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Scalable implicit, adaptive MFEM-based solvers for reduced resistive MHD QI TANG, LUIS CHACON, Los Alamos National Laboratory, TZANIO KOLEV, Lawrence Livermore National Laboratory, JOHN SHADID, Sandia National Laboratories, XIAN-ZHU TANG, Los Alamos National Laboratory — The extended magnetohydrodynamics (XMHD) equations are advanced continuum models to understand the evolution of complex plasma dynamics in tokamak disruptions. However, solving XMHD numerically is challenging due to its disparity in time and length scales, its strongly hyperbolic nature and its nonlinearity. Therefore, scalable, adaptive implicit algorithms based on efficient preconditioning strategies are necessary for XMHD. In this work, we design and develop several finite-element schemes for a simple model, the reduced resistive MHD equations. Both explicit and implicit schemes are developed using the scalable C++ framework MFEM (mfem.org). The implicit scheme is based on the JFNK method with a physics-based preconditioner as proposed in [Chacon et al. JCP 2002]. The preconditioner is generalized for the finite element discretization, and algebraic multigrid methods are used to invert certain operators to achieve scalability. Our preconditioner effectively treats stiff hyperbolic components in the system. Both explicit and implicit solvers are implemented in parallel with adaptive mesh refinement and dynamic load-balancing. Benchmark results will be presented to demonstrate the accuracy and scalability of the implicit scheme in the presence of strong scale disparity.

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