Abstract Submitted
for the DFD05 Meeting of
The American Physical Society

Efficient solutions of the nonlinear Boltzmann equation for low-speed applications[1] LOWELL BAKER, NICOLAS HADJICONSTANTINOU, MIT — We show that efficient Monte Carlo solution methods for the nonlinear Boltzmann equation for low-speed applications can be constructed by expressing the single-particle distribution function as the sum of an equilibrium distribution and a deviational term. By considering the deviation from equilibrium when evaluating the collision integral, one can avoid simulating a large number of physically occuring collisions with no net effect and thus achieve a high degree of variance reduction. As the degree of deviation from equilibrium decreases, the degree of variance reduction increases, leading to a velocity signal to noise ratio that remains approximately constant and thus a computational cost which is essentially independent of the Mach number (Ma). These features are in sharp contrast to current particle-based simulation techniques (e.g. DSMC) in which statistical sampling leads to computational cost that is proportional to Ma^{-2}, making calculations at small Mach numbers very expensive. The present formulation can be incorporated into both direct numerical methods as well as particle-based methods. These approaches are validated by comparing results with analytical and direct simulation Monte Carlo (DSMC) solutions of the Boltzmann equation.

[1]This work was supported by Sandia National Laboratories

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Date submitted: 07 Jul 2005 Electronic form version 1.4