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A Lattice-based Numerical Solution Of Collisional Boltzmann Equation BOE GREEN, PRAKASH VEDULA, University of Oklahoma — Accurate prediction capabilities of nonequilibrium flow behavior are important for efficient design of a wide range of emerging technologies ranging from micro-scale flow devices and hypersonic re-entry vehicles. Challenges for nonequilibrium flow predictions are mainly due to the breakdown of the continuum flow field hypothesis and the corresponding classical continuum field equations (e.g. Navier-Stokes). To address these challenges we propose an efficient lattice-based computational method (called Collisional Lattice Boltzmann Method or cLBM) for description of non-equilibrium flows, based on fundamental Boltzmann kinetic theory and the underlying full collision operator, without the use of any equilibrium-based approximations. In this moment method, which is applicable for a wide range of Knudsen numbers, the contributions of the full collision operator to the evolution of moments are computed via multinomial expansions and analytical integrals using a discrete quadrature on the lattice while spatial transport is accounted for through a streaming process on the lattice. The underlying conservation laws and invariants of collisional relaxation are also preserved in our approach, along with rates of evolution of selected low order moments. Prediction capabilities of cLBM are demonstrated via good agreement between results obtained from cLBM and other approaches using Couette, Poiseulle and lid-driven cavity flows.

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