6th European Conference on Computational Mechanics (Solids, Structures and Coupled Problems) (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
June 11- 15, 2018, Glasgow, UK

UNFITTED FINITE ELEMENT METHODS FOR COMPLEX FLOW PROBLEMS

ANDRÉ MASSING[1] , DOMINIK SCHILLINGER[2], ANNA SCOTTI[3], AND SARA ZAHEDI[4]

[1] Department of Mathematics and Mathematical Statistics, Umeå University, SE–90187 Umeå
email: andre.massing@umu.se, web page : http://www.math.umu.se/english/

[2] Department of Civil, Environmental, and Geo-Engineering, University of Minnesota, USA
email: dominik@umn.edu, web page : http://www.tc.umn.edu/~dominik/

[3] MOX, Department of Mathematics, Politecnico di Milano, Italy
email: anna.scotti@polimi.it, web page : https://mox.polimi.it/

[4] Department of Mathematics, KTH Royal Institute of Technology, Sweden
email: sara.zahedi@math.kth.se, web page : https://www.kth.se/en/sci/institutioner/math

Key words: Unfitted Finite Element Methods, Fluid Dynamics, Complex and Evolving Domains, Multiphysics Flow Problems, Multidimensional Coupling.

ABSTRACT

Many advanced engineering problems require the numerical solution of multidomain, multidimension, multiphysics and multimaterial flow problems with interfaces. When the interface geometry is highly complex or evolving in time, the generation of conforming meshes may become prohibitively expensive, thereby severely limiting the scope of conventional discretization methods. For instance, the simulation of geological flow and transport problems requires a series of highly non-trivial steps to transform geological image data into conforming domain discretizations which respect complex geometric structures such as faults and large-scale networks of fractures. Potential multidimensional coupling between bulk and fracture related quantities poses additional challenges. The mesh generation problem is even more pronounced if the geometry of the model domain changes substantially in the course of the simulation, e.g., for multiphase flows, where the interface between different fluid phases can undergo large and even topological changes when bubbles merge or break up. Similar challenges are encountered in parameter studies and optimization problems with changing geometric domains.

A potential remedy to these challenges are flexible numerical schemes for PDEs which allow to embed complex or changing domain parts freely into a static and easy-to-generate computational domain. Consequently, so-called unfitted finite element methods such as the extended finite element method, unfitted discontinuous Galerkin methods, traceFEMs, cut finite element and finite cell methods, and related techniques have received a lot of attention in recent years. The objective of this minisymposium is to present the latest advances and application areas for unfitted finite element technologies for complex flow problems, and to discuss their theoretical and implementational challenges.