Mathematical Sciences

Fall 2021

Colloquium Series

Dr. Xianyi Zeng

The University of Texas at El Paso

Online (Zoom) Meeting

Friday, September 17 : 3pm

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A superconvergent hybrid-variable discretization framework for hyperbolic conservation laws

Abstract

A new hybrid-variable (HV) discretization framework is presented for partial differential equations (PDE) in general and hyperbolic conservation laws in particular. It distinguishes from conventional methods in that numerical approximations to both cell-averaged solutions and nodal solutions are utilized to discretize the governing equation, and leads to an inherent superconvergence property that is not possessed by existing numerical schemes. The first half of the talk focuses on the mathematical foundation of the HV methodology using one-dimensional (1D) advection and advection-diffusion equations as model problems. In particular, it addresses the existence of discrete differential operator to arbitrary order of accuracy, the technical condition for a universal superconvergence property, and a systematic procedure to verify the stability of a particular HV scheme. At the end of this part, some open questions regarding the stability barrier as well as possible avenues to answer these questions are discussed briefly. In the second half, extensions of the HV methods to solve nonlinear hyperbolic systems in both one and two space dimensions are discussed, with a focus on the Euler equations. To capture strong shocks, an entropy viscosity is incorporated in the HV framework. Extensive numerical results are presented to assess the performance of the HV methods using both structured and unstructured computational grids. Finally, the talks is closed with a brief discussion of the next directions as well as related on-going research projects.

For further information, please contact Dr. Emil Schwab, eschwab@utep.edu

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