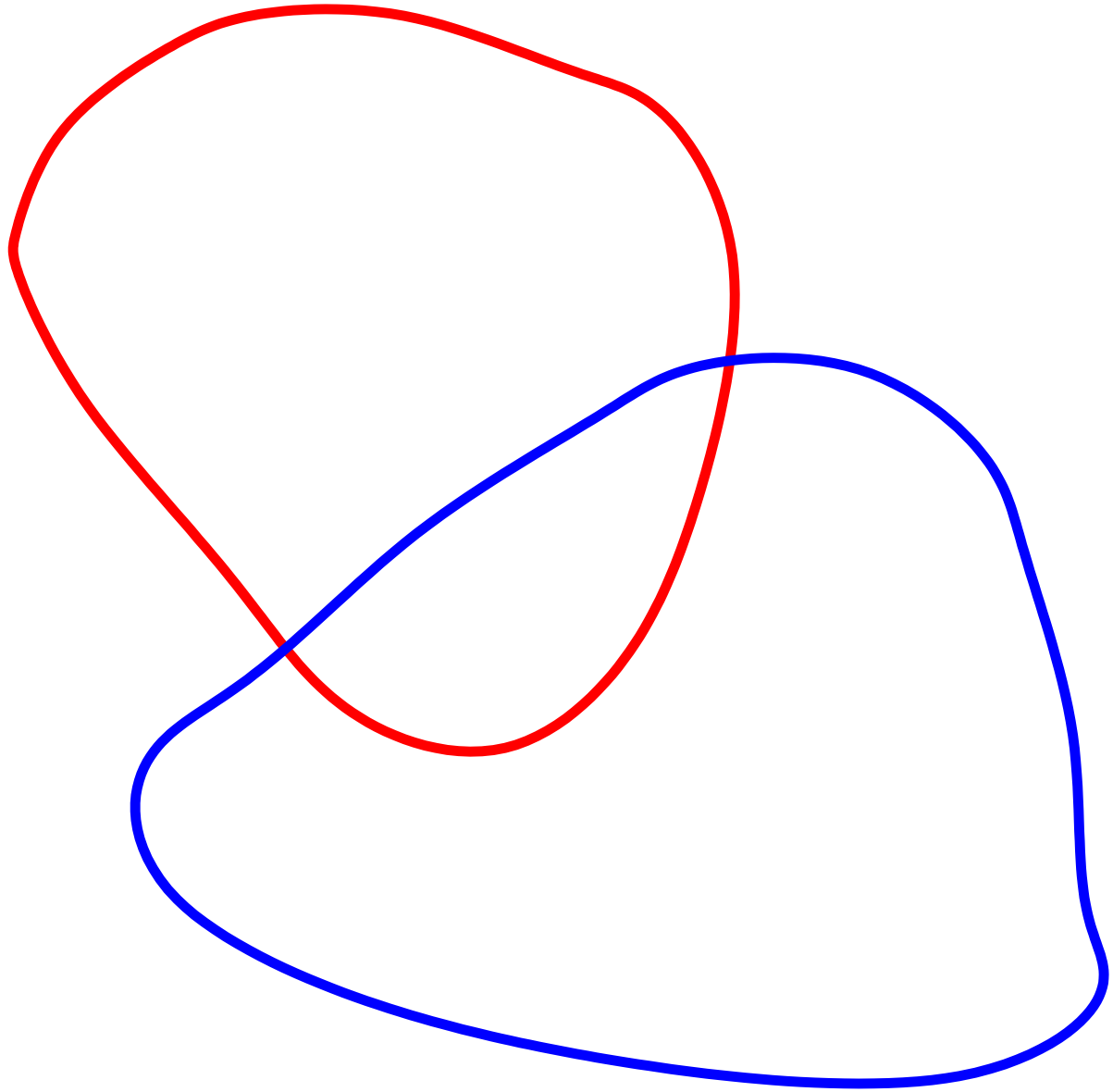
Find and Fix or Route Around?



