
MARIE-ODETTE ST-HILAIRE, Université de Montréal

Toward an improved capture of stiff detonation waves

The simultaneous presence of two scales: macroscopic for the gas flow and microscopic for the chemical reaction, makes numerical approximation of detonation waves very delicate. A resolved simulation, where the small chemical time scale is fully resolved, effectively captures the wave in details. However, it is far too expensive in computing time, especially for multi-dimensional problems. While being economic, an underresolved approach, where the discretisation is proportional to the macroscopic scale, is unfortunately inefficient for the capture of stiff detonation waves because it leads to unphysical solutions.

We propose a family of accurate time-splitting methods, numerically stable, allowing underresolved calculations and requiring neither the resolution of the Riemann problem nor the knowledge of the characteristic structure of the flux jacobian matrix and of course, converging to the physical solution. With a refinement of the grid, these methods moreover effectively capture the unstable character of the detonation and provide the exact front structure of the wave. It is realistic to claim that such methods can moreover solve about any hyperbolic system with source term. We thus elaborate “black box”-type methods, while the majority of the schemes existing for the detonation problem use properties of the solution.