18.086, Spring 2016

Introduction

Syllabus, Psets etc.

- Course website: http://math.mit.edu/~stoopn/18.086/
- 3 PSets (50% grade)
- Computational project & presentation (50% grade)
- Office hours: TBA

Schedule

- Check updated detailed schedule on the course website
- Rough schedule:

February	Finite differences, stability/accuracy, conservation laws
March	Conservation laws, finite volume, levelset methods
April	Solving large linear (and maybe nonlinear) systems, Newton-Krylov methods etc., Optimization
May	Optimization/minimzation problems, N-body problems, project presentations

Course book

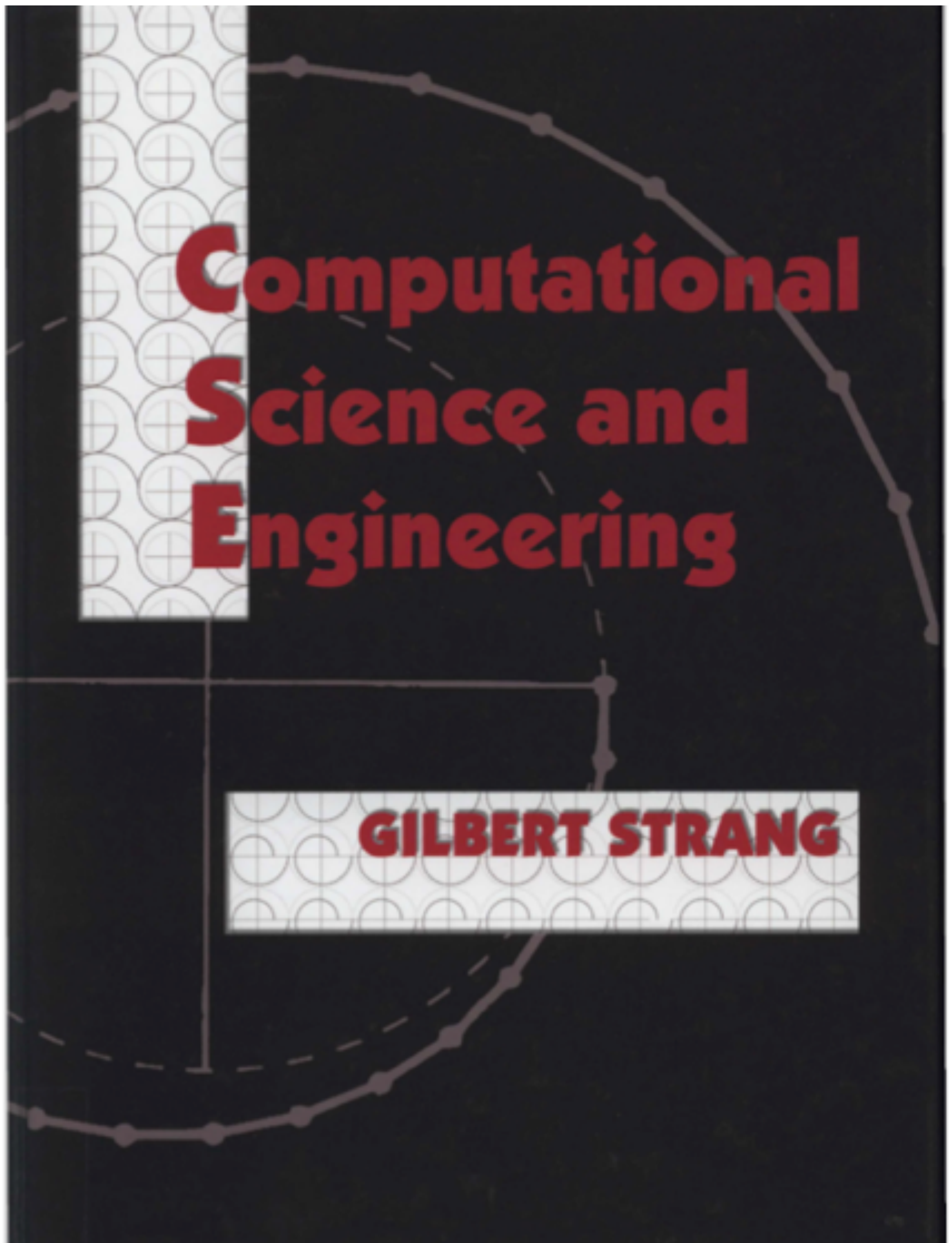


Table of Contents

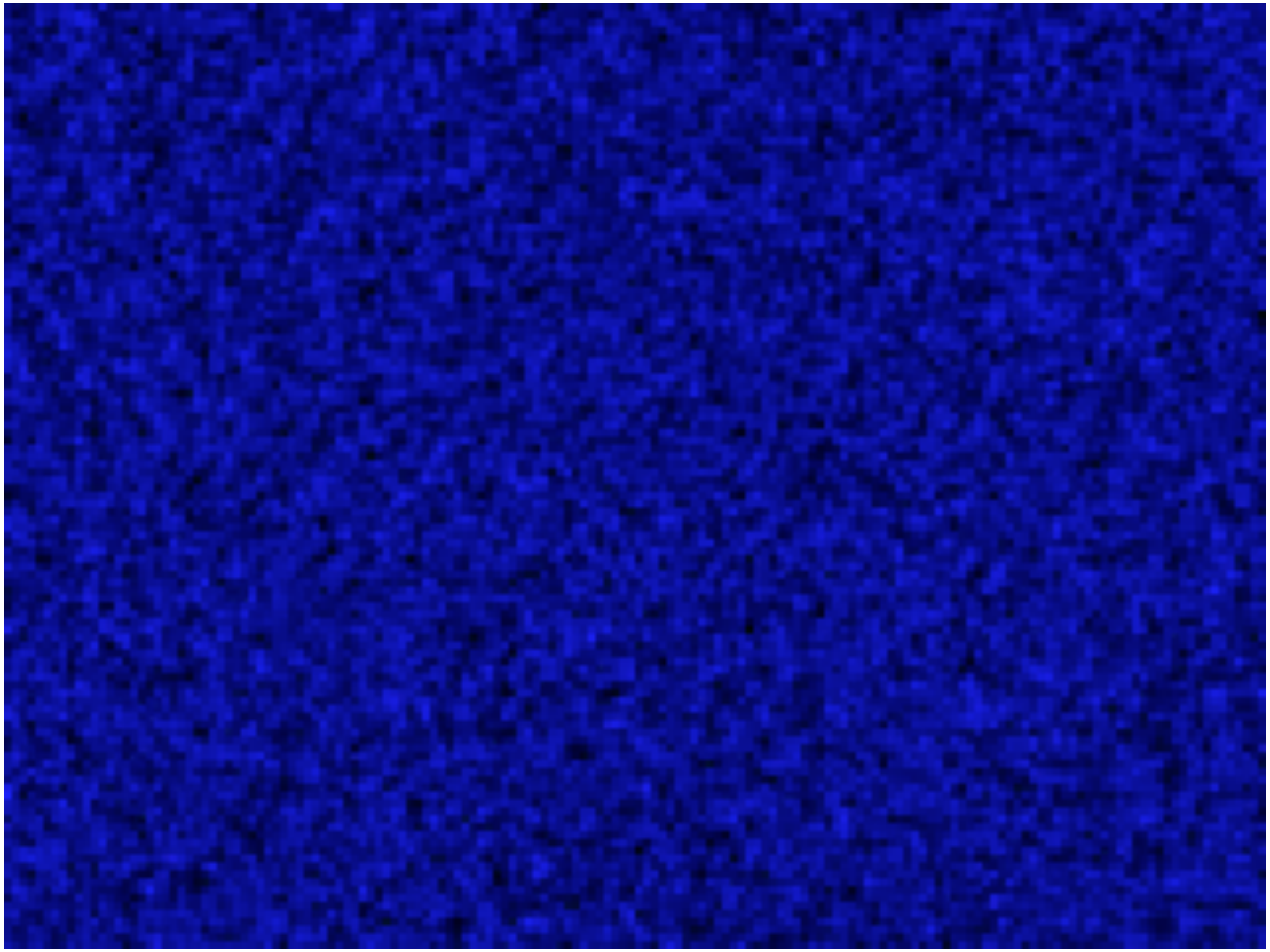
Prerequisites

- Calculus: Gradients/Divergence, Volume/Area/Line integrals, Stokes/Gauss-Theorem
- Linear Algebra: Matrices/Vectors, Eigenvalues and -vectors
- Basic differential equations (ODE/PDE) (18.08)
- Programming: C/C++, Matlab, Mathematica, Python…

