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Magnetized Edge Plasma Fluid Simulation Using High-Order Finite Elements[1] ILON JOSEPH, MILAN HOLEC, CHRIS VOGL, KETAN MITTAL, ANDRIS DIMITS, ALEX FRIEDMAN, TZANIO KOLEV, MARK STOWELL, XUEQIAO XU, BEN ZHU, Lawrence Livermore Natl Lab, TOM MANTEUFFEL, BEN SOUTHWORTH, University of Colorado, Boulder — A novel finite element approach is developed and applied to magnetized edge plasma simulation. The multiscale nature of the problem makes edge plasma physics simulations challenging due to the fast timescales associated with electric conductivity, thermal conduction, Alfven waves, and sound waves. Strong anisotropy in a magnetized plasma generates multiple spatial scales due to the formation of sharp boundary layers and filamentary structures that are aligned with the magnetic field lines. We are exploring the use of the MFEM framework, a highly scalable software library used for large-scale simulations to address these challenging physical, geometric, and numerical issues. Strategies for refining and adapting meshes near X-points caused by divertors and magnetic islands, as well as external walls, are being developed through adaptive mesh refinement, mesh optimization, high-order discretization, and high-order curved meshes. We have begun development of both linear and nonlinear solvers for the plasma fluid equations, including preconditioning strategies and block preconditioning strategies that address the combination of the shear Alfven wave, advection by the ExB flow, and anisotropic diffusion.

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