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Fully implicit adaptive mesh refinement MHD algorithm BOBBY PHILIP, MICHAEL PERNICE, LUIS CHACON, LANL — In the macroscopic simulation of plasmas, the numerical modeler is faced with the challenge of dealing with multiple time and length scales. The former results in stiffness due to the presence of very fast waves. The latter requires one to resolve the localized features that the system develops. Traditional approaches based on explicit time integration techniques and fixed meshes are not suitable for this challenge, as such approaches prevent the modeler from using realistic plasma parameters to keep the computation feasible. We propose here a novel approach, based on implicit methods and structured adaptive mesh refinement (SAMR). Our emphasis is on both accuracy and scalability with the number of degrees of freedom. To our knowledge, a scalable, fully implicit AMR algorithm has not been accomplished before for MHD. As a proof-of-principle, we focus on the reduced resistive MHD model as a basic MHD model paradigm, which is truly multiscale. The approach taken here is to adapt mature physics-based technology[1] to AMR grids, and employ AMR-aware multilevel techniques (such as fast adaptive composite –FAC– algorithms) for scalability. We will demonstrate that the concept is indeed feasible, featuring optimal scalability under grid refinement. Results of fully-implicit, dynamically-adaptive AMR simulations will be presented on a variety of problems.

[1]L. Chacón et al., *J. Comput. Phys.* **178** (1), 15- 36 (2002)

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