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A particle method with remeshing for compressible multifluids

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ABSTRACT

We present a particle method with remeshing applied to the simulation of compressible multifluids, more particularly to hydrodynamic instabilities. Similarly to standart particle methods, like SPH (Smoothed Particle Hydrodynamics) [1] or PIC (Particle In Cell) [2], the advection is in our case solved by moving the particles at the fluid velocity. But, in order to maintain the regularity of the particle distribution (and thus maintain the accuracy of the computation) we perform at each time step a particle-mesh interpolation on an underlying grid, in order to create new particles uniformly distributed. This remeshing process, inspired by VIC (Vortex In Cell) methods [3] used for incompressible fluids, represents the key element of the particle method presented here.

In order to simulate multifluids, we use a level-set like technique adapted to this particle method. A color function ϕ, whose value is for example 1 in one fluid and -1 in the other fluid, is discretized on the particles, advected and interpolated as the other variables. To adapt the accuracy of the computation in areas of steep gradients, for example at the interface between the fluids, we use a refinement technique for particles introduced by Bergdorf, Cottet and Koumoutsakos in [6]. This refinement technique can be applied to the whole set of equations to solve, or simply to the function ϕ carrying the information about the interface. In this latter case, the refinement allows for a better conservation of partial masses, which is not guaranteed by the level-set method.

We present numerical results obtained with this method applied to several instability computations: compressible Kelvin-Helmholtz instability, shock-bubble interaction, Richtmyer-Meshkov instability. This results are particularly interesting because, to our knowledge, standart particle methods for compressible fluids (SPH, PIC) are not able to solve correctly this kind of instabilities ([4], [5]).

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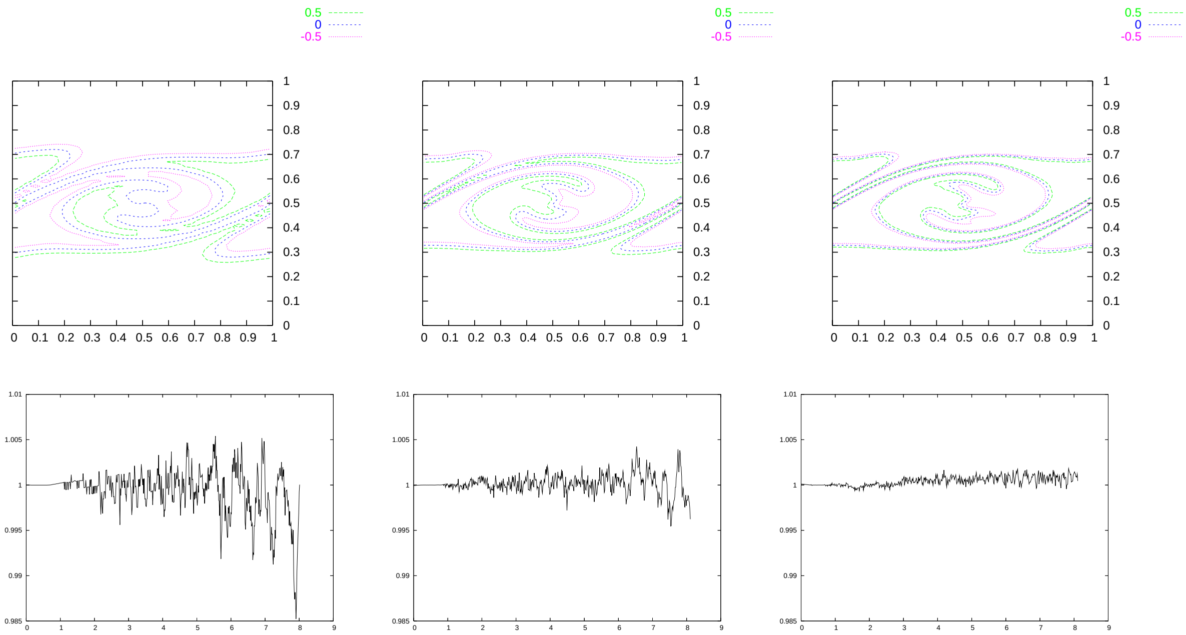

Figure 1: Kelvin-Helmholtz instability computed with a refinement of the color function ϕ, top: isolines $\phi = -0.5,\ 0,\ 0.5$, at $t = 8$, bottom: time evolution of partial masses ratio, from left to right 50, $50/100$ and $50/200$ particles.

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