Abstract Submitted
for the DPP20 Meeting of
The American Physical Society

A Spectral Electrostatic Particle-in-Cell Algorithm with Sparse Grid and Exact Energy Conservation GUANGYE CHEN, Los Alamos Natl Lab, LEE RICKETSON, Lawrence Livermore Natl Lab — The standard particle-in-cell (PIC) method employs explicit finite-difference (FD) methods (e.g. the leap-frog scheme) for both spatial and temporal integrations. Here we employ a sparse-grid pseudo-spectral method for solving the Poisson equation [1] and a fully implicit time integration to achieve exact energy conservation. The advantage of the pseudo-spectral field solver is its spectral accuracy in solving the field solutions. The introduction of the sparse-grid technique to PIC [1] has the potential of mitigating the curse of dimensionality, which may dramatically reduce the number of simulated particles to achieve satisfactory statistical resolution. Earlier studies of implicit time integration of PIC FD equations can enforce exact energy exchange between field and particles, resulting exact energy-conserving schemes [2]. We prove that the energy-conserving scheme can be carried over to the pseudo-spectral scheme, and to sparse grids. We demonstrate the new scheme in a 2D electrostatic PIC code. Theoretical results are confirmed via numerical examples. [1] L. F. Ricketson and A. J. Cerfon. Plasma Physics and Controlled Fusion 59.2 (2016): 024002. [2] G. Chen, Luis Chacn, and Daniel C. Barnes. Journal of Computational Physics 230.18 (2011): 7018-7036.

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Date submitted: 10 Jul 2020 Electronic form version 1.4