The Hong Kong University of Science and Technology

Department of Mathematics

PhD THESIS EXAMINATION

High-order Non-compact and Compact Gas-kinetic Schemes

By

Mr. Xing JI

ABSTRACT

In this thesis, we mainly focus on the efficient implementations of HGKS, especially on the construction of compact schemes. By combining the second-order or third-order GKS flux functions with the multi-stage multi-derivative technique, a family of HGKSs can be constructed. As an extension of the previous two-stage fourth-order GKS, the fifth-order schemes with two and three stages have been developed. It provides a framework to construct HGKS with temporal accuracy towards to an arbitrary order. Then the weighted essentially non-oscillatory with adaptive order (WENO-AO) method is adopted for the initial reconstruction in HGKS. With the help of the new reconstruction method, HGKS can achieve uniform high-order for equilibrium and non-equilibrium states. The fifth-order WENO-AO GKS is presented for validation. Then, a fourth-order compact GKS is developed. It is composed of three ingredients, which are the two-stage fourth-order framework for temporal discretization, the higher-order gas evolution model for the evaluations of interface values and fluxes, and the fifth-order Hermite WENO reconstruction for the cell-averaged values updated through fluxes and their first order derivatives obtained through the differences of flow variables at the cell interfaces. Furthermore, targeting on simulating more challenging flow problems, such as the aeroacoustic generation and propagation, and turbulence, up to eighth-order compact schemes have been developed, which show spectral-like resolution. Lastly, the two-stage compact scheme has been successfully extended to unstructured meshes. The robustness of the scheme has been validated through many cases, including strong shocks in the hypersonic viscous flow simulations.

Date: 06 Aug 2019, Tuesday

Time: 3:00 p.m.

Venue: Room 3494 (near lifts 25-26)

***Thesis Examination Committee*:**

Chairman	**:**	**Prof. Cameron Dougall CAMPBELL, SOSC/HKUST**
Thesis Supervisor	**:**	**Prof. Kun XU, MATH/HKUST**
Member	**:**	**Prof. Xiaoping WANG, MATH/HKUST**
Member	**:**	**Prof. Tiezheng QIAN, MATH/HKUST**
Member	**:**	**Prof. Huihe QIU, MAE/HKUST**
External Examiner	**:**	**Prof. Jianxian QIU School of Mathematical Sciences/ Xiamen University**

(Open to all faculty and students)

The student's thesis is now being displayed on the reception counter in the General Administration Office (Room 3461).