The Effect of an Isentropic Correction on a Collocated Lagrange-Remap Scheme

Christina Paulin[1,2], Jean-Philippe Braeunig[1], and Renaud Motte[1]

[1]CEA, DAM, DIF, F-91297 Arpajon, France
[2]CMLA, ENS Cachan, CNRS, Université Paris-Saclay, and LRC MESO
(Christina.Paulin@cmla.ens-cachan.fr)

Keywords: Collocated scheme, Lagrange–Remap, entropy production, isentropic flows.

Abstract

We study an Eulerian scheme of Lagrange-Remap type, which simulates compressible multi-material fluid flows. The Lagrangian phase is based on a collocated Lagrangian scheme called EUCCLHYD (Explicit Unstructured Cell-Centered Lagrangian HYDrodynamics, [1]), whereas the remap phase uses alternate directions with interface reconstruction of PLIC type. The EUCCLHYD scheme, which is built on the resolution of acoustic Riemann problems at nodes, is totally conservative, second order in time and space, and captures shock waves accurately. However, the intrinsic entropy production turns out to be an inconvenient for isentropic flows (rarefaction/expansion waves, isentropic compression).
In [2], Braeunig expresses the isentropic production of a cell as its contribution on the faces. This idea was used in [3] to modify the EUCCLHYD scheme in order to nullify the entropy production in expansion zones. The first results with this so-called *isentropic flux* have been presented at the Multimat conference 2017. We extend these results to a conservative version of this isentropic flux (see figure 1). Furthermore, we compare ourselves to other state of the art approaches, such as the Tadmor flux [4].

Figure 1: Density profiles Stony Brook benchmark at end time($\approx$ 7 10^{-3}s, 2400 $\times$ 60 cells). Top: isentropic flux, middle: conservative isentropic flux, bottom: EUCCLHYD.

References

[1] Pierre-Henri Maire, Rémi Abgrall, Jérôme Breil, and Jean Ovadia. A cell-centered Lagrangian scheme for two-dimensional compressible flow problems. *SIAM Journal on Scientific Computing*, 29(4):1781–1824, 2007.

[2] Jean-Philippe Braeunig. Reducing the entropy production in a collocated Lagrange–Remap scheme. *Journal of Computational Physics*, 314:127–144, 2016.

[3] Christina Paulin, Jean-Philippe Braeunig, and Renaud Motte. Isentropic correction for collocated Lagrange-Remap scheme. Submitted to the procceedings of Multimat 2017.

[4] Eitan Tadmor. Entropy stability theory for difference approximations of nonlinear conservation laws and related time-dependent problems. *Acta Numerica*, 12:451–512, 2003.