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Generation of velocity distribution functions in a coupled microscopic-continuum-level approach for gas flows DAVID KESSLER, ELAINE ORAN, CAROLYN KAPLAN, Naval Research Lab — Gas flows can be treated as either a collection of discrete molecules or as a continuum. In the continuum treatment, using linear relations for the energy flux and deviatoric stress tensor produced the Navier-Stokes equations. These linear relations lose their validity at moderate Knudsen numbers. The molecular-level description, however, has no such limitation and molecular velocities are described statistically by a velocity distribution function. Particle-based solution algorithms, such as the DSMC method, describe gas flows for a very broad range of Knudsen numbers, but are expensive. Here we describe a coupled microscopic-continuum-level method in which the molecular kinetic description replaces the linear constitutive relations in the continuum equations. One step in the process is to reconstruct the molecular velocity distribution from the continuum-level flow field. We discuss limitations of using the Maxwellian and Chapman-Enskog distribution functions and compute the temporal evolution of these functions in a steady channel flow using DSMC.

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