Abstract Submitted
for the GEC13 Meeting of
The American Physical Society

Automatic Coarsening of the Particle Interaction Mesh in a Hybrid PIC-DSMC Simulation STAN MOORE, PAUL CROZIER, CHRIS MOORE, MATTHEW BETTENCOURT, MATTHEW HOPKINS, Sandia National Laboratories — Hybrid particle-in-cell (PIC) and direct simulation Monte Carlo (DSMC) methods are frequently used to simulate low density interacting plasmas, and a single mesh is often used for both DSMC and PIC calculations. Typically however, the mesh size for the PIC method is limited by the Debye length, while the particle interaction mesh in DSMC is limited by the mean free path, which is often much larger than the Debye length. Insufficient computational particles in a DSMC collision cell can also lead to spurious results when using the no-time-counter scheme. Therefore, the optimal PIC mesh may be suboptimal for calculating DSMC collisions. We have developed a method where a finer unstructured tetrahedral mesh is used for PIC calculations, and a coarser conglomeration of PIC mesh elements is used by the DSMC algorithm to calculate particle interactions (i.e. elastic collisions, ionizations, etc.). This automatic coarsening of the PIC elements into DSMC interaction cells is accomplished using an oct-tree algorithm, based on the mean free path calculated using the previously simulated local collision rate. Using two different sized meshes for PIC vs. DSMC gives greater flexibility to the simulation and allows one to reduce the computational cost by using fewer computational particles while still accurately simulating the DSMC collisions. The new method is demonstrated and results and computational speed are compared to the traditional hybrid PIC-DSMC simulation method.

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Date submitted: 12 Jun 2013 Electronic form version 1.4