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An examination of collisional Lattice Boltzmann Method for microchannel flows BOE GREEN, PRAKASH VEDULA, University of Oklahoma —
A new computational approach for prediction of microchannel flows, which accounts for the full collision operator of the Boltzmann equation via a lattice framework, is presented. Unlike the widely used Lattice Boltzmann Method (LBM), our approach, called the collisional Lattice Boltzmann Method (cLBM), does not make any a priori assumptions on the equilibrium state and hence is capable of handling general nonequilibrium flows (i.e. over a wide range of Knudsen numbers). In cLBM, an operator splitting approach is used for solution of the Boltzmann equation, where representative populations of notional particles are streamed along the underlying lattice from all lattice nodes and the effects of collisional relaxation at each node are accounted for via a solution of a system of differential equations, derived from the full collision operator. This approach not only preserves several symmetries of the full collision operator, but is also structured to account for the evolution of selected generalized moments of the distribution (including conservation of mass, momentum, energy). Simulations of microchannel Couette and Poiseulle flows (including pressure driven and body force driven cases) over a broad range of Knudsen numbers, using a D3Q27 lattice structure, show that the results obtained from cLBM are in good agreement with those obtained from conventional LBM (relying on equilibium based BGK model).

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