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Scalable and optimal preconditioners for coupled multiphysics problems

Thursday, December 11, 2025 9:45 AM (45 minutes)

We introduce augmented Lagrangian preconditioning strategies for solving linear systems arising from coupled problems. In particular we explore in details finite element discretizations of fictitious domain formulations with Lagrange and distributed Lagrange multipliers. The presentation focuses on two- and three-block structures appearing in Poisson, Stokes, and elliptic interface problems, and on their efficient solution with Flexible GMRES. We discuss both exact and inexact augmented Lagrangian preconditioners, including a computationally cheaper block-triangular variant. A spectral analysis is provided to explain the observed convergence behavior. Numerical experiments in two and three dimensions demonstrate the robustness and scalability of the proposed preconditioners, even in the presence of strong coefficient jumps.

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