



**INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS**

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Development of a Partially Saturated Cells based Lattice Boltzmann Solver for Thermo-Fluidic Applications

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SHORT ABSTRACT

This thesis is devoted to the development of a robust and accurate partially saturated cells (PSC) based lattice-Boltzmann (LB) solver for incompressible flows and its application to conjugate heat transfer process. The lattice-Boltzmann (LB) method has emerged as a promising alternative to the conventional Navier-Stokes solvers in the last two decades. Despite certain promising advantages, the conventional treatment of boundary conditions on the curved surfaces using LB approaches suffer staircase representation of the surface. This disparity gets exacerbated in moving boundary problems with continuous interchange of fluid and solid lattice nodes necessitating refilling algorithms at each time, and leads to an increased computational expense. Hence, the need for a fast and robust computational framework for moving body problems has led to the emergence of non-body conformal methods, like the coupled immersed boundary-lattice Boltzmann (IB-LB) method, over the last two decades. Recently, one such variant of the IB-LB method, namely the partially saturated computational cells (PSC) method, has evolved as a promising numerical framework for several moving boundary applications. The key advantage of the technique is that, it employs a unified evolution equation for all media (solid and fluid) present in the computational domain comprising a weighting function based on solid volume fraction and an additional solid collision operator. The latter two elements of the PSC technique are responsible for affecting the boundary conditions to be imposed on the solid body, which may be stationary or moving.

The present thesis demonstrates a comprehensive appraisal of the PSC algorithm subjected to moving boundary scenarios that have hitherto not been explored in open literature but are important for the practical viability of the approach. Key aspects pertaining to the performance assessment of the approach comprise accuracy studies, discrete conservation of properties, dependence of spurious fluctuations on grid resolution for moving boundary problems and Galilean invariance. In addition, the solver's robustness is exhibited for a wide range of non-trivial benchmark problems encompassing stationary and moving boundary problems for hydrodynamic and thermal flows. Furthermore, a novel algorithm for simulating conjugate heat transfer problems using PSC is expounded. A novel strategy for implementation of adiabatic boundary conditions is also elaborated in the present work. Both of these strategies are validated with standard free, forced and mixed convection problems.