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ADVANCED NUMERICAL METHODS FOR EXTREME COMPRESSIBLE FLOWS

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ABSTRACT

Extreme compressible flow regimes arise in a wide range of challenging applications, including hypersonic aerodynamics, high-energy-density physics, plasma dynamics, and astrophysical flows. These systems involve strong shock waves, steep gradients, intricate wave interactions, and the coexistence of multiple spatial and temporal scales. Their numerical simulation therefore requires methods that combine robustness, accuracy, and efficiency in the presence of severe nonlinearities and complex multiscale dynamics.

This mini-symposium aims to bring together researchers working on the analysis and design of advanced numerical methods for highly compressible flows and related multiphysics models, with particular emphasis on **domain-preserving** and **structure-preserving** schemes. Domain-preserving methods play a central role in ensuring robustness by enforcing physically admissible states such as positivity, realizability, and nonlinear stability, especially in shock-dominated regimes. Structure-preserving methods, in turn, are essential for accuracy, as they are designed to respect key mathematical or physical properties of the underlying models, including conservation, entropy consistency, asymptotic limits, and geometric structure.

Topics of interest include, but are not limited to, high-order discretization techniques, shock-capturing and shock-tracking methods, invariant-domain-preserving algorithms, entropy-stable and positivity-preserving schemes, adaptive mesh refinement, multiscale and multiphysics coupling strategies, and efficient methods for large-scale simulations.

By emphasizing the interplay between robustness and accuracy, this mini-symposium seeks to foster exchange between numerical analysts, computational scientists, and application specialists, and to highlight recent advances in computational methods for extreme compressible flow phenomena.

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