

BEYOND CLASSICAL SCHEMES: RECENT DEVELOPMENTS OF HIGH-ORDER STRUCTURE-PRESERVING METHODS FOR COMPRESSIBLE FLOWS

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ABSTRACT

The accurate and robust simulation of compressible flows remains a cornerstone of computational fluid dynamics (CFD), with applications ranging from aerospace engineering to astrophysics, weather prediction, and beyond. Traditional numerical schemes have achieved significant success, but they often face limitations when applied to complex, multi-scale phenomena characterized by shocks, turbulence, and wave interactions.

This mini-symposium highlights recent advances in high-order structure-preserving numerical methods for compressible flows, going beyond classical schemes. The focus is placed on modern approaches such as Continuous/Discontinuous Galerkin (CG/DG), Flux Reconstruction (FR), Residual Distribution (RD), and advanced Finite Volume (FV) and Finite Difference (FD) methods that embed essential structures like local conservation, entropy stability, positivity and kinetic energy preservation. Topics include innovative high-order schemes for unstructured meshes, well-balanced and asymptotic-preserving methods, adaptive and multi-resolution strategies. In particular, the mini-symposium welcomes

contributions that extend classical schemes, including those based on point and cell-average representations, the use of generalized function spaces beyond polynomial approximations (e.g., radial basis functions, function-space summation-by-parts operators), and structure-preserving approaches to uncertainty quantification and stochastic modeling pushing limitations in turbulent, hypersonic, and reactive flow applications.

These topics align closely with the DFG Priority Programme SPP-2410 “Hyperbolic Balance Laws in Fluid Mechanics: Complexity, Scales, Randomness (CoScaRa),” which advances modern solution concepts and numerical methods for multi-scale and stochastic models while preserving hyperbolic structure. The mini-symposium will showcase selected recent results from the SPP-2410 alongside contributions from the wider community, fostering exchange between academia and industry on high-order structure-preserving methods for compressible flows, with emphasis on accuracy, robustness, and practical performance.