An ADER-WENO Finite Volume AMR code for Astrophysics

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The first high order one-step ADER-WENO finite volume scheme with Adaptive Mesh Refinement (AMR) in multiple space dimensions is presented \cite{1}. A high order one-step time discretization is achieved using a local space-time discontinuous Galerkin predictor method \cite{2}, while a high order spatial accuracy is obtained through a WENO reconstruction. 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. 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. Tests will be shown of the new scheme over a wide range of examples for nonlinear systems of hyperbolic conservation laws, including the classical and relativistic Euler equations and the equations of ideal magnetohydrodynamics (MHD). 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 astrophysical scenarios.

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{amr_grid.png}
\caption{AMR grid with two levels of grid refinement in the Double Mach reflection problem.}
\end{figure}

\cite{2} M. Dumbser, C. Enaux, E. Toro, JCP 227, 3971 (2008).