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Numerical simulation of particle dynamics at a fluid interface[1]

PENGTAO YUE, Virginia Tech — Particles straddling a fluid interface exhibit rich dynamics due to the coexistence of moving boundaries, fluid interfaces, and moving contact lines. For instance, as a particle falls onto a liquid surface, it may sink, float, or even bounce off depending on a wide range of parameters. To better understand the dynamics of such a multiphase system, we develop a finite-element based arbitrary Lagrangian-Eulerian-phase-field method. The governing equations for particles and fluids are solved in a unified variational framework that satisfies an energy law. We first validate our code by computing three problems found in literature: sinking of a horizontal cylinder through an air-water interface, sinking of a sphere through an air-oil interface at small Reynolds numbers, and bouncing of a sphere after its normal impact onto an air-water interface. Our numerical results show good agreements with experimental data. We then investigate the effect of wetting properties, including static contact angle, slip length, and wall energy relaxation, on particle dynamics at the fluid interface.

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