

Multi-Resolution Analysis for two-phase flows with heat and mass transfer

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ABSTRACT

Two-phase flows combined with heat and mass transfer may present configurations in which dilatable gas pockets coexist along with nearly-incompressible liquid. Finite Volume discretisation of such compressible equations are known to introduce excessive numerical diffusion and to severely restrain time steps. Adequate solver has been developed to tackle these issues (Chalons, 2016), especially in the presence of a sharp interface (Zou, 2020, 2022). To handle multi scales inherently arising in complex two-phase flows, adaptive meshing is an efficient strategy to reduce computation cost compared to uniform grids. In the present study, we use the Multi-Resolution Analysis (MRA) (Harten, 1994), based on local wavelet basis decomposition. This method provide a measure of local error to select regions to refine or derefine and guarantees a precise control of the additionnal error introduced by mesh operations, independantly of conservation equations and problems. This approach was successfully applied to two-phase flows with sharp interface representation (Han, 2014) and we extend it to low-Mach flows. We focus on configurations with heat and mass transfer, to exhibit accuracy and advantages of the MRA method, with respect to other adaptive methods (mainly Adaptive Mesh Refinement (AMR) (Berger, 1989)).

References

- Berger, M. J. & Colella, P., Local adaptive mesh refinement for shock hydrodynamics. *Journal of computational Physics* 82(1), 64-84 (1989).
- Chalons, C., Girardin, M. & Kokh, S. An all-regime lagrange-projection like scheme for the gas dynamics equations on unstructured meshes. *Communications in Computational Physics*, 20(1), 188-233 (2016).
- Han L.H., Hu X.Y. & Adams N. A., Adaptive multi-resolution method for compressible multi-phase flows with sharp interface model and pyramid data structure, *Journal of Computational Physics*, 262, 131-152 (2014).
- Harten A., Adaptive multiresolution schemes for shock computations, *Journal of Computational Physics*, 115, 319-338 (1994).
- Zou, Z., Audit, E., Grenier, N. & Tenaud, C., An Accurate Sharp Interface Method for Two-Phase Compressible Flows at Low-Mach Regime, *Flow, Turbulence and Combustion*, 32 (2020).
- Zou, Z., Grenier, N., Kokh, S., Tenaud, C. & Audit, E., Compressible solver for two-phase flows with sharp interface and capillary effects preserving accuracy in the low Mach regime, *Journal of Computational Physics*, 448, 110735 (2022).