A multi-dimensional minmod limiter based on nodal gradients for a GCL conservative cell-centered Lagrangian scheme

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Solving the gas dynamics equations under the Lagrangian formalism enables to model complex flows with strong shock waves. This formulation is well suited to the simulation of multi-material compressible fluid flows such as those encountered in the domain of High Energy Density Physics (HEDP). These flows can present complex geometries and 3D aspects such as hydrodynamical perturbations which require 3D schemes [?]. Recently, the 3D extension of different Lagrangian schemes have been proposed and appear to be challenging [?, ?]. More precisely, the definition of the cell geometry in the 3D space through the treatment of its non-planar faces and the limitation of a reconstructed field in 3D in the case of a second-order extension are of great interest. This paper proposes two new methods to solve these previous problems. A systematic and symmetric geometrical decomposition of the polyhedral cells is presented. This method enables to define a discrete divergence operator leading to the respect of the Geometric Conservation Law (GCL). Moreover, a multi-dimensional minmod limiter is proposed. This new limiter constructs, from nodal gradients, a cell gradient which enables to recover the stability on strong shocks. These two new methods are applied to a cell-centered Lagrangian scheme and assessed on several academic test cases to highlight their robustness and accuracy.

Références

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