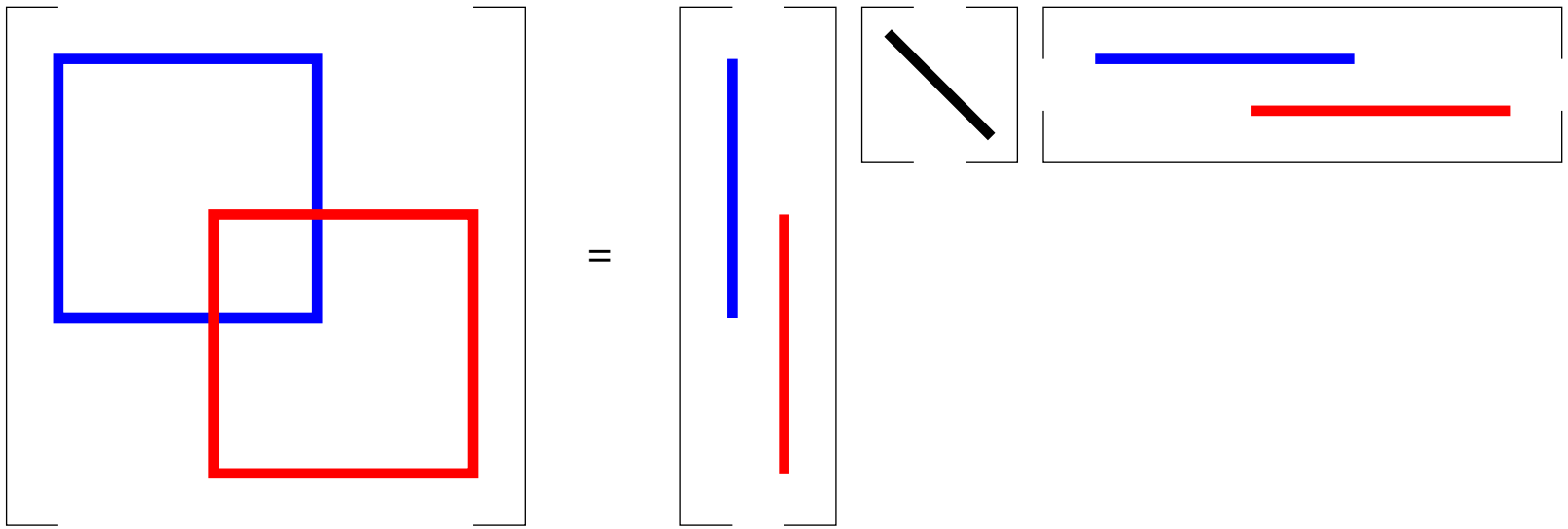
Linear Algebra of Paths



Application: Detecting Overlapping Communities

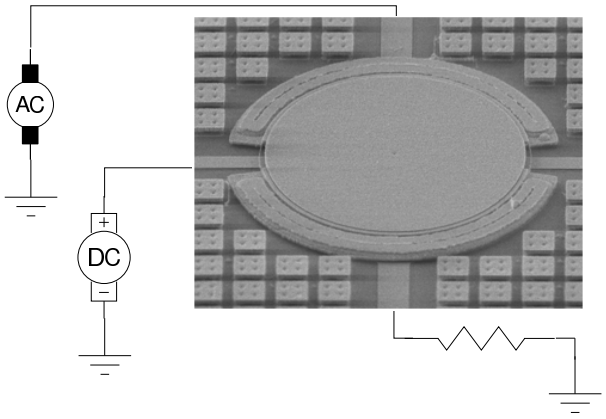


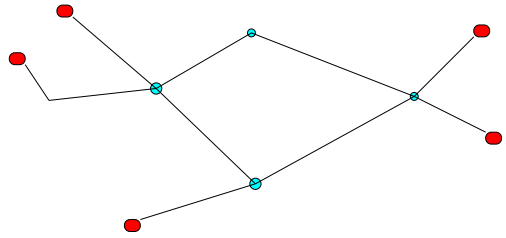
Linear Algebraic View

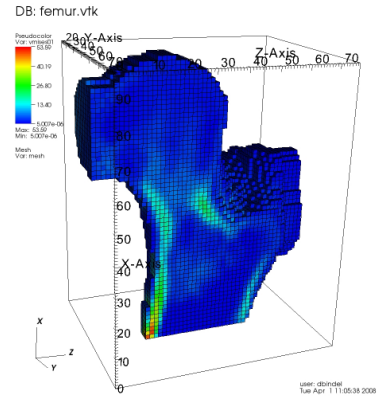


$$\hat{A} \approx CDC^T$$

- Find dominant subspace for range of $\hat{A}$
- Find sparse indicator vector in space (linear programming)
- Deflate and repeat to decompose A







Application modeling

Analysis ⟷ Algorithms and software

$\rho\ddot{u} = \nabla \cdot \sigma$

$Ax = b$

$Ax = \lambda x$

HiQLab, Matscat, ...

