

Project VF-GD

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Intuitively, to simulate the compressible Navier-Stokes equations one could think of using a tried and tested schema for Euler equations coupled with a method of discretization of diffusion operators. One can think of this approach, based on a classical Riemann solver, as a splitting algorithm that separates these two phenomena. That being so, however seductive it may seem, such a method sometimes gives unsatisfactory results. It is to be hoped that these defects will fade when, instead of using a Riemann solver, we instead implement a staggered scheme where the unknowns of temperature and velocity are stored on different grids. The objectives of this project are as follows :

- highlight, on specific test cases, the flaws of the naive approach and try to understand them ;
- implement, in a Python code, a scheme on staggered grids, following the approach conceived in J. Llobell's thesis for the "hyperbolic" part of the equations, and with a finite volume scheme for the diffusion ;
- relevant test cases will be exhibited (eg. inspired by the works of R. Herbin, J.-C. Latché and their collaborators) ;
- we can study the stability properties of the proposed scheme,
- and consider physically interesting extensions (especially with diffusion coefficients that may depend on density or temperature).

Références

- [1] Ansanay-Alex, G., Un schéma éléments finis non-conformes/Volumes finis pour approximation en maillages non-structués des écoulements à faible nombre de Mach, Aix-Marseille Univ., 2009.
- [2] Berthelin, F. and Goudon, T. and Minjeaud, S., Multifluid flows : a kinetic approach, J. Sci. Comput., 66, 792–824, 2016.
- [3] Boyer, F. and Dardalhon, F. and Lapuerta, C. and Latché, J.-C., Stability of a Crank-Nicolson pressure correction scheme based on staggered discretizations, Int. J. Numer. Meth. Fluids, 74, 34-58, 2014.

- [4] Gallouët, T. and Herbin, R. and Latché, J.-C., Kinetic energy control in explicit finite volume discretizations of the incompressible and compressible Navier-Stokes equations, *Int. J. Finite Vol.*, 7, 2010.
- [5] Gastaldo, L. and Herbin, R. and Kheriji, W. and Lapuerta, C. and Latché, J.-C., Staggered discretizations, pressure correction schemes and all speed barotropic flows, *Finite Volumes for Complex Applications VI, Problems and Perspectives*, Prague, Czech Republic, 4, 839–855, 2011.
- [6] Kheriji, W. and Herbin, R. and Latché, J.-C., Pressure correction staggered schemes for barotropic one-phase and two-phase flows, *Comput. & Fluids*, 88, 524 - 542, 2013.
- [7] Llobell, J., *Schémas Volumes Finis à mailles décalées pour la dynamique des gaz*, Université Côte d’Azur, 2018.
- [8] Zaza, C., *Contribution à la résolution numérique d’écoulements à tout nombre de Mach et au couplage fluide-poreux en vue de la simulation d’écoulements diphasiques homogénéisés dans les composants nucléaires*, Aix-Marseille Univ., 2015.