Abstract Submitted
for the DPP10 Meeting of
The American Physical Society

A fully implicit Hall MHD algorithm based on the ion Ohm's law LUIS CHACÓN, ORNL — Hall MHD is characterized by extreme hyperbolic numerical stiffness stemming from fast dispersive waves. Implicit algorithms are potentially advantageous, but of very difficult efficient implementation due to the condition numbers of associated matrices. Here, we explore the extension of a successful fully implicit, fully nonlinear algorithm for resistive MHD,[1] based on Jacobian-free Newton-Krylov methods with physics-based preconditioning, to Hall MHD. Traditionally, Hall MHD has been formulated using the electron equation of motion (EOM) to determine the electric field in the plasma (the so-called Ohm's law). However, given that the center-of-mass EOM, the ion EOM, and the electron EOM are linearly dependent, one could equivalently employ the ion EOM as the Ohm's law for a Hall MHD formulation. While, from a physical standpoint, there is no *a priori* advantage for using one Ohm's law vs. the other, we argue in this poster that there is an algorithmic one. We will show that, while the electron Ohm's law prevents the extension of the resistive MHD preconditioning strategy to Hall MHD, an ion Ohm's law allows it trivially. Verification and performance numerical results on relevant problems will be presented.

[1]L. Chacón, *Phys. Plasmas*, **15** (2008)

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Date submitted: 16 Jul 2010 Electronic form version 1.4