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THE HONG KONG UNIVERSITY OF SCIENCE & TECHNOLOGY

Department of Mathematics

PHD STUDENT SEMINAR

A three-dimensional unified gas-kinetic wave-particle solver for all flow regime

By

Mr. Yipei CHEN

Abstract

In this paper, the multiscale unified gas-kinetic wave-particle (UGKWP) method has been implemented on three-dimensional unstructured mesh with the capability of large-scale parallel computing. By recovering the multiscale transport process in the unified gas-kinetic scheme (UGKS), the UGKWP method is a multiscale method as well with no requirement of the mesh size and the time step less than the mean free path and the mean collision time. The UGKWP method involves the evolution of both deterministic hydrodynamic waves as in traditional CFD solvers and the stochastic kinetic particles as in the direct simulation Monte Carlo (DSMC) method. With the novel wave-particle adaptive formulation, the UGKWP method is capable of simulating all Knudsen number flows from continuum to rarefied regimes with high efficiency. The implementation is validated by several three-dimensional test cases covering different Mach numbers and Knudsen numbers, including the shock tube problem, lid-driven cavity flow, and high-speed flow pass a cube. The parallel performance has been tested on the Tianhe-2 supercomputer, and good parallel scaling property has been observed up to one thousand processing cores. With high efficiency and low memory requirement due to particles' adaptation in velocity space, the UGKWP method shows great potentials in solving three-dimensional multiscale flows in continuum and rarefied regimes, especially for high-speed flows in the transition regime.

Date : 14 May 2020 (Thursday)
Time : 4:00pm – 5:00pm
Zoom Meeting : https://hkust.zoom.us/j/97608926782

All are Welcome!