



THE HONG KONG UNIVERSITY OF SCIENCE & TECHNOLOGY

Department of Mathematics

PHD STUDENT SEMINAR

**A three-dimensional unified gas-kinetic wave-particle solver
for flow computation in all regimes**

By

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Abstract

In this talk, the unified gas-kinetic wave-particle (UGKWP) method will be presented for the three-dimensional multiscale flow simulations. Based on the direct modeling methodology, the unified gas-kinetic scheme (UGKS) models the flow dynamics directly on the numerical mesh size and time step scales, and it is able to capture the flow dynamics from the kinetic scale particle transport to the hydrodynamic wave propagation seamlessly according to the local cell Knudsen number. Instead of discretizing the particle velocity space in UGKS, the UGKWP method is composed of the evolution of deterministic waves and stochastic particles. With dynamic wave-particle decomposition according to the cell Knudsen number, the UGKWP method is able to capture the continuum wave interaction and rarefied particle transport under a unified framework and achieves high efficiency in different flow regimes. The UGKWP flow solver is constructed in three-dimensional space and is validated by many test cases at different Mach and Knudsen numbers. The examples include a 3D shock tube problem, lid-driven cubic cavity flow, high-speed flow passing through a cubic object, and hypersonic flow around a space vehicle. Moreover, the UGKWP method is further developed for diatomic gas with the energy exchange between translational and rotational modes for flow study in all regimes. With the wave-particle formulation, the UGKWP method has great potential in solving three-dimensional multiscale transport problems with the co-existence of continuum and rarefied flow regimes, especially for the high-speed rarefied and continuum flow simulation around a space vehicle in near-space flight, where the local Knudsen number can vary significantly with five or six orders of magnitude differences.

Date : 21 June 2021 (Monday)

Time : 11:00am

Zoom Meeting : <https://hkust.zoom.us/j/92899365623> (Passcode: 812352)

All are Welcome!