Department of Mathematics

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Scientific Computing Seminar

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Bounds-Preserving Schemes Based on Continuous High-Order Bernstein Finite Element Approximations

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1:30 PM- 2:30 PM
Room 646   PGH

Abstract: This talk presents the first extension of the flux-corrected transport (FCT) methodology to continuous high-order finite element discretization of scalar conservation laws. Using the Bernstein basis representation of polynomial shape functions, we modify the Galerkin discretization so as to enforce local discrete maximum principles for the coefficients and guarantee that the numerical solution stays in the admissible range.

The design of accuracy-preserving FCT schemes for high-order Bernstein finite elements requires a major revision of algorithms designed for linear and multi-linear Lagrange elements. In this talk, we present

1. a new discrete upwinding strategy leading to variation diminishing low-order approximations with compact stencils,
2. a high-order stabilization operator based on the divergence of the difference between two gradient approximations,
3. new localized limiters for anti-diffusive element contributions, and
4. an accuracy-preserving smoothness indicator that allows violations of strict maximum principles at smooth peaks.

The predictor-corrector algorithm based on these ingredients constrains the difference between provisional solutions corresponding to a high-order Bernstein finite element approximation and its bounds-preserving low-order counterpart. Similar criteria can be used to limit the difference between the underlying discrete operators or finite element basis functions. Monolithic limiting techniques of this kind will also be discussed.