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Smoothed particle hydrodynamics applied to multiphase flows

MARION VANCE, KYLE SQUIRES, Arizona State University — Fully Lagrangian numerical simulations of multiphase flows are performed using a numerical approach that is a variation of smoothed particle hydrodynamics. The momentum conservation equation for the constant mass fluid elements is described using the Boltzmann transport equation and particle phase space probability density function. Analogous to the familiar forms of continuum fluid mechanics, the acceleration of a fluid element is due to the gradient of local kinetic stress, the constitutive terms of which are determined following expansion methods from kinetic theory of a dense gas. Including first-order terms, the acceleration of fluid elements is proportional to local particle density and relative velocity, and those elementary forces tend to drive the system towards an equilibrium state. The fundamental restoring and dissipative particle forces are shown to model familiar pressure, viscous, and surface tension effects at the macroscopic scale. The method is applied to test problems that include the wall- bounded flow of two nearly immiscible fluids, the rise of bubbles in an infinite quiescent liquid, and hard sphere sediment transport. Simulations are performed in both two and three dimensions, and the observations are compared to published results.

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