Turbulent mixing

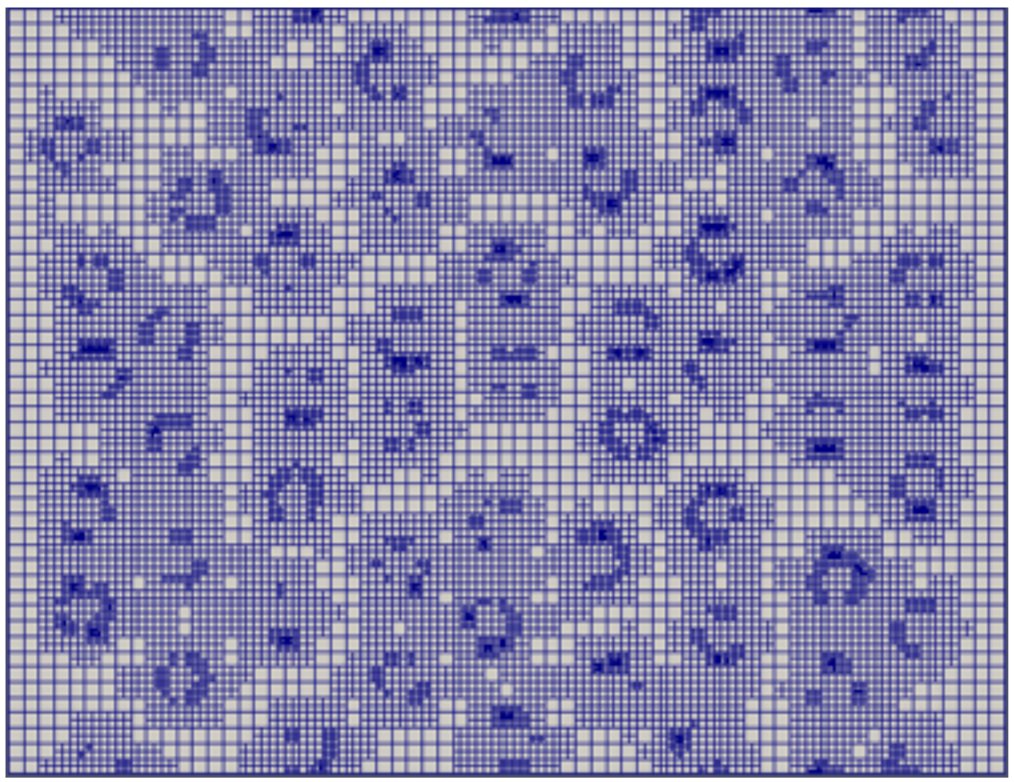
https://www.youtube.com/watch?v=OM0l2YPVMf8

