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Multidimensional Coupled Problems: Mathematical Foundations, Numerical Methods and Applications

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ABSTRACT

Many challenging problems arising in science and engineering involve the interaction of physical phenomena described by coupled partial differential equations on domains of different dimensions, scales, or geometrical complexity. Examples include fluid-structure interaction, flow and transport in networks and fractured media, solid-fluid interactions, biomedical systems, modeling of new materials, and coupled processes in geophysical applications.

The differences in dimensionality and physical nature of the coupled models raise fundamental questions concerning mathematical modeling, coupling conditions, discretization, stability and error control, while also posing significant computational challenges for large-scale simulations.

This session aims to bring together recent developments in the mathematical analysis and numerical approximation of multidimensional and multiphysics coupled problems. Particular emphasis will be placed on the interplay among mathematical models, discretization strategies and efficient solvers, with the goal of connecting theoretical advances with challenging applications.

Topics of interest include, but are not limited to multiphysics and multiscale systems, non-conforming and immersed discretizations, and interface and contact problems, with the aim of highlighting the challenges, capabilities, and effectiveness of mixed-dimensional models.

The session welcomes contributions ranging from mathematical analysis and numerical methods to computational mechanics and application-driven modeling. A particular goal is to foster interaction between different communities and to identify common numerical and analytical structures underlying seemingly different coupled problems, highlighting how advances in theory can translate into robust and efficient computational tools for real-world applications.