DIVERGENCE PRESERVING CUT FINITE ELEMENT METHODS

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Abstract. I will give an introduction to Cut Finite Element Methods (CutFEM) for interface problems and present our recent development that results in pointwise divergence-free velocity approximations of incompressible flows.

I will first introduce a cut finite element discretization of a Darcy interface problem based on the mixed finite element pairs $\mathbf{RT}_k \times Q_k$ [1]. Here, Q_k is the space of discontinuous polynomial functions of degree k and $\mathbf{RT}_k$ is the Raviart-Thomas space. I will then based on $\mathbf{H}^{\mathrm{div}}$-conforming finite elements present cut finite element methods for the Stokes equations [2]. These methods exhibit optimal convergence order for the velocity, pointwise divergence-free velocity fields, and well-posed linear systems, independently of the position of the boundary/interface relative to the computational mesh. In cut finite element methods Dirichlet boundary conditions are imposed weakly, which gives rise to some challenges that I will discuss.

Keywords: mass conservation, mixed finite element methods, unfitted finite element methods, weak imposition of boundary conditions

Mathematics Subject Classifications (2010): 65N30, 65N85, 65N22.

References

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[2] T. Frachon, E. Nilsson, S. Zahedi. Divergence-free cut finite element methods for Stokes flow. arXiv:2304.14230, 2023.

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