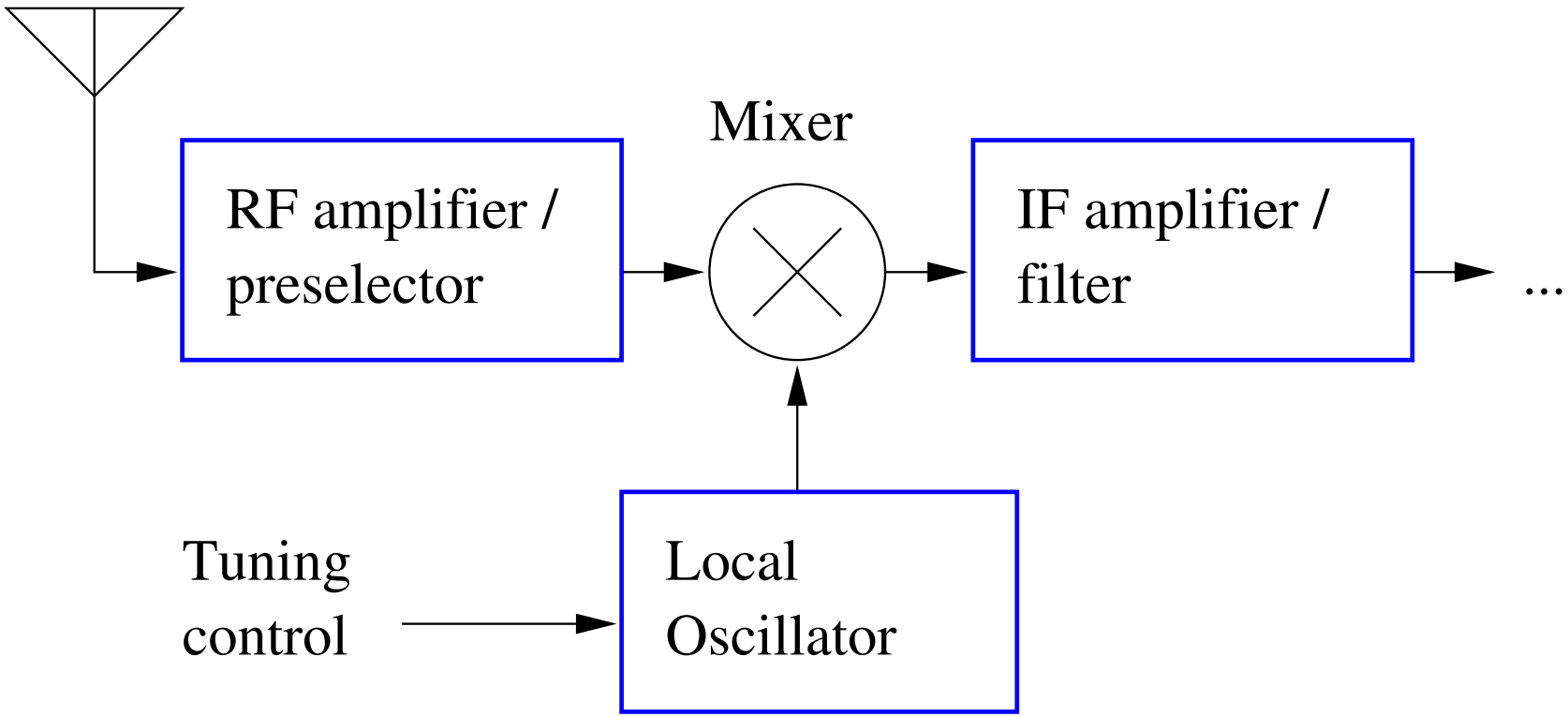
Model reduction methods

Structured linear solvers

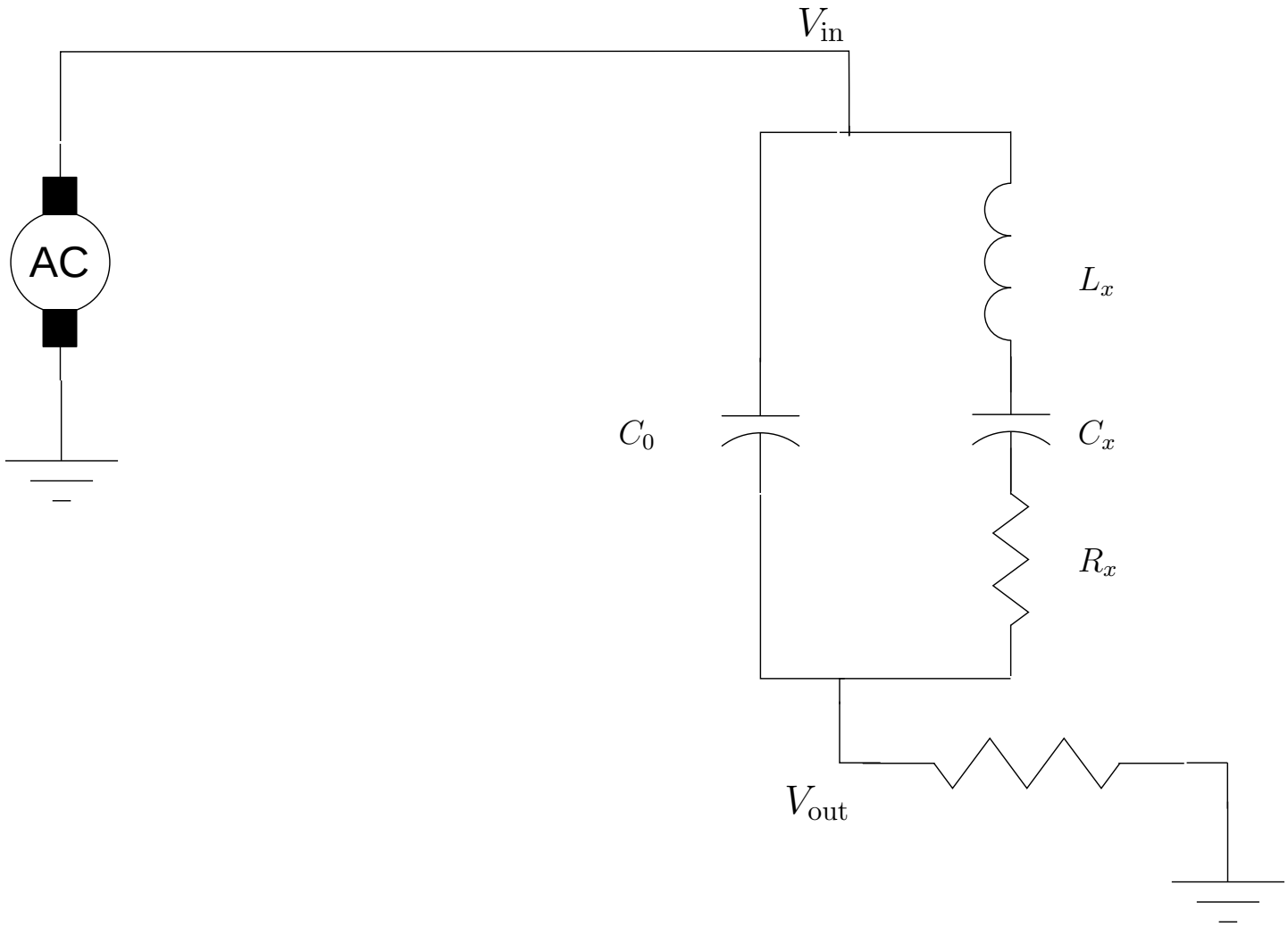
