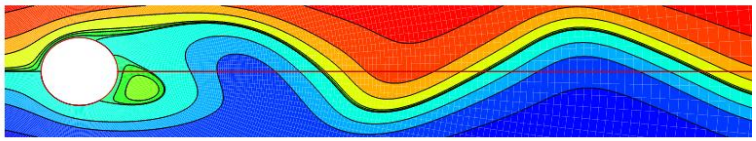
Fluid Mechanics Group
Mechanical Engineering

NUS National University of Singapore

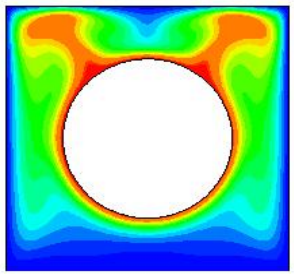
Development and Applications of Lattice Boltzmann Method

Lattice Boltzmann method (LBM) is an alternative computational fluid dynamics approach for simulation of viscous flows. It does not involve partial differential equations and their resultant algebraic equations. Its major advantage is simplicity, easy for implementation and parallel computation.

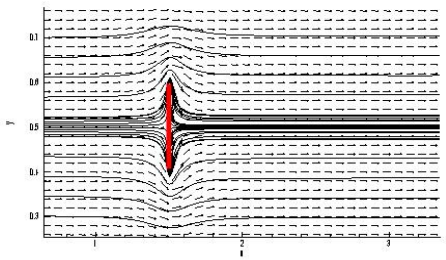
In the application of LBM, we developed a mesh-free Taylor series expansion and least square-based lattice Boltzmann method (TLLBM) for simulation of flows with complex domains and non-uniform mesh, the simplified thermal LBM for heat transfer problems and the fractional step LBM for high Reynolds number flows.



Simulation of Flow around a Circular Cylinder by TLLBM

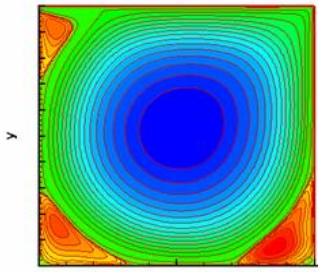


Simulation of Natural Convection by Simplified Thermal LBM

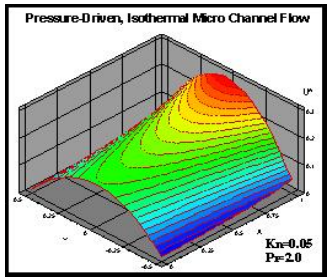


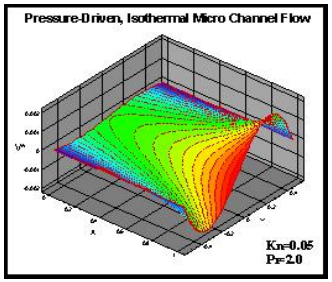
Simulation of Inviscid Flow past a Vertical Plate by Fractional Step LBM

In the development of LBM, we proposed a platform from which one can easily design his own lattice velocity model and associated equilibrium distribution functions. We also proposed a new relationship between the relaxation time and Knudsen number for the simulation of micro flows. In addition, we developed a new lattice Boltzmann interface capturing method for simulation of multiphase/multi-component flows with large density ratio, a new lattice Boltzmann model for compressible flows with strong shock waves, and the lattice Boltzmann-immersed boundary velocity correction method (LB-IBVCM) for simulation of flows with complex domains and/or moving boundaries.

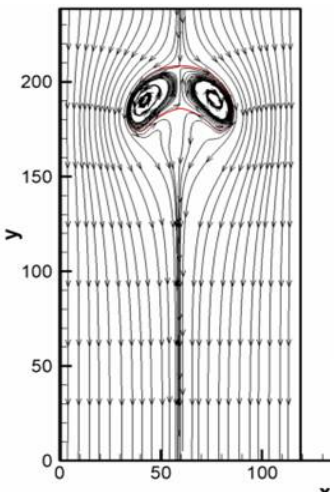


Simulation of Driven Cavity Flow by New Platform

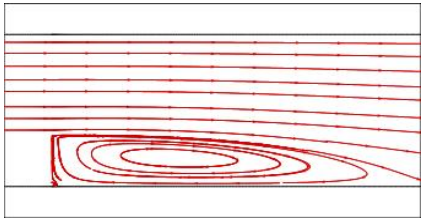




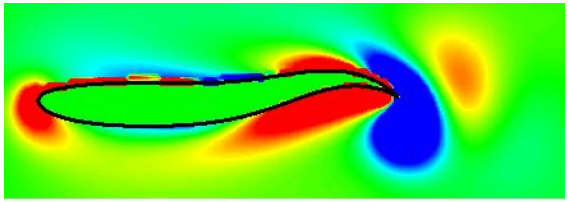
Simulation of Micro Channel Flow by LBM



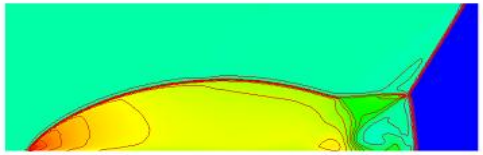
Simulation of Bubble Dynamics by New Interface capturing LBM



Simulation of Turbulent Flow by LBM



Simulation of Fish Motion by LB-IBVCM



Simulation of Double Mach Reflection by Compressible LBM

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