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A multi-dimensional nonlinearly implicit, electromagnetic Vlasov-Darwin particle-in-cell (PIC) algorithm GUANGYE CHEN, LUIS CHACÓN, LANL, COCOMANS TEAM — For decades, the Vlasov-Darwin model has been recognized to be attractive for PIC simulations (to avoid radiative noise issues) in non-radiative electromagnetic regimes.[1] However, the Darwin model results in elliptic field equations that renders explicit time integration unconditionally unstable.[1] Improving on linearly implicit schemes, fully implicit PIC algorithms for both electrostatic and electromagnetic regimes, with exact discrete energy and charge conservation properties, have been recently developed in 1D.[2,3] This study builds on these recent algorithms to develop an implicit, orbit-averaged, time-space-centered finite difference scheme for the particle-field equations in multiple dimensions. The algorithm conserves energy, charge, and canonical-momentum exactly, even with grid packing. A simple fluid preconditioner allows efficient use of large timesteps, $O(\sqrt{\frac{m_i}{m_e}}\frac{c}{v_{eT}})$ larger than the explicit CFL. We demonstrate the accuracy and efficiency properties of the of the algorithm with various numerical experiments in 2D3V.

[1]Nielson and Lewis, Methods Comput. Phys.,16 (1976)
[2]Chen, Chacón, and Barnes, J. Comput. Phys. 230 (2011)
[3]Chen and Chacón, Comput. Phys. Commun. (2014)

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