http://www.cs.cornell.edu/~bindel

Application: Better Radio Devices

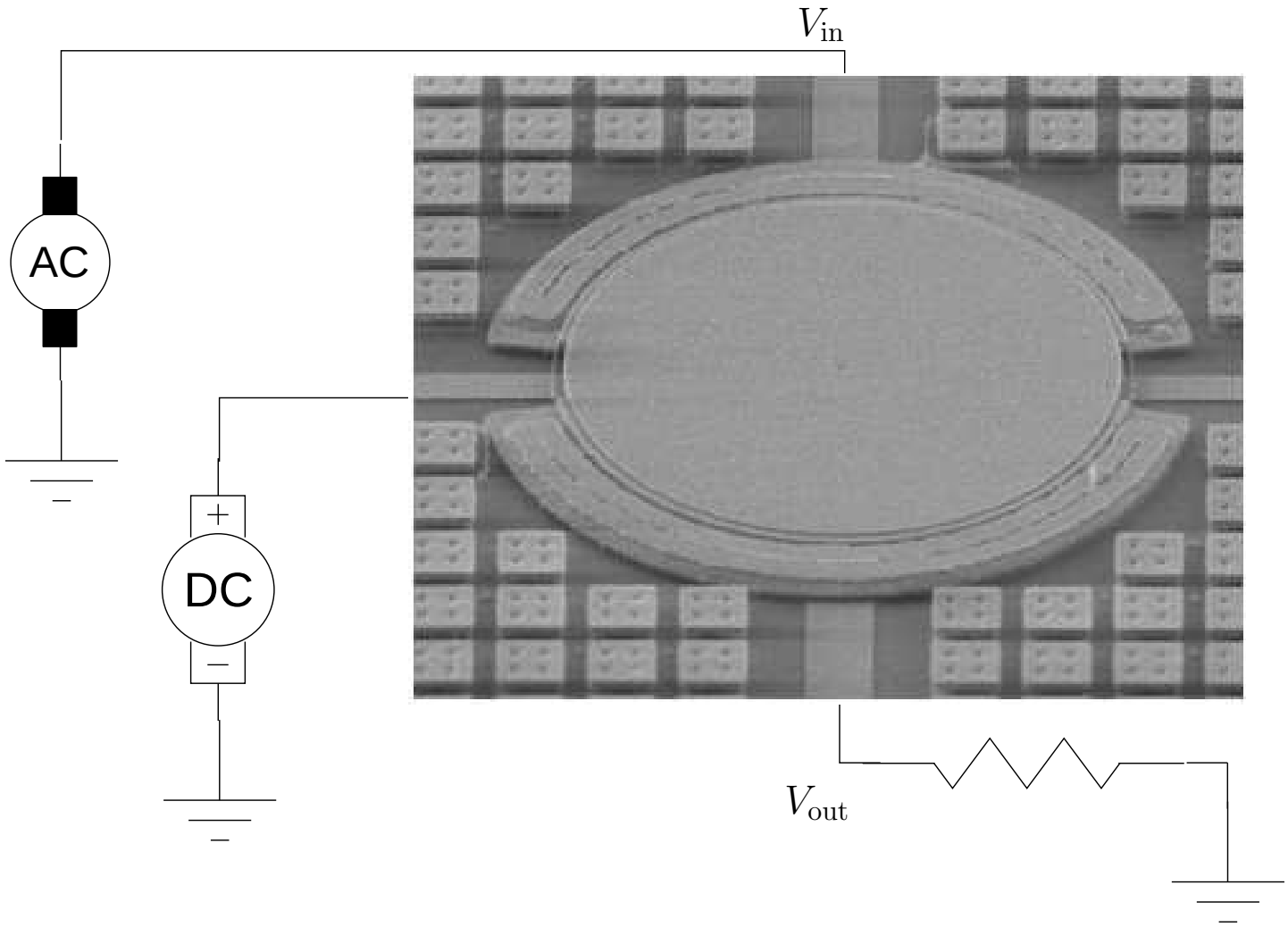
The Mechanical Cell Phone



