Multiphase flows

Lecture 3

Multiscale modelling of multiphase flows

Goals achieved in relation to development of models – a historical perspective

1. **To get some understanding** - mostly empirical models used
2. **Scaling up of processes** (from laboratory to industrial scale)
3. **Designing processes** – modelling from first principles

- **Fundamental questions** about any model

1. How much is a model ***ab initio*** (from the beginning, from first principles in a mathematical sense)?

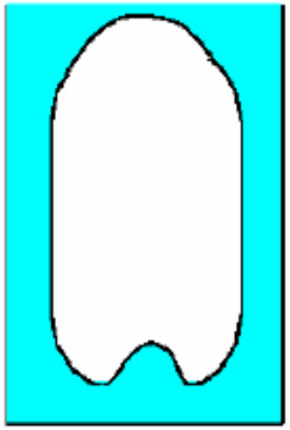
2. If not, why? Can it be changed in the future?

3. Can a model be used as ***predictive*** and ***design*** procedures (instead of experiments and trial and error studies)?

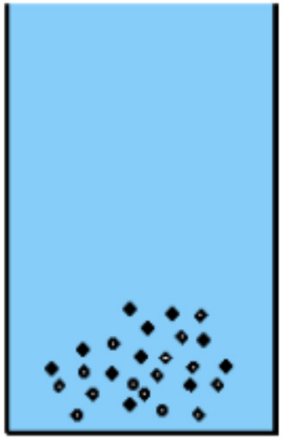
Principal difficulty in modelling of multiphase flows (but, there are may more):

A wide range of scales: the largest flow structures ~ *m* (even *km*), but influenced by events on a single particle level (~ *mm* or μm)

