

Lattice-Boltzmann method

a short course for Engineering PGR students

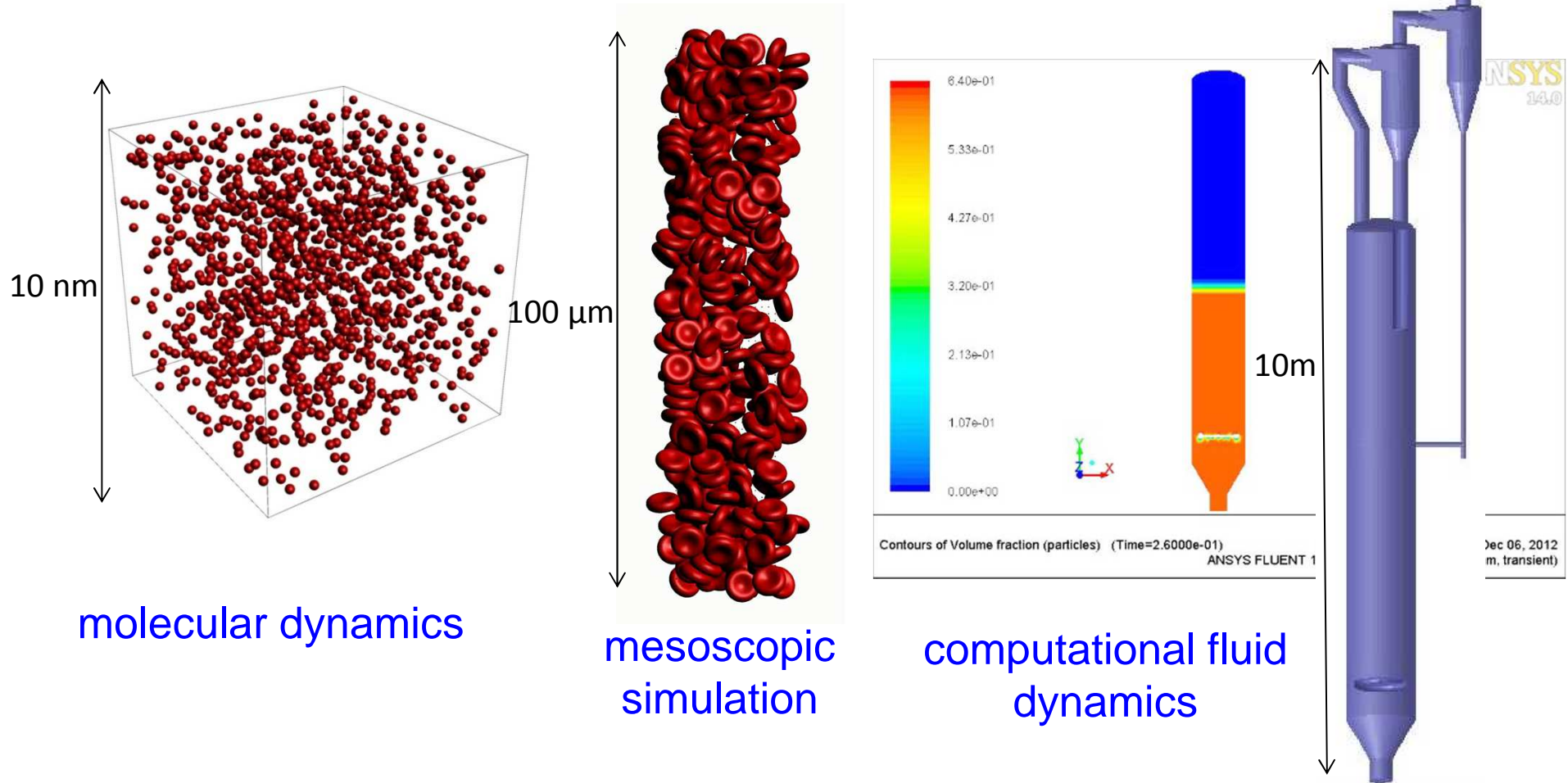
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Five lectures & five sets of lecture notes

