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Nested Iteration and Adaptive Local Refinement for Resistive Magnetohydrodynamic (MHD) Equations

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In this talk, we propose new adaptive local refinement (ALR) strategies for first-order system least-squares (FOSLS) finite element in conjunction with algebraic multigrid (AMG) methods in the context of nested iteration (NI). The goal is to reach a certain error tolerance with the least amount of computational cost and nearly uniform distribution of the error over all elements. This talk will develop theory that supports this argument, as well as show experiments to confirm that the algorithm can be efficient for MHD problems. These methods are applied to a 2D reduced model of the incompressible, resistive magnetohydrodynamic (MHD) equations. These equations are used to simulate instabilities in a large aspect-ratio tokamak. We show that, by using the new ALR strategies on this system, we are able to resolve the physics using only 10 percent of the computational cost used to approximate the solutions on a uniformly refined mesh within the same error tolerance.