Boltzmann-equation based computational fluid dynamics

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Since the 1980s, direct numerical simulations have served as a vital research tool to probe flow structures and nonlinear dynamics in complex flows such as multiphase flows and turbulent flows. Most of these simulations were performed based on the continuum (conventional or macroscopic) Navier-Stokes equation. In recent years, mesoscopic methods based on the Boltzmann equation, such as the lattice Boltzmann method and gas kinetic schemes, have been developed and applied to these complex flows. In this talk, I will discuss some recent advances in applying mesoscopic methods for rigorous simulations of such complex flows. Three specific examples will be considered: (a) turbulent channel flow laden with finite-size moving particles, (b) hydrodynamic interactions of cloud droplets, and (c) compressible turbulent flow. A few implementation issues in these simulations will be discussed. The purpose is to expose the capabilities of these mesoscopic methods, open research issues, and their potentials for various complex flow problems.

*****PLEASE NOTE SPECIAL LOCATION and TIME*****

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