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Numerical analysis of the nonlinear plane Couette-flow problem of a rarefied gas for hard-sphere molecules

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Abstract

The plane Couette flow of a rarefied gas is investigated on the basis of the Boltzmann equation over the wide range of Knudsen and Mach numbers. The velocity distribution function and its first thirteen moments are obtained from the accurate numerical solution based on the projection discrete-velocity method extended for nonuniform rectangular velocity grids. The DSMC simulation is used to reinforce the obtained results. The nonlinear Hilbert-type asymptotic solution for a slightly rarefied gas is constructed and also included in the comparison. For this purpose, some additional transport coefficients for hard-sphere molecules are evaluated.

Keywords: Couette flow, rarefied gas dynamics, Boltzmann equation, asymptotic analysis, projection method, OpenFOAM, DSMC

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