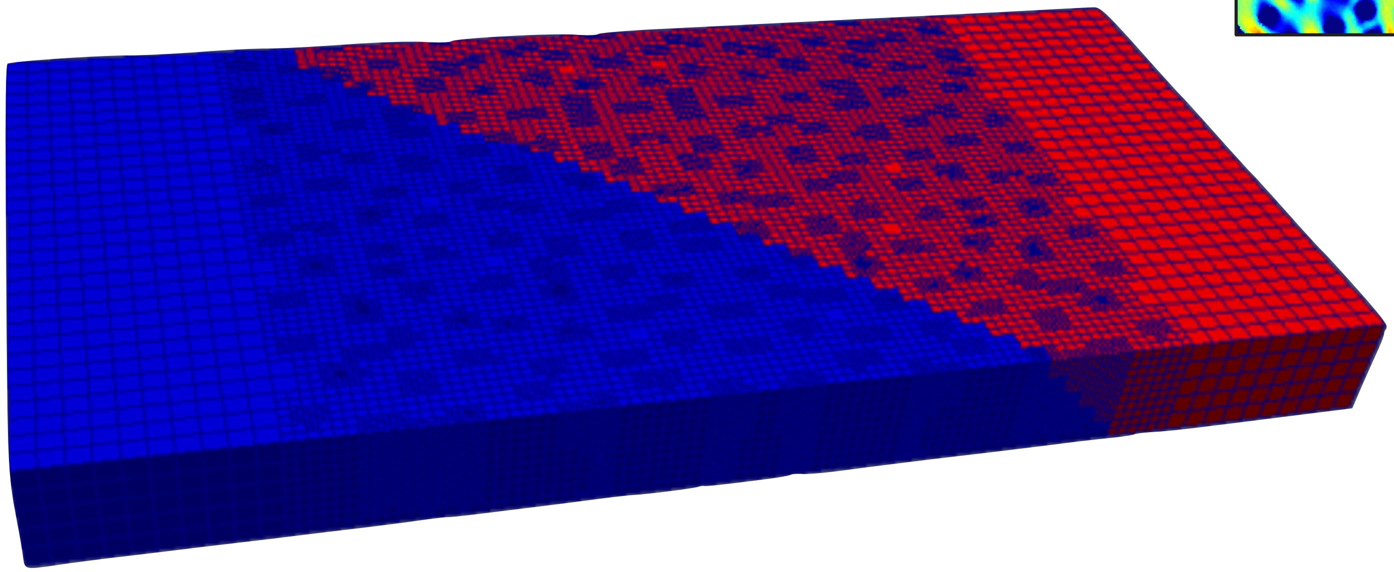
Rayleigh-Bernard convection

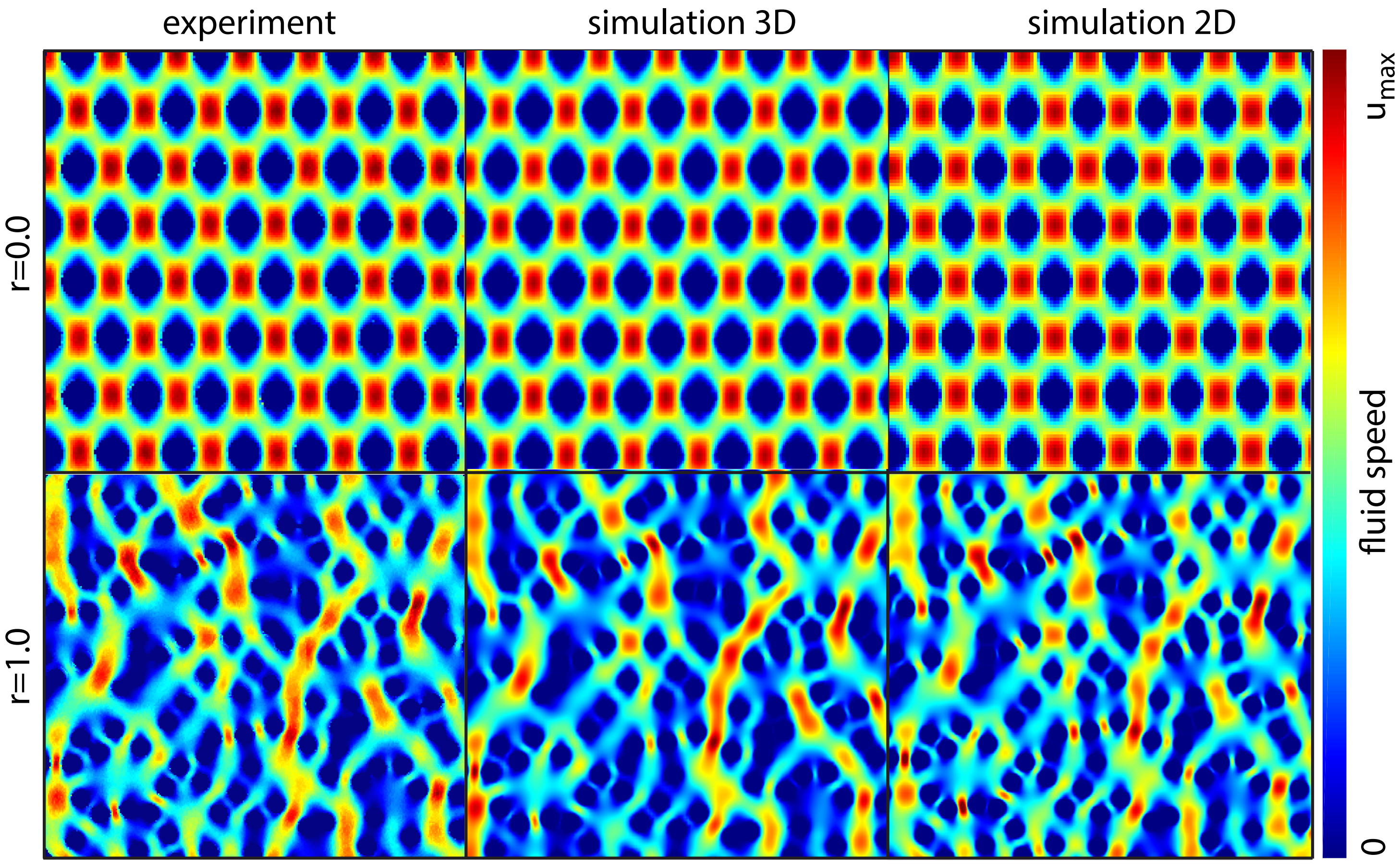


https://www.youtube.com/watch?v=X5h6hbCxjz8

Flow in porous media

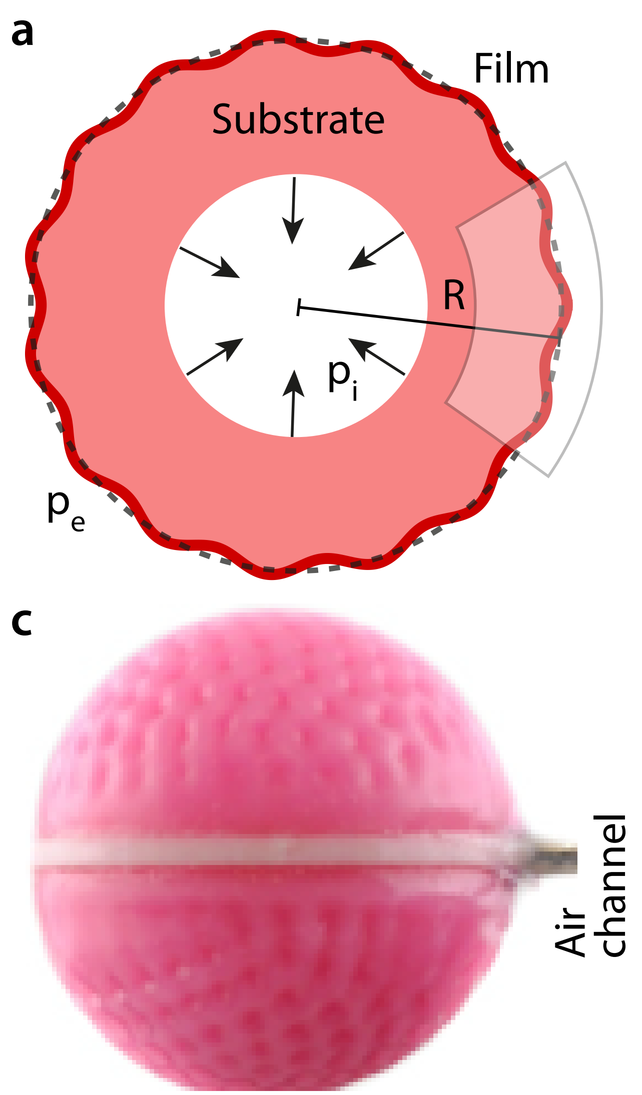




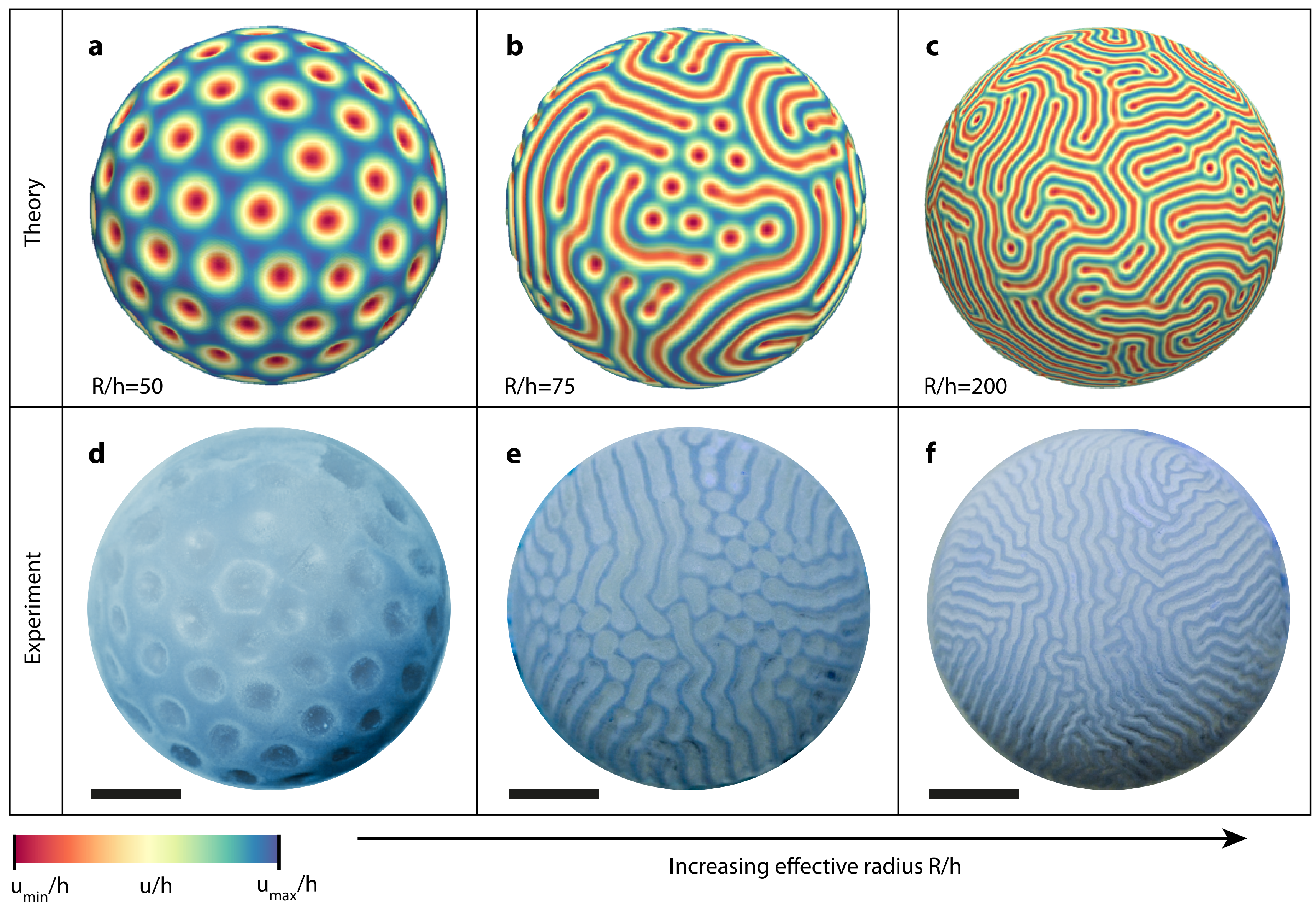


Surface patterns

