CEMRACS 2011 project proposal : Large time-step and asymptotic-preserving numerical schemes for compressible two-phase flows

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We are interested in the computation of compressible two-phase flows using bi-fluid models. Let us quote for instance the four-equation mixture models or the so-called *two-fluid two-pressure* or *seven-equation* model first introduced in Baer & Nunziato [1]. So far, many of the proposed numerical methods are based on time-explicit, exact or approximate, Godunov-type methods (Roe or Roe-like scheme, HLL or HLLC scheme...). For stability reasons, the time steps involved in such methods obey a natural Courant-Friedrichs-Lewy (CFL) condition driven by the fastest eigenvalues of the model, associated with the so-called acoustic waves.

In many applications, like for instance in two-phase flows involved in nuclear reactors which motivates this proposal, the acoustic waves are not predominant. A CFL condition based on the most influent waves, the so-called contact waves would be more adapted. The idea is then to use a time-implicit treatment of the (fast) acoustic waves, in order to get rid of a too restrictive CFL condition, together with an explicit treatment of the (slow) contact waves in order to keep accuracy. This was recently proposed in Coquel *et al.* [3] in the context of Euler equations, using a Lagrange-Projection approach. This approach is well-adapted as it naturally decouples the fast and slow waves in the Lagrange and Projection steps respectively.

In Chalons, Coquel, Kokh and Spillane [2], a first attempt to extend this approach to the seven-equation model was presented. We propose to go further in the study of this extension and to consider various models. Even though the program is still open, a list of possible tasks for this project could be as follows :

- Study, improvement and justification of the method
- Careful implementation via compiled language
- Numerical illustrations in one-space dimension and on unbounded domains (with convergence study, CPU cost evaluation...)
- Consideration of boundary conditions and numerical illustrations in one-space dimension
- Study of Asymptotic-Preserving properties
- Study of the low-Mach regime and possible extension to two-space dimension

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References

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