

Lothar-Collatz-Seminar

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High-Order, Optimal, Entropy-Stable, Non-Intrusive, Multirate Time Integration for Compressible Fluid Dynamics

Abstract:

We present novel entropy-conservative and entropy-stable multirate Runge-Kutta methods based on Paired Explicit Runge-Kutta (P-ERK) schemes with relaxation for conservation laws and related systems of partial differential equations. Optimized schemes up to fourth-order are derived and validated in terms of order of consistency, conservation of linear invariants, and entropy conservation/stability. We demonstrate the effectiveness of these P-ERRK methods when combined with a high-order, entropy-conservative/stable discontinuous Galerkin spectral element method on unstructured meshes. The Paired Explicit Relaxation Runge-Kutta methods (P-ERRK) are readily implemented for partitioned semidiscretizations arising from problems with equation-based scale separation such as non-uniform meshes. We highlight that the relaxation approach acts as a time-limiting technique which improves the nonlinear stability and thus robustness of the multirate schemes. The P-ERRK methods are applied to a range of problems, ranging from compressible Euler over compressible Navier-Stokes to the visco-resistive magnetohydrodynamics equations in two and three spatial dimensions. For each test case, we compare computational load and runtime to standalone relaxed Runge-Kutta methods which are outperformed by factors up to four. Additionally, applications of the P-ERK schemes to bulk-coupled systems such as Euler-Acoustic and Euler-(self) Gravity. For further information please contact

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www.c3s.uni-hamburg.de/news-events/seminar-c3s.html

