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The eXtended Finite Element Method for Moving interface problems

Multi-phase flows exist in nature and in technological systems. Numerical modeling of multi-phase flows faces several intrinsic difficulties, mainly due to the changes in the topology of the interface as it evolves with time. In standard finite element methods with level-set techniques, the approximation of the unknown interface is not always aligned with the grid. Standard polynomial finite element spaces have very poor approximation quality when used for discretization. The eXtended Fnite Element Method (XFEM) introduced initially by Belytschko and Black addresses these difficulties by potentially making the mesh independent of the interface geometry. In the XFEM, the approximation space is enriched and, as a consequence, able to represent a priori known solution properties such as jumps and kinks exactly in element interiors. . In this talk, we address the issue of the choice of the enrichment functions for the velocity and for the pressure and investigate a solution algorithm. We consider flows dominated by gravity and by the jumps in the fluid properties. We use the Taylor-Hood element so that the standard Galerkin finite element formulation can be used to discretize the Navier-Stokes equations. The velocity is either un-enriched or enriched. The pressure is enriched by the modified-abs function, the discontinuous sign function or the discontinuous abs function. The latter function is proposed in this work as it satisfies the partition of unity property. Several tests are investigated to evaluate the proposed methods for solving complex moving interface problems