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The Hong Kong University of Science and Technology

Department of Mathematics

Seminar on Scientific Computation

A new paradigm to design high-fidelity Godunov schemes for both smooth and discontinuous solutions in complex flow simulations

By

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Abstract

One of the hard nuts to crack in computational fluid dynamics is how to simultaneously resolve both smooth (vortex, acoustic wave) and discontinuous (shock, contact jump, material interface) flow structures with high fidelity in numerical simulations of complex flows which involve strong discontinuities and flow structures of wide-range scales. The mainstream Godunov finite volume framework, which combines polynomial-based reconstruction and nonlinear limiting projection to compromise between spurious oscillation and numerical dissipation, has been proven to be a great success in many applications. However, it is also found that the existing methods of this sort can hardly provide adequate solution quality for some applications due to excessive numerical dissipation. In this talk, we present a novel paradigm, so-called Boundary Variation Diminishing (BVD) principle, to design high-fidelity finite volume schemes to capture both smooth and non-smooth flow structures with high-fidelity solution quality. The BVD principle minimizes the jumps of the reconstructed physical variables at cell boundaries, and thus effectively reduces the dissipation errors in Godunov finite volume method. More profoundly, the BVD principle provides a completely new alternative to the conventional limiting-projection approach to eliminate numerical oscillation. The resulting schemes are able to retrieve the unlimited very-high-order polynomials for smooth solution while eliminating numerical oscillations around discontinuities. With proper BVD-admissible functions and BVD algorithms, we have developed a new class of numerical schemes of great practical significance for compressible and interfacial multiphase flows. The numerical schemes have been extensively verified with various benchmark tests of single and multiphase compressible flows involving strong discontinuities and complex flow structure of broad-band scales.

Date: **Friday, 18 January 2019**
Time: **4:00p.m.-5:00p.m.**
Venue: **Room 4504, Academic Building (near Lifts 25 - 26), HKUST**

All are welcome!