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Surface tension in incompressible Rayleigh-Taylor mixing flow

YUAN-NAN YOUNG, Dept. of Mathematical Sciences, NJIT, FRANK HAM, Dept. of Mechanical Engineering, Stanford University — We study the effect of surface tension on the incompressible Rayleigh-Taylor instability. We modify Goncharov's local analysis [1] to consider the surface tension effect on the Rayleigh-Taylor bubble velocity. The surface tension damps the linear instability and reduces the nonlinear terminal bubble velocity. We summarize the development of a finite-volume, particle-level-set, two-phase flow solver with an adaptive Cartesian mesh, and results from convergence and validation studies of this two-phase flow solver are provided. We use this code to simulate the single-mode, viscous Rayleigh-Taylor instability with surface tension, and good agreement in terminal bubble velocity is found when compared with analytic results. We also simulate the immiscible Rayleigh-Taylor instability with random initial perturbations. The ensuing mixing flow is characterized by the effective mixing rate and the flow anisotropy. Surface tension tends to reduce the effective mixing rate and homogenizes the Rayleigh-Taylor mixing flow. Finally we provide a scaling argument for detecting the onset of the quadratic, self-similar Rayleigh-Taylor growth.

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