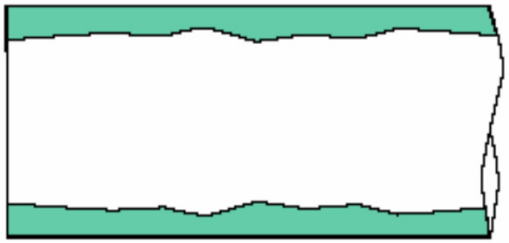
Possible situations



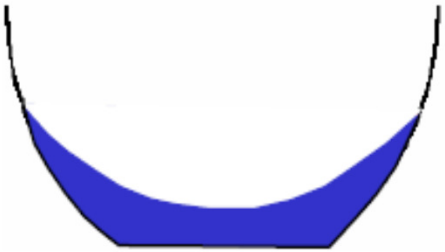
slug flow



bubbly flow
droplet flow
particle-laden flow

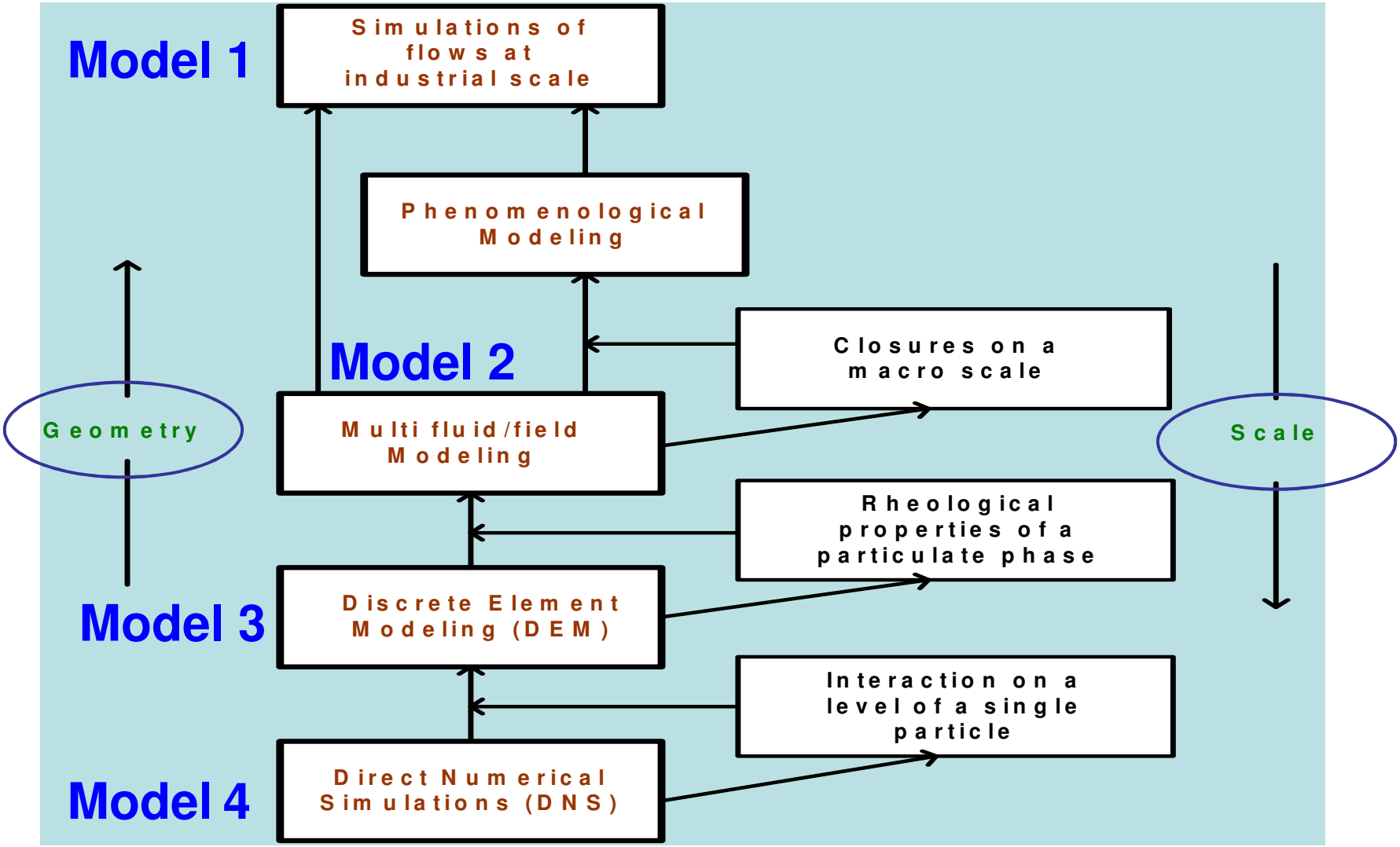


annular flow

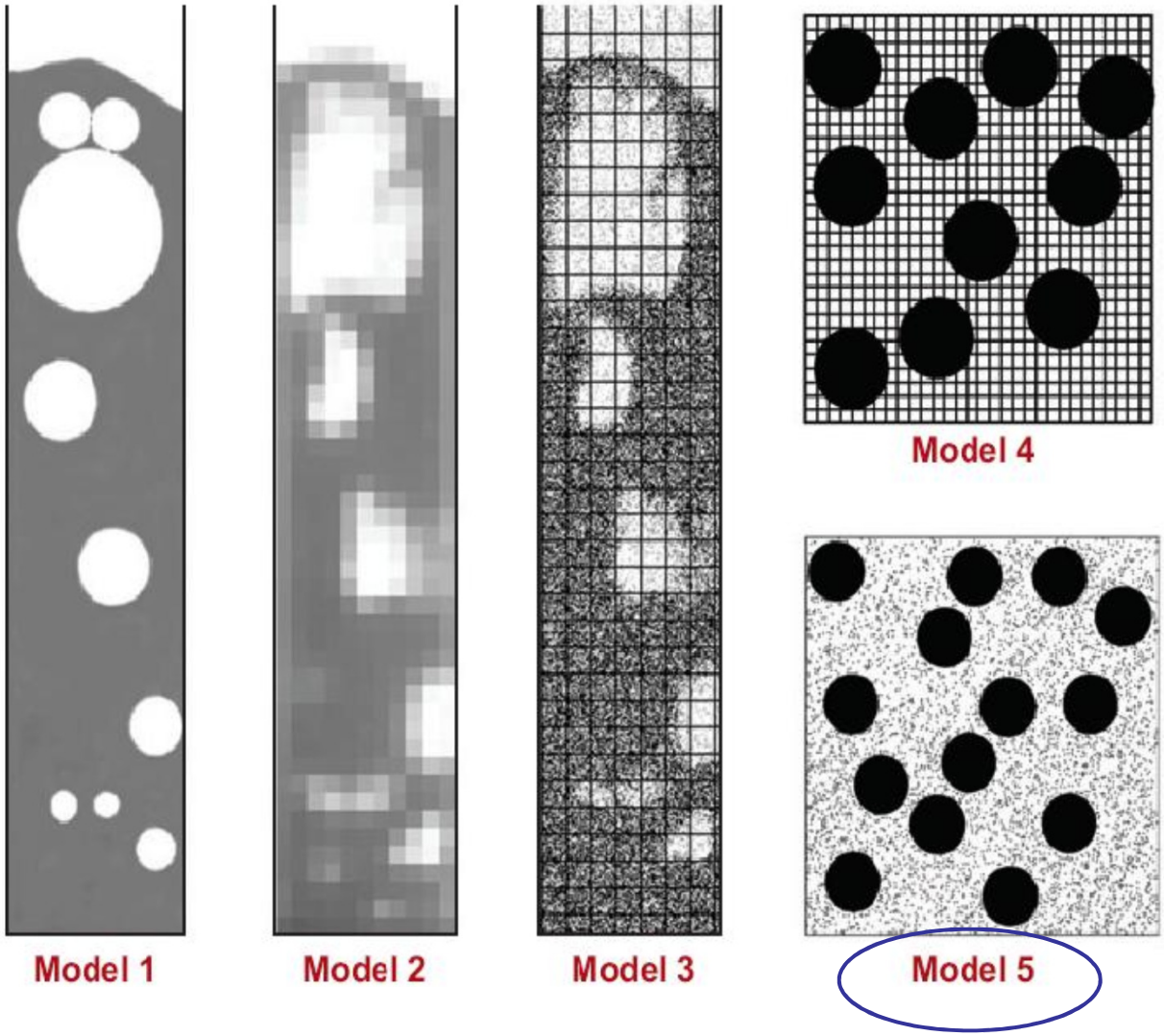


free-surface flow

General picture



