Advanced techniques for coupled problems

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ABSTRACT

Many important societal problems, for instance, in geothermal energy exploration, enhanced oil recovery, water management, (bio-)medicine, battery design and food technology, are described mathematically by interface-coupled systems of partial differential equations based on porous media modelling. To a large extent urged on the ongoing technological progress, the necessity for a profound understanding of such problems and the capability of their numerical simulation highly increased in the past. However, the development of stable, efficient and robust solvers for interface-coupled multi-physics continues to remain a challenging task. Many computational algorithms still exhibit severe fundamental issues. Current limitations arise from their inability to deal with topological changes of the geometry or the resolution of layers.

The development, elucidation and further advancements with regard to fundamental properties of numerical stability of new simulation techniques for interface-coupled problems related to porous media and subsurface dynamics is addressed here. Solvers based on monolithic and splitting techniques, also for nonlinear multi-physics, and unfitted and new finite element techniques, (for instance, CutFEM [1,2]) for problems with topologically changing domains or thin layers or fractures are targeted. Analyses of algorithms and their applications to problems of practical interest are contributions.

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