- Kinetic theory
 - Distribution functions*
 - Boltzmann equation*
 - Transport equations
- Lattice-Boltzmann (LB) method
 - Discrete space, time & velocity
 - An LB algorithm
 - Chapman-Enskog analysis*
- Practical aspects of the LB method
 - Dimensional analysis
 - Boundary conditions
 - Coding
- Forces, collision operators, turbulence
- Multiphase flow
 - Free energy LBM & interfaces*
 - Volume-averaged Navier-Stokes equation

Microscopic Mesoscopic Macroscopic



molecular dynamics

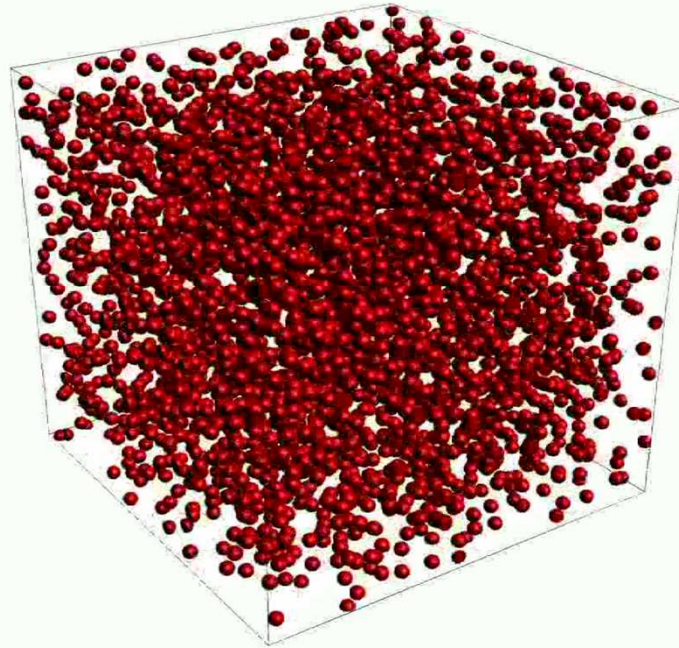
mesoscopic simulation

computational fluid dynamics



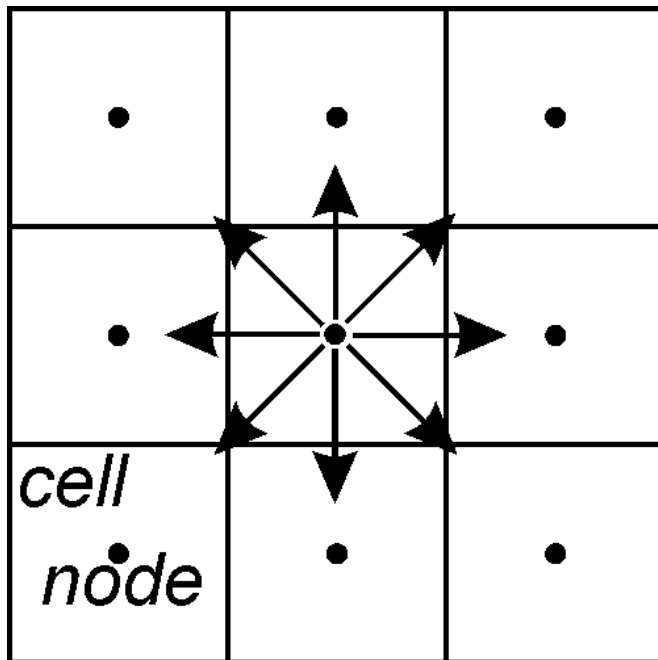
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Microscopic



molecular dynamics

Lattice-Boltzmann method: molecular dynamics with *molecules on a regular lattice*



