Other open-source tools
Lecture 10

Balogh Miklós

April 15, 2014
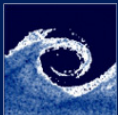
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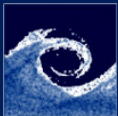Sampling

Solver, Mesher, Post-processor

- Solvers
    - Code-Saturne – general purpose solver
    - Open Flower – CFD solver in C++
    - Gerris – CFD solver in C++
    - Dolfyn – CFD solver for teaching
    - Palabos – lattice-Boltzmann solver
- Mesher
    - GMSH – 3D finite element mesher
    - Salome – 3D CAD software including mesher (GUI)
    - NETGEN – automatic 3D tetrahedral mesher
    - Discretizer – GUI for blockMesh and snappyHexMesh
- Post-processor
    - EnSight – CFD post-processor
    - Gnuplot – powerful tool for plotting
    - Octave – Matlab clone
    - Discretizer – GUI for OpenFOAM post-processing tools
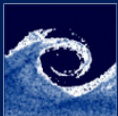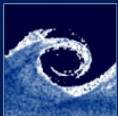
lattice-Boltzmann method

- A class of computational fluid dynamics
  - The discrete Boltzmann equation is solved,
  - for a Newtonian fluid,
  - using collision models
- The concept differs from the Navier-Stokes solvers
  - CFD: conservation equations of macroscopic properties
  - LBM: fictive particles perform consecutive propagation and collision processes over a discrete lattice mesh
- Advantages over other conventional methods
  - dealing with complex geometry (e.g. aneorism, complex pore network)
  - incorporating microscopic interactions
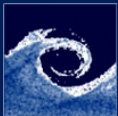 - parallelization of the algorithm (less memory)

D2Q9

D3Q19

- Palabos framework is a C++ library
  - Its kernel based on the lattice Boltzmann method
  - With no external dependencies (only Posix and MPI)
  - Additional programmer intefaces: Python and Java
- Physics
  - Incompressible Navier-Stokes equations
  - Weakly compressible, non-thermal Navier-Stokes equations
  - Flows with body-force term
  - Thermal flows with Boussinesq approximation
  - Single-component multi-phase fluids (Shan/Chen model)
  - Multi-component multi-phase fluids (Shan/Chen model, He/Lee model)
  - Free surface flows (volume-of-fluid approach)
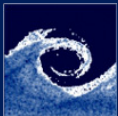 - Static Smagorinsky model for fluid turbulence

Palabos

- Basic fluid models (collision)
    - BGK, regularized BGK
    - MRT
    - LW-ACM
    - entropic model
- Grids
    - D2Q9
    - D3Q13
    - D3Q15
    - D3Q19
    - D3Q27
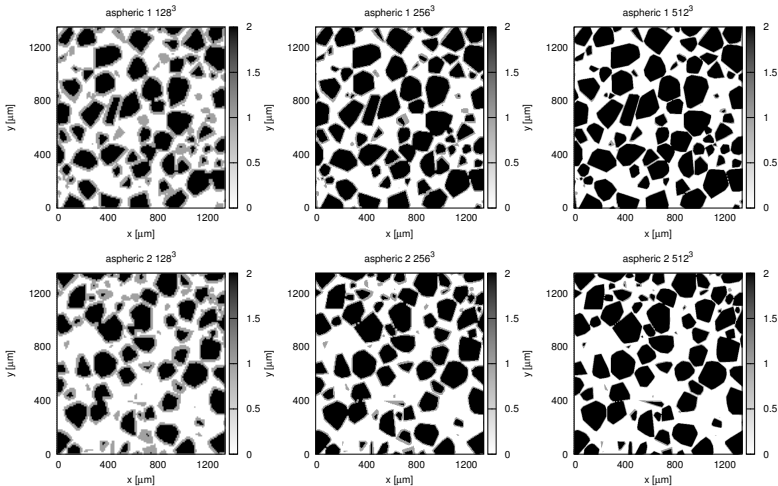
Pore scale voxel map

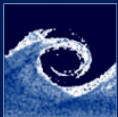Other tools

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LBM

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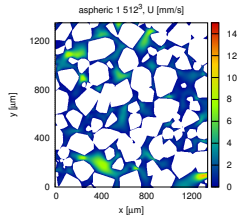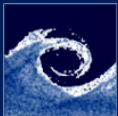# Palabos – Example

Pore scale flow

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LBM
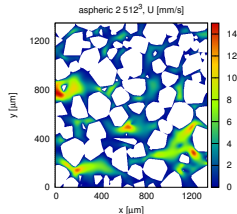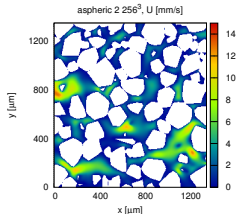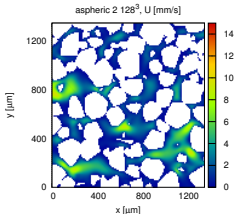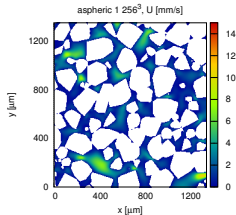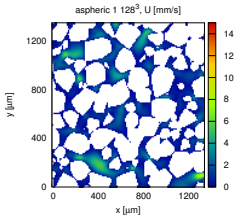
Palabos

Sampling

Rayleigh Taylor instability
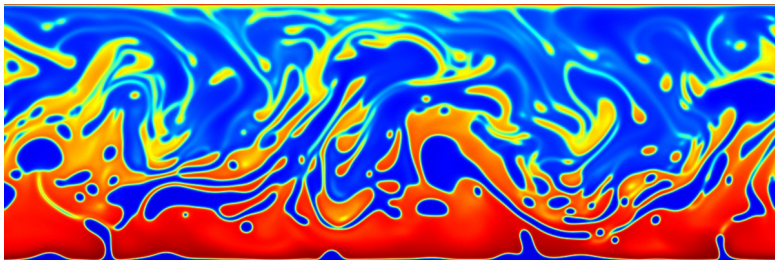
Sampling and plotting

portable command-line driven graphing utility for Linux

- Sampling
    - Sample utility of OpenFOAM
    - Settings in sampleDict
    - Points, Profiles, Planes, Iso-surfaces
    - Formats: raw, gnuplot, grace, vtk, etc.
- Gnuplot – a demanding plotter
    - Portable command-line driven graphic utility
    - Linux, OS/2, MS Windows, OSX, VMS and many other platforms
    - Originally created for scientists and students
    - To visualize mathematical functions and data interactively
    - It has grown to support many non-interactive uses
    - Plotting engine by third-party applications like Octave