Numerical schemes for the compressible Cahn-Hilliard-Navier-Stokes equations

Authors:

- Pep Mulet, Universitat de València (mulet@uv.es)

Abstract: In [4] a spinodal decomposition, governed by the Cahn-Hilliard equation [2], is conjectured as the underlying mechanism that explains the layered sedimentations of monodisperse colloidal particles.

Since the Cahn-Hilliard equation cannot explain this phenomenon by itself, the gravitational force is introduced into the model by means of conservation of mass and momentum, which, together with conservation of individual species and ignoring temperature changes, yields a system of equation, the isentropic compressible Navier-Stokes-Cahn-Hilliard equations [3, 1], which are a system of fourth-order partial differential equations that model the evolution of mixtures of binary fluids under gravitational effects.

Although incompressible models for these equations might be more suitable for explaining the cited layering phenomenon, we consider the compressible case for the evolution of, e.g. foams, solidification processes, fluid-gas interface.

The goal of this contribution is the design of implicit-explicit time-stepping schemes to avoid the severe restriction posed by the high order terms for the efficient numerical solution of boundary-initial problems with these equations.

We show some two-dimensional experiments to assess the possibilities of obtaining efficient algorithms.

References:

[1] Helmut Abels and Eduard Feireisl. On a diffuse interface model for a two-phase flow of compressible viscous fluids. *Indiana Univ. Math. J.*, 57(2):659–698, 2008.

[2] JW Cahn and JE Hilliard. Free energy of a nonuniform system .3. nucleation in a 2-component incompressible fluid. *J. Chem. Phys.*, 31(3):688–699, 1959.

[3] J. Lowengrub and L. Truskinovsky. Quasi-incompressible Cahn-Hilliard fluids and topological transitions. *Proc. Royal Soc. A*, 454(1978):2617–2654, 1998.

[4] Donald B. Siano. Layered sedimentation in suspensions of monodisperse spherical colloidal particles. *J. Colloid and Interface Sci.*, 68(1):111–127, 1979.