LBM is
a toy system that solves the
Navier-Stokes equations

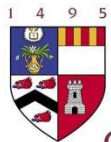
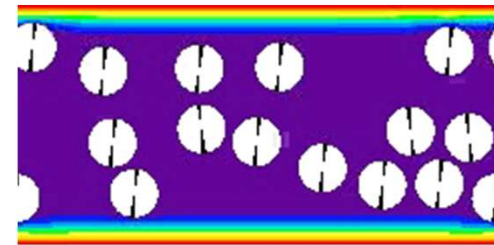
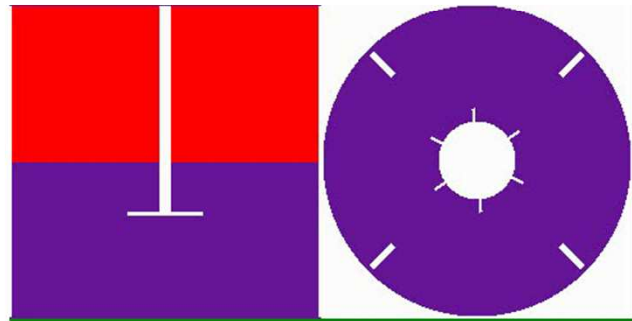
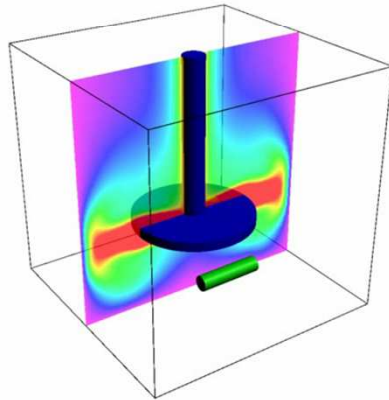
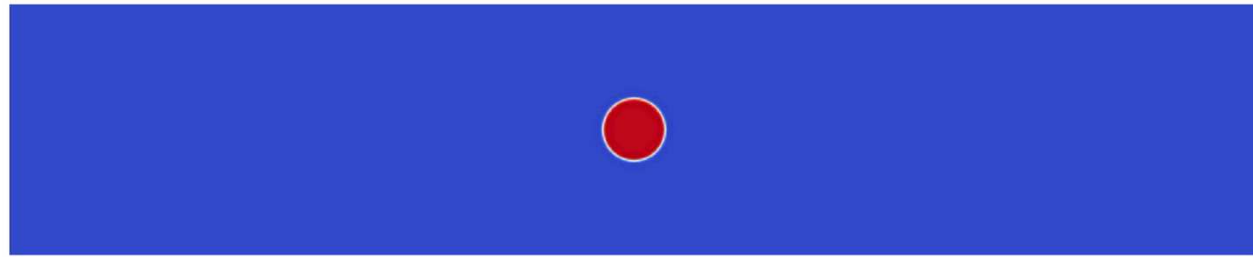
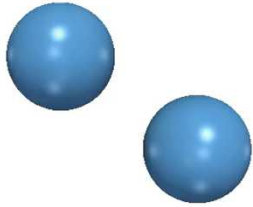
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we will see
how that works mathematically

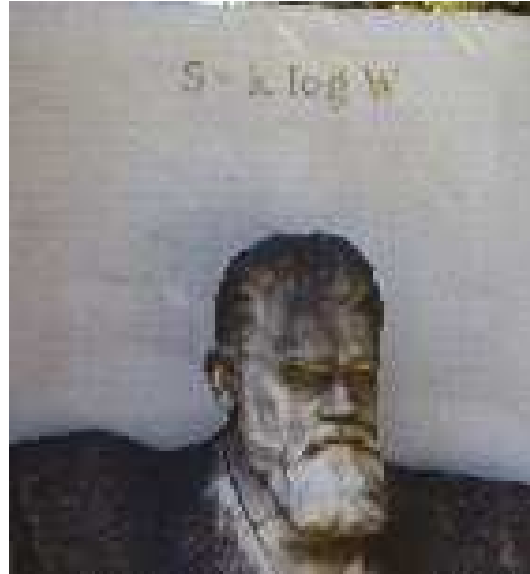
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& how to translate the concept
in computer code

LB: many (types of) applications



LB: Ludwig Boltzmann (1844 – 1906)



$$f^{eq}(\mathbf{x}, |\mathbf{v}|, t) = \rho \left(\frac{1}{2\pi RT} \right)^{3/2} e^{-|\mathbf{v}|^2 / (2RT)}$$

Maxwell – Boltzmann distribution