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Topologically-reduced models of flows in porous media with inclusions

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Mixed-dimensional coupled problems are characterized by coupled partial differential equations defined over domains of different dimensions. Examples include porous media with embedded inclusions. These problems arise in several applications ranging from geosciences to biomedicine. These models are computationally efficient thanks to the dimension reduction of the physical problem valid in the inclusions.

This talk presents recent advances for the numerical analysis of mixed-dimensional PDEs with co-dimension equal to two. First, the convergence of a discontinuous Galerkin scheme is obtained via the derivation of a priori error bounds. The analysis is non-standard because of the low regularity of the weak solution. Second, using topological model reduction, we obtain reduced models of solute transport in tubular-like inclusions of varying cross-section and with arbitrary axial velocity profile. Finally, numerical examples of flow in an organ and its vasculature are shown.

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References

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