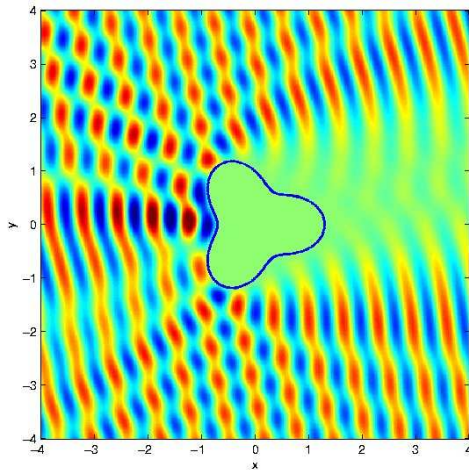


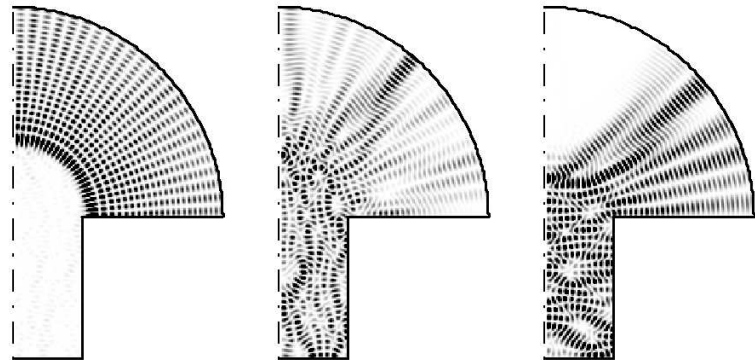
Numerical methods for PDEs and waves

Alex Barnett, Fall 2008, Tu & Th 10:00-11:50am (10A),



2D wave scattering from an obstacle

Questions / input? ahb@math.dartmouth.edu



mushroom eigenmodes: integrability vs quantum chaos

The Laplace equation (describing steady-state diffusion, heat flow, electrostatics) and Helmholtz equation (linear waves, acoustics, electromagnetics, optics, quantum) are linear PDE boundary value problems, ubiquitous in modeling the real world. They may be solved numerically by recasting the problem onto the boundary; this is often more accurate, easier to code, and more efficient at short wavelengths than standard discretization methods (FEM, etc). You will build codes, understand convergence, pick up useful numerical tools along the way, and explore some high-frequency wave phenomena.

Hands-on numerical exploration, current mathematics, and beautiful pictures!

Tentative outline: Overview of PDEs; Conditioning and stability, numerical linear algebra; Integration and quadrature, spectral methods; Integral equations, compact operators, Nyström method; Potential theory; Interior and exterior Laplace BVP; Interior and scattering Helmholtz BVP; Method of Particular Solutions, eigenvalue (resonance) problems, expansion at corners; High-frequency asymptotics of waves, ray theory, quantum chaos.

Optional topics/projects: Isospectral drums, quadrature for corners, Vekua's theory of analytic PDEs, transmission BVPs, periodic lattices, Fast Multipole Method, eigenmodes of manifolds of constant curvature...

- Homeworks: weekly, mostly computer coding investigations (in a language of your choice, *e.g.* Matlab, C, C++, Maple), plus some pencil-and-paper theory/proofs.
- Project: during the final few weeks you will choose then work on a topic, give a class presentation and short write up. *See website for past projects*

Prerequisites: Math 22 (lin alg), 23 (diff eq). Very helpful: 43 (complex), 46 (applied math), 35/63 (real analysis). Some computer programming highly recommended. Undergraduates welcome by permission of instructor.