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Recent advances in nonlinear implicit, electrostatic particle-in-cell (PIC) algorithms GUANGYE CHEN, ORNL, LUIS CHACÓN, ORNL and LANL, DANIEL BARNES, Coronado Consulting — An implicit 1D electrostatic PIC algorithm[1] has been developed that satisfies exact energy and charge conservation. The algorithm employs a kinetic-enslaved Jacobian-free Newton-Krylov method[2] that ensures nonlinear convergence while taking timesteps comparable to the dynamical timescale of interest. Here we present two main improvements of the algorithm. The first is the formulation of a preconditioner based on linearized fluid equations, which are closed using available particle information. The computational benefit is that solving the fluid system is much cheaper than the kinetic one. The effectiveness of the preconditioner in accelerating nonlinear iterations on challenging problems will be demonstrated. A second improvement is the generalization of Ref. 1 to curvilinear meshes,[3] with a hybrid particle update of positions and velocities in logical and physical space respectively.[4] The curvilinear algorithm remains exactly charge and energy-conserving, and can be extended to multiple dimensions. We demonstrate the accuracy and efficiency of the algorithm with a 1D ion-acoustic shock wave simulation.

[1]Chen, Chacón, Barnes, J. Comput. Phys. 230 (2011)
[2]Ibid.
[3]Chacón, Chen, Barnes, J. Comput. Phys. submitted (2012)
[4]Swift, J. Comp. Phys., 126 (1996)

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