An interface-compressed diffuse interface lattice Boltzmann method for multiphase flows

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Abstract

In this study, an interface-compressed diffuse interface lattice Boltzmann method is proposed for simulating multiphase flow with large density ratio. In this method, the flow field is achieved by using the lattice Boltzmann method, and the interface the captured by solving the Cahn-Hilliard equation. A convection-compression term is introduced into the Cahn-Hilliard equation to suppress the interface dispersion caused by the numerical and modeling diffusion. The additional term only takes effect in the region of phase interface and works normal to the interface. The compression rate can be adjusted by compression factor and fluid velocity. Numerical validations of proposed method are implemented by simulating Rayleigh-Taylor instability, bubble deformation in shear flow, bubble merging and bubble rising with density ratio of 1000 and viscosity ratio of 100. Good agreement of interface shapes and flow properties has been achieved as compared with both analytical solutions and published data in the literature. The obtained results also show that the present method makes great improvement of interface sharpness and avoids the occurrence of unphysical phenomenon. Meanwhile, the tiny interfacial structures can be captured effectively.

Keywords: multiphase flow; diffuse interface method; interface compression; large density ratio; tiny interfacial structure