$$\partial_t u \;=\; \gamma_0 \triangle u - \gamma_2 \triangle^2 u - au - bu^2 - cu^3 + (\Gamma_1 + \Gamma_2 u) \cdot \left[(\nabla u)^2 + 2u\triangle u\right]$$

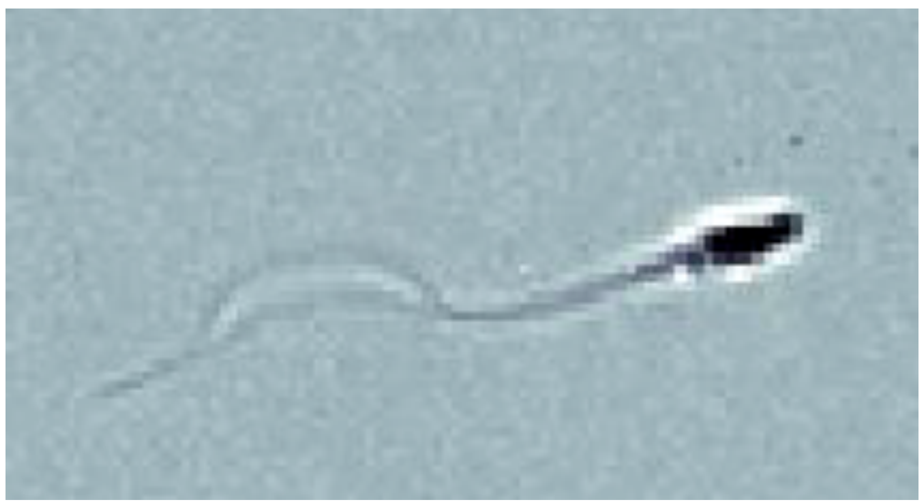


D. Terwange et. al., Adv. Mat. 2014



3D flagellar beat reconstruction of human sperm cells: **optimization**!

- 2D microscopy:



Propagation of scattered field:

$$h(x',y',z') = \frac{1}{2\pi}\frac{\partial}{\partial z'}\frac{\exp(ikr')}{r'}$$

Where to put scatterers to best "fit" observed scattering pattern? => optimization problem!