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A Least-Squares Finite Element Method for Viscoelastic Flow.

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The equations describing viscoelastic fluid flow are inherently nonlinear and pose a continuing challenge to most numerical approximation methods. Even the addition of a small component of elastic behavior to Newtonian fluid can introduce instabilities. In this talk we present progress toward a multilevel least-squares finite element method for steady viscoelastic fluid flow of Oldroyd-B type. Our approach is to combine an outer iteration consisting of linearization steps on a nested sequence of grids with an inner iteration of a least-squares finite element discretization and algebraic multigrid linear solver. One of the challenges arising from this system is in treating the convective nature of the constitutive equation. We discuss an analogous, but simplified, problem that illustrates the difficulties, and suggest a strategy for least-squares discretizations to treat equations with strong convective terms.