Adaptive Mixed Finite Element Method for Stress-Based Formulations of Eigenvalue Problems

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we introduce a novel three-field mixed finite element method for eigenvalue problems (EVPs) in Stokes flow and linear elasticity. Our approach is based on a weakly enforced symmetric Hellinger–Reissner formulation, using a Lagrange multiplier to represent angular momentum conservation. We use a tensor-valued stress field (with rows in a Raviart–Thomas space), a discontinuous piecewise-polynomial field for velocity or displacement, and a continuous piecewise-polynomial space for weak symmetry enforcement. This leads to a stress–velocity–vorticity formulation for Stokes EVPs and a stress–displacement–rotation formulation for elasticity EVPs. Enforcing physical laws like momentum balance, constitutive relations, and mass conservation, this formulation allows direct stress approximation, important in many applications. While uniform refinement may yield suboptimal convergence for low-regularity eigenfunctions, we address this via adaptive refinement guided by reliable a posteriori error estimators. Numerical results in 2D and 3D, on both convex and non-convex domains, confirm the method's efficiency and robustness.

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