LTCC Intensive Course on Lattice-Boltzmann Methods

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Introduction

Lattice Boltzmann (LB) methods, based on discrete kinetic theory, have recently developed into promising numerical schemes for modelling fluid flows. They have particular advantages over other computational methods through the 'stream-and-collide' computational procedure, making the algorithms highly suited to parallel computing. LB methods have also proved highly successful at modelling flows in complex geometries, multiphase flows and interfacial dynamics.

This course aims to give a concise overview of the kinetic-theory background, as well as the derivation and application of lattice-Boltzmann methods in modelling fluid flow. The syllabus is structured as follows:

- **Kinetic Theory:** atomistic dynamics, the Boltzmann equation, the H-theorem. Recovering the Navier-Stokes equations via the Chapman-Enskog procedure. The Bhatnagar-Gross-Krook model equation.
- **Lattice Boltzmann models:** Derivation of the lattice Boltzmann model in two- and three-dimensions. Exactly incompressible lattice-Boltzmann schemes.
- **Boundary conditions:** periodic, no-slip, free-slip, Inamuro method, open boundaries and misaligned boundaries.
- **Applications:** flows at medium Reynolds number, modelling turbulence, modelling multiphase and reactive flows.

Suggested reading

Wolf-Gladrow, D.A. *Lattice-Gas Cellular Automata and Lattice-Boltzmann Models.* Springer. 2000.
Succi, S. *The Lattice-Boltzmann Equation for Fluid Dynamics and Beyond.* OUP. 2001.