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Implementation of a Lattice Boltzmann Method for Pulsatile Flow with Moment Based Boundary Condition

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Abstract : The Lattice Boltzmann Method has been developed and used to simulate both steady and unsteady fluid flow problems such as turbulent flows, multiphase flow and flows in the vascular system. As an example, the study of blood flow and its properties can give a greater understanding of atherosclerosis and the flow parameters which influence this phenomenon. The blood flow in the vascular system is driven by a pulsating pressure gradient which is produced by the heart. As a very simple model of this, we simulate plane channel flow under periodic forcing. This pulsatile flow is essentially the standard Poiseuille flow except that the flow is driven by the periodic forcing term. Moment boundary conditions, where various moments of the particle distribution function are specified, are applied at solid walls. We used a second-order single relaxation time model and investigated grid convergence using two distinct approaches. In the first approach, we fixed both Reynolds and Womersley numbers and varied relaxation time with grid size. In the second approach, we fixed the Womersley number and relaxation time. The expected second-order convergence was obtained for the second approach. For the first approach, however, the numerical method converged, but not necessarily to the appropriate analytical result. An explanation is given for these observations.

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