A High-Order Localized Orthogonal Decomposition for Stokes Equations

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Abstract

We shall present a high-order multiscale method introduced in [1] for heterogeneous Stokes problems. It is based on the Localized Orthogonal Decomposition methodology and achieves optimal convergence orders under minimal structural assumptions on the coefficients. The method can be set on meshes with elements of arbitrary shape, and precomputes problem specific basis functions on patches of cells, associating them to both faces and cells of the mesh. A key feature of our approach is the careful design of so-called quantities of interest, defining functionals of the solution whose values the multiscale approximation aims to reproduce. Their selection is particularly delicate in the context of Stokes problems due to potential conflicts arising from the divergence-free constraint. The exponential decay of the problem-adapted basis functions can be proven, justifying their localized computation in practical implementations. A rigorous *a priori* error analysis predicts high-order convergence for both velocity and pressure, if the basis supports grow logarithmically with the desired accuracy.

This is a joint work with Moritz Hauck (Karlsruhe).

References

[1] Hauck, M., & Lozinski, A. (2025). A High-Order Localized Orthogonal Decomposition Method for Heterogeneous Stokes Problems. arXiv:2511.22684.