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Lattice Boltzmann Modeling of Multi-phase Interfacial Flows[1]

TAEHUN LEE, City College of City University of New York

A free-energy based lattice Boltzmann method (LBM) for liquid-vapor and binary two-phase flows will be presented. Although very efficient and simple to implement, two-phase LBMs have been known to be unstable when the difference in material properties of two phases or the Reynolds number is large. Two major issues associated with the numerical stability of the free-energy based two-phase LBM under these conditions will be discussed. The intermolecular force needs to be in the potential form and its discretization needs to be compact and isotropic in order to eliminate parasitic currents, whose magnitude and extent usually increase as surface tension. High-order polynomial boundary conditions for free-energy are employed to correctly predict the equilibrium contact angle and the density profile at solid surfaces for large density contrast. Test cases include bubble generation in microfluidic devices, and droplet spreading and impact on flat and structured surfaces with different wetting characteristics.

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