Equilibrating effect of Maxwell-type boundary condition in highly rarefied gas

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Abstract

We study the equilibrating effects of the boundary and intermolecular collision in the kinetic theory for rarefied gases. We consider the Maxwell-type boundary condition with variable boundary temperature, which has weaker equilibrating effect than the commonly studied diffuse reflection boundary condition. The gas region is the spherical symmetric domain in $\mathbb{R}^d$, $d = 1, 2$. First, without the equilibrating effect of the collision, we obtain the algebraic convergence rates to the steady state of free molecular flow. The convergence behavior has intricate dependence on the accommodation coefficient of the Maxwell-type boundary condition. Then we couple the boundary effect with the intermolecular collision and study their interaction. We are able to construct the steady state solutions of the full Boltzmann equation for large Knudsen numbers and small boundary temperature variation. We also establish the nonlinear stability with exponential rate of the stationary Boltzmann equation. Our analysis is based on the explicit formulations of the boundary condition for symmetric domains.

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