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A Fully Implicit Particle-in-Cell Method for Gyrokinetic Electromagnetic Modes in XGC BENJAMIN STURDEVANT, SEUNG-HOE KU, C.S. CHANG, ROBERT HAGER, Princeton Plasma Physics Laboratory, LUIS CHACON, GUANGYE CHEN, Los Alamos National Laboratory — Electromagnetic gyrokinetic particle-in-cell methods are known to suffer from numerical difficulties, limiting their applicability to low-β or short wavelength regimes. The $v_\parallel$ formulation with explicit time discretization suffers from a severe time step constraint, and the $p_\parallel$ formulation suffers from an inexact cancellation of two large, non-physical terms appearing in Ampres law that emerge from the choice of coordinates. Here, we describe our implementation of a fully-implicit time integration scheme based on the work of Chen and Chacn [1-2] for a gyrokinetic ion, drift kinetic electron electromagnetic model employing the $v_\parallel$ formulation in the full volume fusion plasma code XGC1. By using an implicit discretization scheme, we overcome the previous time stepping difficulties associated with the $v_\parallel$ formulation and avoid introducing non-physical terms in Ampres law. The resulting system of nonlinear equations is solved iteratively using a preconditioner derived from an electron fluid model. We consider kinetic ballooning and micro-tearing modes to verify the scheme. [1] G. Chen, L. Chacn, and D.C. Barnes, J. Comput. Phys. 230 (2011) 7018. [2] G. Chen, L. Chacn, Comput. Phy. Comm. 197, (2015) 73-87.

Benjamin Sturdevant
Princeton Plasma Physics Laboratory

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