MMALE numerical simulation for multi-material large deformation fluid flows

Qinghong Zeng, Wenjun Sun

Institute of Applied Physics and Computational Mathematics, Beijing 100094, China

Multi-material large deformation fluid flows exist frequently in astrophysics, weapon physics and inertial confinement fusion (ICF) fields. There are two important characteristics in these kinds of flow phenomena. One is the violent movement of the fluid, which leads to large deformation of fluid field. The other is the existence of multi-material and the distortion of the interface between different materials.

Multi-material arbitrary Lagrangian-Eulerian (MMALE) methods are employed widely in the computation of multi-material and large deformation fluid flows. In these methods, mixed cells are introduced and the material interfaces are permitted to cross computational cells. Here mixed cells are cells including two or more kinds of materials. The introduction of mixed cells make the computational code robust, while keep the computational results as accurate as possible. To handle the material interfaces in mixed cells, MOF interface reconstruction method is used in MMALE simulations.

A test case deals with the well-known Rayleigh-Taylor instability. The computational domain is the rectangular box [0,1/3]x[0,1] with is paved with 34x100 cells. The initial set up consists of two immiscible fluids which are separated by a perturbed interface, whose equation writes $y_i(x) = 0.5 + 0.01\cos(6\pi x)$. The heavy fluid is located above the light one. The densities of the two fluids are $\rho_h = 2$ and $\rho_l = 1$. The same polytropic index $\gamma = 1.4$ is shared by the two fluids. A downward gravity field is applied, $\boldsymbol{g} = (0, -0.1)^t$. We have plotted in Fig.1 the grid and interface at times t=7, t=8 and t=9.

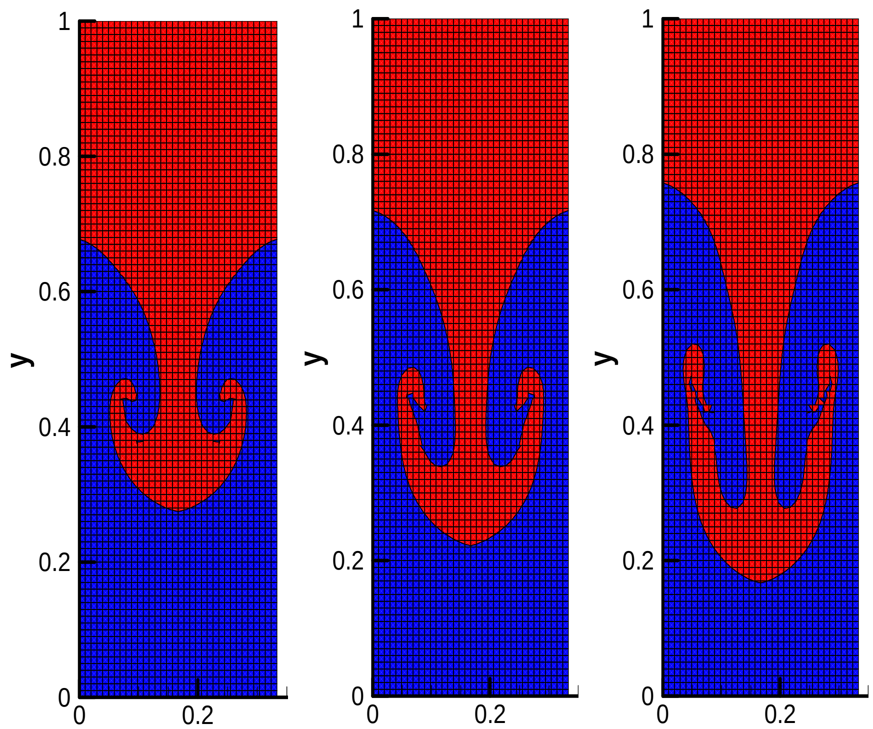

Fig.1 Rayleigh-Taylor instability. Snapshots of the grid and interface at times t=7, t=8 and t=9