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An Implicit Method for Magnetic Fusion MHD Calculations using Adaptive, High-Order, High-Continuity Finite Elements[1] S.C. JARDIN, J. BRESLAU, N. FERRARO, Princeton Plasma Physics Laboratory, A. BAUER, M. SHEPHARD, Rensselaer Polytechnic Institute, M3D TEAM — Many aspects of the physics of toroidal magnetic fusion experiments can be described by a set of "Extended Magnetohydrodynamic" (E-MHD) equations for the evolution of the fluid-like quantities describing the high-temperature plasma and the magnetic field. Because of the multiplicity of time and space scales that develop, it is now recognized that adaptive higher-order finite elements with an implicit time integration scheme offer significant advantages. An ongoing effort to solve these E-MHD equations with finite elements with C^1 continuity is described. This leads to a compact representation and efficient solution algorithm. The method builds on a formalism for representing the velocity in a potential/stream-function form, and the magnetic field in an intrinsically divergence-free form. We report on solution characteristics of the full 8-field E-MHD equations in slab geometry. Recent applications on 2-fluid magnetic reconnection will be discussed, in particular the effect of a guide magnetic field on the onset of fast reconnection.

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