Subcell Adaptive Shock Capturing for Discontinuous Galerkin Methods

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Abstract

The aim of this talk is to present a shock capturing approach for high order Discontinuous Galerkin (DG) methods applied to very high Mach number flows with turbulence (e.g. astrophysical flows). The challenge is to preserve the accuracy and the subcell resolution of high order DG discretizations while at the same time enabling robust capturing of very strong shocks.

Our approach is based on a smooth blending of several versions of the DG method at the same degrees of freedom. Depending on a smoothness indicator and on other important criteria such as e.g. positivity of the solution, we compute blending factors in $[0, 1]$ that we use to combine 1st order finite volume, 2nd order DG and 4th order DG on the same grid. This strategy allows us to preserve as much approximation quality and discretisation accuracy as possible, e.g. for turbulent structures. On the other hand, for singular or discontinuous parts of the solution, the blending factors smoothly transition the resulting discretisation to a robust finite volume method that allows us to capture strong astrophysical shocks. The resulting discretisation allows to adapt the discretisation on a subcell level by construction. To further enhance its efficiency, we combine the scheme with the parallel adaptive mesh refinement (AMR) library p4est.

Several numerical experiments show an excellent behaviour of the adaptive subcell shock capturing approach.