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Direct Numerical Simulations of Immiscible Rayleigh-Taylor Instability ZHAORUI LI, Texas A&M University-Corpus Christi, DANIEL LIVESCU, Los Alamos National Laboratory — Accurate simulations of multi-mode immiscible Rayleigh-Taylor instability (RTI) are presented with the recently developed generalized Cahn-Hilliard Navier-Stokes (GCHNS) equations method. In immiscible turbulent flows, besides the viscous cut-off scale, there are two additional characteristic length scales, which also affect the flow. One is the so-called "cut-off" length scale caused by the presence of surface tension and the other is the physical interface thickness. While in some practical applications the interface thickness can be large, in many other cases this thickness approaches the molecular scales. Accurate results can be obtained for these cases if the interface thickness is maintained smaller than all the cut-off scales of the flow, but still much larger than the molecular scales (e.g. mean free path). Our study shows that, as long as the scale-separation (e.g. the ratio of Kolmogorov scale to the interface thickness) is above a certain value (4 to 6 for the RTI problem considered in this study), the numerical results are fully converged with respect to the interface thickness. The results are used to study the physics of multi-mode immiscible RTI and contrasted to those obtained for the miscible case.

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