Lattice Boltzmann models based on half-space quadratures and the corner transport upwind method

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Keywords: Lattice Boltzmann modelling, Gauss-Laguerre quadratures, half-space quadratures, corner transport upwind, diffuse reflection, Shakhov model.

In the simulation of realistic flows, it is essential that the boundary conditions capture the correct physics. In micro-flows, where the Knudsen number Kn is non-negligible, a Knudsen layer forms close to the boundary. To describe the Knudsen layer using the Boltzmann equation, Maxwell introduced the diffuse reflection concept, according to which the particles of the inward flux on a wall thermalise before being emitted back into the bulk [1]. To calculate such fluxes, the Laguerre Lattice Boltzmann (LLB) models were constructed using the Gauss-Laguerre quadrature methods to exactly recover half-space integrals [2]. In our talk, we compare the LLB models to lattice Boltzmann models constructed using half-range Hermite polynomials [3] (HHLB models) and highlight differences in their performance.

In highly symmetric flows (e.g. the Couette flow), the projection method involving flux limiters [4, 5] can give reasonable results. However, for general flows, such methods fail to capture correctly the wave-front aspect of the propagation of the fluid particles described by the Boltzmann equation. To overcome this drawback, we discuss the implementation of the corner transport upwind scheme [6], which we compare through numerical simulations to the projection method involving flux limiters.

Acknowledgements: This work was supported by a grant of the Romanian National Authority for Scientific Research, CNCS-UEFISCDI, project number PN-II-ID-PCE-2011-3-0516. The computer simulations were done on the IBM Blue Gene / P system at the West University of Timișoara using PETSc 3.1.

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