General picture

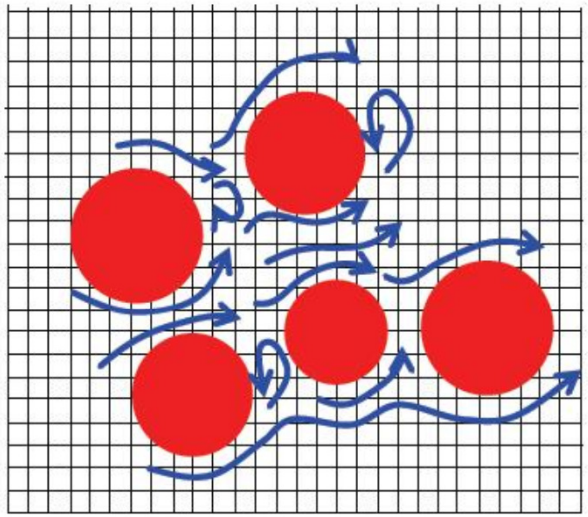


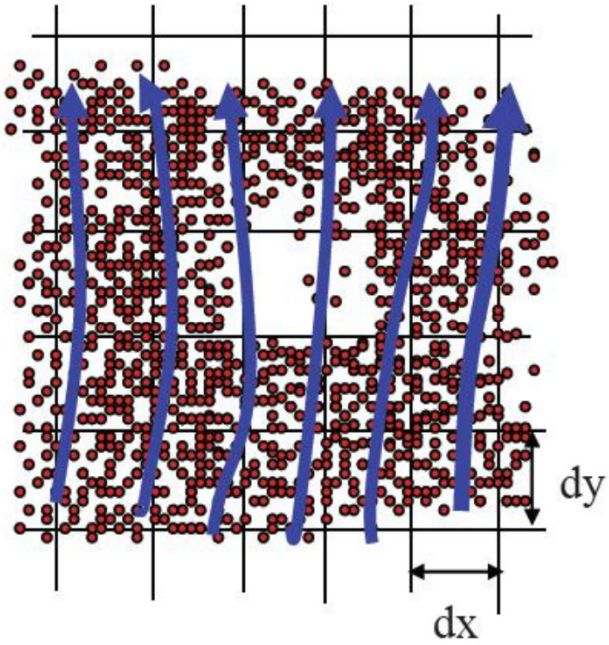
Fluid motion resolved at a molecular level

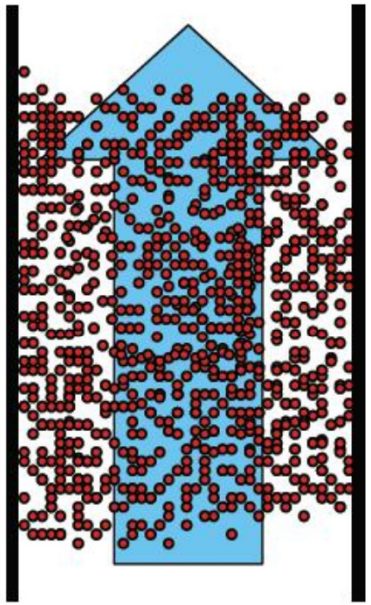
General picture

Surface-resolved models

Point-source or discrete element models







Model 4

Model 3

Model 1