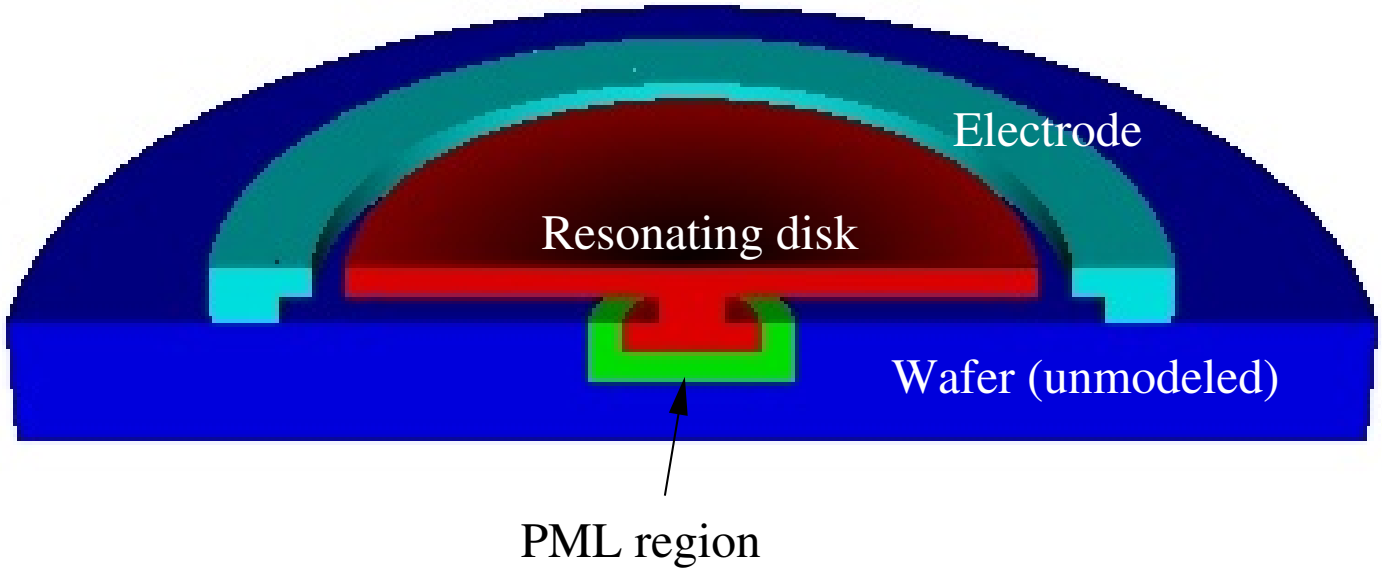
A Simple Circuit



An Electromechanical Circuit



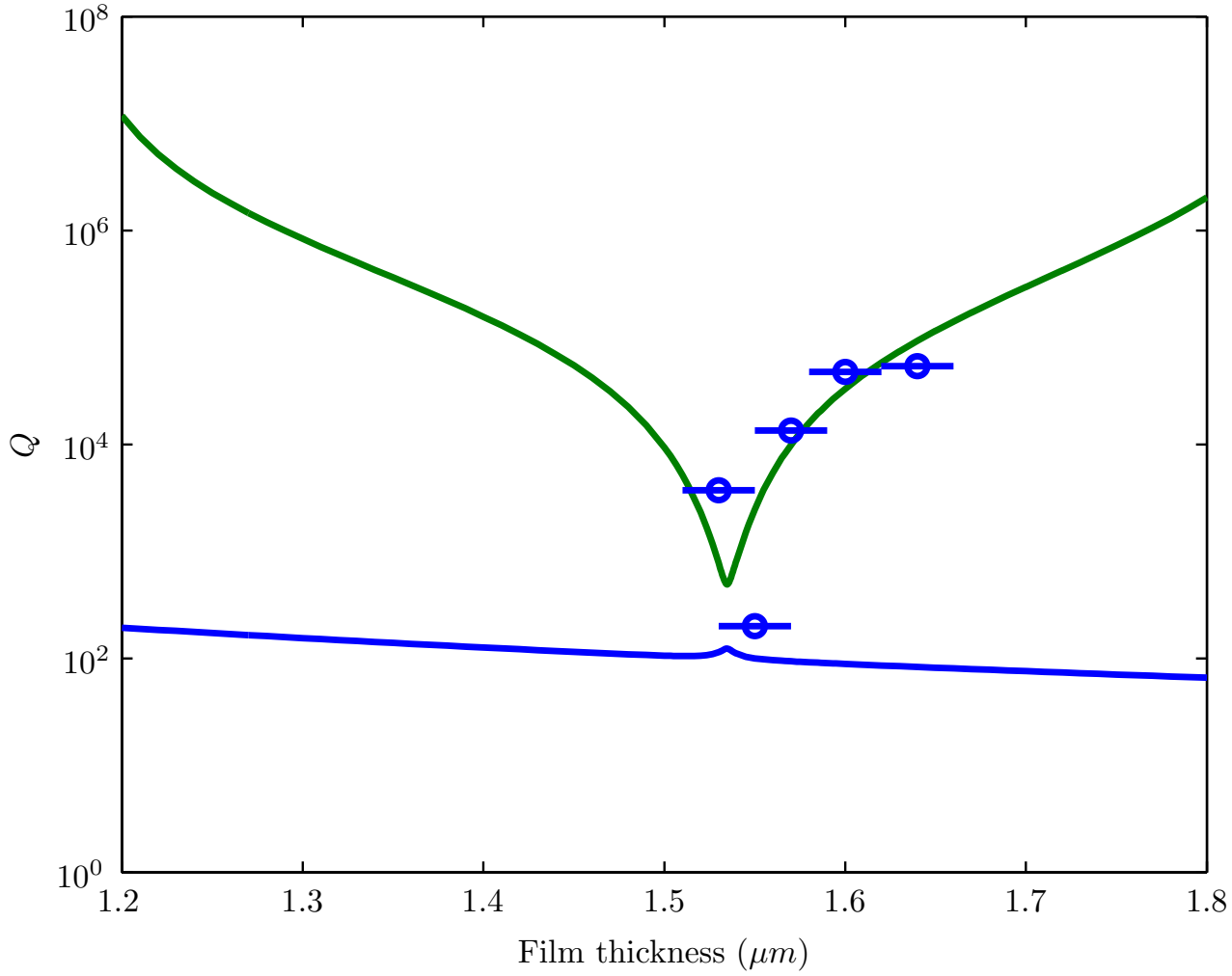
Modeling Damping and Radiation



Ingredients:

- Physics: Radiation, thermoelasticity
- Numerics: Structured eigensolvers, model reduction
- Software: HiQLab

Damping: Devil in the Details!



Simulation and lab measurements vs. disk thickness