Abstract Submitted
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Fast, parallel, high-order simulation of the extended magnetohydrodynamic model[1] BEN SOUTHWORTH, University of Colorado, MILAN HOLEC, CHRIS VOGL, ILON JOSEPH, Lawrence Livermore National Laboratory, TOM MANTEUFFEL, University of Colorado — This project develops fast, parallel numerical methods to resolve Kelvin-Helmholtz and drift-wave instabilities with high-order (HO) accuracy in space and time. A drift-reduced extended magnetohydrodynamic (XMHD) model is used to describe the effects of macroscopic transport phenomena in plasma at the edge of a confinement device, which we then solve using high-order (HO) approximations, including HO curvilinear meshes discretized with HO finite elements and HO time integration schemes. HO methods offer unmatched resolution of the stiff nonlinear behavior of edge plasma and drift instabilities, but introduce numerous difficulties in solving the resulting equations. Here, we present a broad framework for the parallel numerical solution of HO XMHD models. The spatial problem is discretized using HO finite elements in the MFEM library, yielding a semidiscrete set of differential algebraic equations in time. For each time step, we apply a new framework for the fast parallel solution of fully implicit Runge-Kutta methods, coupled with an Anderson-accelerated nonlinear iteration. Each inner linear iteration is then solved implicitly using block preconditioning techniques, and a new nonsymmetric algebraic multigrid method called AIR is applied to the highly advective variables.

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