Stable and efficient numerical schemes for the computation of transsonic compressible two-phase flows modelled by the Baer-Nunziato equations

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The Baer-Nunziato model is used in many application areas to simulate two-phase compressible flows. At IFP Énergies Nouvelles, this model is involved in the simulation of slugs in oil pipes, fuel droplets in automobile engines, or bubble columns in engineering processes.
We are interested in the numerical solution of the Baer-Nunziato system [1, 2] as a hyperbolic system with several mathematical problems, including resonance and non-conservative products. Numerical difficulties arise when we approach the sonic point, in the neighborhood of which the Riemann problem associated with the Baer-Nunziato system begins to have several solutions.
We design a new numerical scheme, combining relaxation methods [3, 4] and the Lagrangian Projection formalism. We propose a method to guarantee the existence and the uniqueness of the solution in supersonic flows. Our contribution, for the approximation of this system, is a natural extension of that of Saleh [5] to the supersonic case. The advantage of this new scheme is to be able to take into account the subsonic-supersonic transition while ensuring the stability and positivity properties.

Références

[1] M. R. Baer and J. W. Nunziato, *A two-phase mixture theory for the deflagration-to-detonation transition (DDT) in reactive granular materials,*, J. Mult. Flow 12 (1986), 861-889, 1986.

[2] P. EMBID and M. R. BAER, *Mathematical analysis of a two-phase continuum mixture theory*, Continuum Mech. Thermodyn. 4 (1992), 279-312, 1992.

[3] S. JIN and Z. XIN, *The relaxation schemes for systems of conservation laws in arbitrary space dimensions*, Comm. Pure Appl. Math. 48 (1995), 235-276, 1995.

[4] M. BAUDIN, C. BERTHON, F. COQUEL, R. MASSON and Q. H. TRAN, *A relaxation methode for two-phase flow models with hydrodynamic closure law*, Numer. Math. 99 (2005), 411-440, 2005.

[5] K. SALEH, *Analyse et simulation numérique par relaxation d'écoulements diphasiques compressibles. Contribution au traitement des phases évanescentes*, Phd thesis, Université Pierre et Marie Curie, 2012.

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