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IMMERSED-BOUNDARY VARIATIONAL METHODS: THEORY, DATA STRUCTURES, AND APPLICATIONS

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MINISYMPOSIUM

Immersed Boundary Methods (IBM) have been attracting strongly increased attention during the past ten to fifteen years. Their central principle is to extend a domain of computation to a larger one, typically with a simple shape, which is easy to mesh. On this extended domain a finite element type computation is performed, distinguishing between regions interior and exterior to the original domain. Under the denotation 'fictitious domain' or 'embedded domain methods' the central principle has been followed already since the 1960ies. The recent new interest results from innovative and efficient algorithmic developments, from mathematical analysis showing optimal convergence despite the presence of cut elements, the possibility to efficiently link these methods to various types of geometric models and from many new engineering applications. Many variational versions of Immersed Boundary Methods have been developed, like CutFEM, the Finite Cell Method, Unfitted Finite Elements, the Shifted Boundary Method, Phi-FEM, Immersogeometric Analysis, just to name a few.

This mini-symposium will focus on Immersed Boundary Methods of variational type, and the various aspects that make them successful in addressing complex problems, namely: mathematical analysis, a priori and a posteriori error estimation and adaptivity, advanced numerical integration procedures, data structures and parallel scaling of algorithms, integration with CAD models and non-standard geometric representations, and applications. The scope of this mini-symposium is to be as broad as possible in terms of applications, such as, but not limited to: problems in solid mechanics, heat transfer, CFD, fluid/structure interaction, and any other types of domain coupling. Topics will also include computational homogenization techniques and the connection between Immersed Boundary Methods and meta-algorithms, such as the ones used in Uncertainty Quantification, Reduced Order Models, Machine Learning and Artificial Intelligence, Direct and Inverse Problems, and Topology Optimization, just to name a few.