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An asymptotically consistent diffuse interface method for simulating bubble dynamics in inhomogeneous environments A. TIWARI, C. PANTANO, J.B. FREUND, University of Illinois at Urbana–Champaign — Theoretical models are effective for describing the physics of spherically symmetric bubble collapse, rebound and oscillation. However, for multi-bubble problems (bubble clouds) or near a solid wall, linear Bjerknes theory can only explain weak bubble interactions that do not lead to significant deviations from spherical bubble. Full-domain-based numerical methods are, in principle, capable of describing the nonlinear dynamics of bubble interactions in these inhomogeneous environments, but simulation of even a single bubble collapse poses significant computational challenges resulting from the inherent dynamical instability of such bubbles. We present an efficient and geometrically flexible numerical method to study bubble interactions. The method is build around a five-equation Eulerian diffuse-interface flow model, asymptotically reduced from Baer–Nunziato's compressible multi-fluid model within the 3D finite-volume framework. A consistent compression technique is developed to prevent the smearing of volume fraction and density across the interface. Upon being rigorously tested for spherically symmetric bubble collapses, we use it to simulate near-wall collapses. We show the distinctive formation of a torus bubble as the involuting jet from the distal surface penetrates the proximal surface. Preliminary results for multi-bubble interactions are also presented.

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