



THE HONG KONG UNIVERSITY OF SCIENCE & TECHNOLOGY

Department of Mathematics

PHD STUDENT SEMINAR

**An Implicit UGKS for Large Time Steps in
Radiative Transfer Preserving Microscopic Transport via
Cellwise Block Elimination and Moment-Consistent Coupling**

By

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Abstract

We present a large-time-step implicit unified gas-kinetic scheme (UGKS) for gray radiative transfer coupled with material energy evolution. The central design principle is to retain the discrete microscopic transport operator in the implicit formulation, rather than allowing the time-integrated UGKS flux itself to serve as the large-step closure. To this end, the classical UGKS flux evaluated with the physical time step is used only to construct predictor residuals, while the actual correction is obtained from a macro–micro system posed in pseudo-time. The microscopic equation preserves the directional upwind transport structure and is solved by exact sweeps. The stiff radiation–material source block is treated through cellwise elimination of the local 2×2 Jacobian, which is shown to be exactly equivalent to the Schur complement of the global macro block because the temperature block is diagonal. A moment-consistency constraint is introduced to couple the macro correction back to the microscopic angular moment without altering any fixed point that is already consistent. Numerical experiments, including the Marshak wave and Hohlraum problems, show good agreement with reference solutions and demonstrate speedups of several tens of times.

Date : 6 May 2026 (Wednesday)

Time : 3:00pm

Venue : Room 2408 (near Lifts 17/18)

All are Welcome!