Frontiers of Scientific Computing Lecture Series

Maximum-Principle-Satisfying and Positivity-Preserving High Order Discontinuous Galerkin and Finite Volume Schemes

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Abstract:
When solving convection dominated partial differential equations, such as the incompressible and compressible Euler equations in fluid dynamics, it is a challenge to design numerical schemes which are both strongly stable and high order accurate, especially when the solution contains sharp gradient regions or discontinuities. Previous schemes satisfying strict maximum principle for scalar equations and positivity-preserving for systems are mostly first order, or at most second order accurate. We construct uniformly high order accurate discontinuous Galerkin (DG) and weighted essentially non-oscillatory (WENO) finite volume (FV) schemes satisfying a strict maximum principle for scalar conservation laws and passive convection in incompressible flows, and positivity preserving for density and pressure for compressible Euler equations. One remarkable property of our approach is that it is straightforward to extend the method to two and higher dimensions on arbitrary triangulations. We will also emphasize recent developments including arbitrary equations of state, source terms, integral terms, shallow water equations, high order accurate finite difference positivity preserving schemes for Euler equations, and a special non-standard positivity preserving high order finite volume scheme for convection-diffusion equations. Numerical tests demonstrating the good performance of the scheme will be reported. This is a joint work with Xiangxiong Zhang.

Speaker's Bio:
Chi-Wang Shu obtained his BS degree from the University of Science and Technology of China in 1982 and his PhD degree from the University of California at Los Angeles in 1986. He came to Brown University as an Assistant Professor in 1987, moving up to Associate Professor in 1992 and Full Professor in 1996. He was the Chair of the Division of Applied Mathematics between 1999 and 2005, and is now the Theodore B. Stowell University Professor of Applied Mathematics. His research interest includes high order finite difference, finite element and spectral methods for solving hyperbolic and other convection dominated partial differential equations, with applications to areas such as computational fluid dynamics, semi-conductor device simulations and computational cosmology. He is the managing editor of Mathematics of Computation and the chief editor of Journal of Scientific Computing. His honors include the First Feng Kang Prize of Scientific Computing in 1995 and the SIAM/ACM Prize in Computational Science and Engineering in 2007. He is an ISI Highly Cited Author in Mathematics and a SIAM Fellow.

Refreshments will be served.
This lecture has a reception.