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Fast Solvers for Models of Fluid Flow with Spectral Elements

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Numerical simulation provides a mechanism for predicting the behavior and aiding in the design of fluid systems. Computational methods based on explicit or semi-implicit time stepping can fail to provide a scalable means of performing simulations because of a stability-based time step constraint. Implicit and steady state solvers, however, are not limited by this constraint and can provide an efficient alternative for performing flow studies. The expense of implicit and steady-state solvers depends primarily on the cost of solving associated large sparse linear systems. These linear systems are solved using iterative methods, and the convergence can often be accelerated via preconditioning. We will introduce a new technique for solving convection-diffusion systems that leverages properties of the spectral element discretization and demonstrate how this technique can be used as a component of a block preconditioning strategy for solving a range of fluid flow problems.