ADER-WENO Finite Volume Schemes with Space-Time Adaptive Mesh Refinement

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We present the first high order one-step ADER-WENO finite volume scheme with Adaptive Mesh Refinement (AMR) in multiple space dimensions [1]. High order spatial accuracy is obtained through a WENO reconstruction, while a high order one-step time discretization is achieved using a local space-time discontinuous Galerkin predictor method [2], [3]. Due to the one-step nature of the underlying scheme, the resulting algorithm is particularly well suited for an AMR strategy on space-time adaptive meshes, i.e. with time-accurate local time stepping. Tests will be shown of the new scheme over a wide range of examples for nonlinear systems of hyperbolic conservation laws, including the classical Euler equations of compressible gas dynamics and the equations of ideal magnetohydrodynamics (MHD). A detailed analysis of the computational speed-up with respect to highly refined uniform meshes is also presented. We provide convincing evidence that the presented high order AMR scheme behaves better than traditional second order AMR methods. The proposed scheme that combines for the first time high order ADER methods with space–time adaptive grids in two and three space dimensions is likely to become a useful tool in several fields of computational physics, applied mathematics and mechanics.

References

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Joint work with: Prof. M. Dumbser, Prof. A. Hidalgo and Prof. D. Balsara