Groupe de travail
“Schémas de Boltzmann sur réseau”

Institut Henri Poincaré
11 rue Pierre et Marie Curie, Paris 5 ième

Jeudi 10 novembre 2016
salle 421 (4ème étage), de 14h à 15h30

Li-Shi Luo

(Old Dominion University, Norfolk, VA, USA et CSRC, Pékin)

Finite volume lattice Boltzmann method for nearly incompressible flows on arbitrary unstructured meshes

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Abstract

A genuine finite-volume (FV) method based on the lattice Boltzmann equation (LBE) for nearly incompressible flows is developed. The proposed finite-volume lattice Boltzmann method (FV-LBM) is grid-transparent, i.e., it requires no knowledge of cell topology, thus it can be implemented on arbitrary unstructured meshes for effective and efficient treatment of complex geometries. Due to the linear advection term in the LBE, it is easy to construct multi-dimensional schemes. In addition, inviscid and viscous fluxes are computed in one step in the LBE, as opposed to in two separate steps for the traditional finite-volume discretization of the Navier-Stokes equations. Because of its conservation constraints, the collision term of the kinetic equation can be treated implicitly without linearization or any other approximation, thus the computational efficiency is enhanced. The collision with multiple-relaxation-time (MRT) model is used in the LBE. The developed FV-LBM is of second-order convergence.

The proposed FV-LBM is validated with three test cases in two-dimensions: (a) the Poiseuille flow driven by a constant body force; (b) the Blasius boundary layer; and (c) the steady flow past a cylinder at the Reynolds numbers Re =10, 20, and 40. The results verify the designed accuracy and efficacy of the proposed FV-LBM.

If time allows, a newly developed implicit FV-LBE scheme will also be discussed. The speed up of the implicit FV-LBE is at least 45 times or better, depending on flows. The implicit FV-LBE scheme can also be used to simulate inviscid flows.