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Diffuse interface surface tension models in an expanding flow. (English) Zbl 1272.35025

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Summary: We consider a diffusive interface surface tension model under compressible flow. The equation of interest is the Cahn-Hilliard or Allen-Cahn equation with advection by a non-divergence free velocity field. These are two reduced models which show important properties of the full-scale surface tension model. We prove that both model problems are well-posed. We are especially interested in the behavior of solutions with respect to droplet breakup phenomena. Numerical simulations of 1, 2, and 3D all illustrate that the Cahn-Hilliard model is much more effective for droplet breakup. Using asymptotic methods we correctly predict the breakup condition for the Cahn-Hilliard model. Moreover, we prove that the Allen-Cahn model will not break up under certain circumstances due to a maximum principle.

MSC:

35B32 Bifurcations in context of PDEs
35B50 Maximum principles in context of PDEs
76T10 Liquid-gas two-phase flows, bubbly flows

Keywords:

Cahn-Hilliard equation; numerical simulation; compressible flow; Allen-Cahn equation with advection; non-divergence free velocity field; droplet breakup phenomena

Full Text: DOI