Abstract Submitted
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Lattice Boltzmann simulations of genuinely multidimensional rarefied flows in microchannels[1] PAUL DELLAR, TIM REIS, Mathematical Institute, University of Oxford — We present lattice Boltzmann simulations of rarefied slip flows driven by applied pressure differences across microchannels of finite length. We correctly capture the nonlinear streamwise pressure variation and the cross-channel velocity component, as well as the streamwise velocity and volume flux. The former effects are both absent from almost all previous work that approximated the pressure difference using a uniform body force. We demonstrate second-order convergence of both velocity components towards the asymptotic solution for long microchannels, and slower convergence of the pressure. We use the standard lattice Boltzmann formulation that reduces to a second-order recurrence relation for the streamwise velocity in uniform shear, and whose analytical solution gives a parabolic profile from wall to wall. We therefore cannot capture Knudsen boundary layers, but instead implement Maxwell–Navier slip boundary conditions directly on the hydrodynamic moments of our discrete velocity model. Our only parameter is the tangential momentum accommodation coefficient, so we require no fitting to known solutions. Our moment-based approach shows that existing boundary conditions impose conditions on higher non-hydrodynamic moments rather than on the tangential fluid velocity itself.

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