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A deflated Schur complement method for the iterative solution of a high-order discontinuous element discretization of the Poisson equation

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A combination of block-Jacobi and deflation preconditioning is used to solve a high-order discontinuous element-based collocation discretization of the Schur complement of the Poisson-Neumann system as arises in the operator splitting of the incompressible Navier-Stokes equations. The ill-posedness of the Poisson-Neumann system manifests as an inconsistency of the Schur complement problem, but it is shown that this can be accounted for with appropriate projections out of the null space of the Schur complement matrix without affecting the accuracy of the solution. The block-Jacobi preconditioner, combined with deflation, is shown to yield GMRES convergence independent of the polynomial order of expansion within an element. Finally, while the number of GMRES iterations does grow as the element size is reduced (e.g. h-refinement), the dependence is very mild; the number of GMRES iterations roughly doubles as the element size is divided by a factor of six. In light of these numerical results, the deflated Schur complement approach seems practicable, especially for high-order methods given its convergence independent of polynomial order.