Hybrid Monte Carlo methods for fluid and plasma dynamics

Russel Caflisch

Mathematics, UCLA, Los Angeles, CA 90095-1555

caflisch@math.ucla.edu

Resumen

For small Knudsen number, simulation of rarefied gas dynamics by the Direct Simulation Monte Carlo (DSMC) method becomes computationally intractable because of the large collision rate. To overcome this problem we have developed a hybrid simulation method, combining DSMC and a fluid dynamic description into a single seamless method. The molecular distribution function f is represented as a linear combination of a Maxwellian distribution M and a particle distribution g; i.e., $f = bM + (1 - b)g$. The density, velocity and temperature of M are governed by fluid-like equations, while the particle distribution g is simulated by DSMC. In addition there are interaction terms between M and g. The coefficient b is determined automatically, by a thermalization approximation. Numerical results will be presented to demonstrate the validity of this method, as well as the acceleration that it provides over DSMC. This method has been extended to simulation of Coulomb collisions in a plasma. For this extension, the underlying Monte Carlo method is Nanbu's method for Coulomb collisions.