On an Adaptive Artificial Viscosity Method for Hyperbolic Systems of Conservation Laws

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I will first describe the adaptive artificial viscosity (AAV) method, which has been recently introduced. This is a finite volume method for solving general multidimensional hyperbolic systems of conservation laws. The AAV method is based on an appropriate numerical flux and a high-order piecewise polynomial reconstruction. The latter is utilized without any computationally expensive nonlinear limiters, which are typically needed to guarantee nonlinear stability of a finite volume scheme. Instead, we enforce stability of the AAV method by adding an artificial viscosity term, whose coefficients are proportional to the size of the weak local residual, which is sufficiently large at the shock regions, much smaller near the contact waves, and very small in the smooth parts of the computed solution.

I will then show how to develop an AAV method for the Saint-Venant system of shallow water equations. To design a highly accurate and robust scheme, we apply special techniques to guarantee that the method is well-balanced (that is, it is capable of preserving the "lake at rest" steady state) and that the positivity of water depth is always preserved.

Finally, I will demonstrate a superb performance of the AAV method on a number of benchmarks for both scalar conservation laws, the Euler equations of gas dynamics and the Saint-Venant system.