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Numerical simulation of free surface flows using a DG level-set method

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Abstract

Free-surface and multiphase flows arise in numerous natural and industrial processes and remains challenging to simulate due to the presence of moving interfaces and strong discontinuities in material properties. Interface-capturing methods provide an efficient framework for handling complex interface deformations and topological changes without explicit interface tracking.

In this work, the interface is described using a level-set approach [1], whose evolution is governed by a transport equation. This equation is discretized using a reformulated discontinuous galerkin method [2]. The flow field is modeled by the incompressible Navier-Stokes equations with variable density and viscosity. Surface tension effects are incorporated as a volumetric force using a continuum surface force model [3].

The proposed approach is evaluated using the classical rising bubble benchmark of Hysing et al. [4]. The numerical results show stable interface evolution and good agreement with reference solutions, demonstrating the capability of the method to simulate free-surface flows reliably.

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