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Block Preconditioning to Enable Physics-Compatible Implicit Multifluid Plasma Simulations EDWARD PHILLIPS, JOHN SHADID, ERIC CYR, SEAN MILLER, Sandia Natl Labs — Multifluid plasma simulations involve large systems of partial differential equations in which many time-scales ranging over many orders of magnitude arise. Since the fastest of these time-scales may set a restrictively small time-step limit for explicit methods, the use of implicit or implicit-explicit time integrators can be more tractable for obtaining dynamics at time-scales of interest. Furthermore, to enforce properties such as charge conservation and divergence-free magnetic field, mixed discretizations using volume, nodal, edge-based, and face-based degrees of freedom are often employed in some form. Together with the presence of stiff modes due to integrating over fast time-scales, the mixed discretization makes the required linear solves for implicit methods particularly difficult for black box and monolithic solvers. This work presents a block preconditioning strategy for multifluid plasma systems that segregates the linear system based on discretization type and approximates off-diagonal coupling in block diagonal Schur complement operators. By employing multilevel methods for the block diagonal subsolves, this strategy yields algorithmic and parallel scalability which we demonstrate on a range of problems.

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