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Numerical simulations of cavitation near an elastic object

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Bubbles cavitate near surfaces during medical therapies like lithotripsy, which pulverizes urinary stones using ultrasound. The ultrasound pressures cause bubbles to oscillate in volume, the surrounding liquid to evaporates into the gas bubble, water vapor to condense, and non-condensable gases to dissolve. Phase change and mass diffusion affect the nucleation, growth, and collapse stages of these bubble dynamics, though it is often ignored during numerical simulations for simplicity. As a step towards improving ultrasound therapies, we systematically study the effect of phase change and mass diffusion on bubble dynamics.

Our study uses the Multicomponent Flow Code (MFC), which solves the 3D, compressible Navier–Stokes equations using a six-equation multiphase computational model that has been recently extended to include phase change and mass diffusion [1]. We conduct simulations of asymmetric bubble dynamics near a rigid wall with three components: liquid water, water vapor, and gas. The phase change is modeled as a kinetic process at interfaces using the fractional time-stepping algorithm and thermodynamic relaxation technique of [2]. Numerical simulations of 1D Riemann problems and 2D and 3D underwater explosion problems verify our implementation. The role of phase change and mass diffusion on the dynamics of one and multiple bubbles oscillating near a compliant elastic object is characterized.

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