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A robust multiphase flow solver for high density ratio wave structure interaction problems AMNEET PAL S. BHALLA, San Diego State University — In this talk, we present a robust, adaptive numerical scheme for simulating high-density ratio and high shear multiphase flows on locally refined staggered Cartesian grids that adapt to the evolving interfaces and track regions of high vorticity. The algorithm combines the interface capturing level set method with a variable-coefficient incompressible Navier-Stokes solver that is demonstrated to stably resolve material contrast ratios of up to six orders of magnitude. The discretization approach ensures second-order pointwise accuracy for both velocity and pressure with several physical boundary treatments, including velocity and traction boundary conditions. To ensure the stability of the numerical scheme in the presence of high density and viscosity ratios, we employ a consistent treatment of mass and momentum transport in the conservative form of discrete equations. We demonstrate through several test cases that the lack of consistent mass and momentum transport in non-conservative formulations, which are commonly used in practice can yield very large numerical error and very poor accuracy for convection-dominant high-density ratio flows. Finally, we combine our robust multiphase fluid solver with an efficient implementation of immersed boundary method to simulate wave-structure interaction problems. Several cases from practical ocean and marine engineering applications, including simulations of wave energy converter devices are presented.

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