

A fully-discrete entropy conserving/stable discretization for inviscid unsteady flows

A. Colombo¹, A. Crivellini² and A. Nigro²

¹ Università degli Studi di Bergamo, Department of Engineering and Applied Sciences
alessandro.colombo@unibg.it

² Marche Polytechnic University, Department of Industrial Engineering and
Mathematical Science

a.crivellini@univpm.it, a.nigro@univpm.it

Keywords: *Discontinuous Galerkin, Crank-Nicolson, entropy variables, entropy conserving/stable numerical fluxes.*

The aim of this work is to present a fully-discrete entropy conserving/stable scheme to simulate inviscid unsteady flows. The discretization in space of the Euler equations is performed with a high-order Discontinuous Galerkin (DG) method, while the time advancement is performed with an implicit second order accurate entropy conserving Crank-Nicolson scheme. To ensure the entropy conserving/stable property in space, the DG discretization is written in terms of entropy working variables and several entropy conserving/stable numerical fluxes are employed [1, 2, 3]. To advance the solution in time ensuring a null entropy variation, the Crank-Nicolson scheme, originally developed for a Finite Volume scheme with conservative working variables [4, 5], is extended to DG method with entropy variables. Several temporal and spatial refinement studies have been performed on different test-cases to assess the accuracy and the conservation properties of both the temporal and the spatial discretizations.

REFERENCES

- [1] F. Ismail, P. Roe, Affordable, entropy-consistent Euler flux functions II: Entropy production at shocks, *Journal of Computational Physics* 228 (15) (2009) 5410–5436.
- [2] P. Chandrashekar, Kinetic energy preserving and entropy stable finite volume schemes for compressible Euler and Navier-Stokes equations, *Communications in Computational Physics* 14 (5) (2013) 1252–1286.
- [3] J. Gottlieb, C. Groth, Assessment of riemann solvers for unsteady one-dimensional inviscid flows of perfect gases, *Journal of Computational Physics* 78 (2) (1988) 437–458.
- [4] E. Tadmor, Entropy stability theory for difference approximations of nonlinear conservation laws and related time-dependent problems, *Acta Numerica* 12 (2003) 451–512.
- [5] P. G. LeFloch, J.-M. Mercier, C. Rohde, Fully discrete, entropy conservative schemes of arbitrary order, *SIAM Journal on Numerical Analysis* 40 (5) (2003) 1968–1992.