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Preface

Lattice Boltzmann Method: A Powerful Numerical Tool for Fluid Dynamics and Beyond

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Computational Fluid Dynamics (CFD) is playing a more and more important role in both fundamental researches of fluid dynamics and practical applications. Usually CFD methods are developed to solve Navier-Stokes (N-S) equations and their simplified forms. The CFD solvers often involve numerical discretization of partial differential equations and solution of resultant ordinary differential equations or algebraic equations. The process is quite tedious, and may encounter stability and convergence problems. In addition, since N-S equations are valid for continuum flows, the conventional CFD solvers may have difficulties for their applications to the micro flow, rarefied gas flow, and other non-continuum fluid systems. On the other hand, the lattice Boltzmann method (LBM), developed about two decades ago, provides an alternative way for simulating complex fluid systems. Unlike the conventional CFD methods, LBM is a mesoscopic approach based on kinetic models for fluid flows. The kinetic nature brings many distinctive features to LBM such as the clear picture of the colliding and streaming processes of simulated fluid particles, the simple algorithm structure, the easy implementation of boundary conditions, and the natural parallelism. As compared to the conventional CFD solvers, no partial differential equations are involved. These appealing features have made LBM a powerful numerical tool for simulating fluid systems involving complex physics.

The past two decades have witnessed the rapid development of LBM in fundamental theories, basic models, and wide applications. Indeed, the method has gained much success in modeling and simulating various complicated flows such as single- or multi-phase flows in porous media, colloidal suspension systems, polymer-solvent systems, diffusion and chemical reactions, electro-kinetics flows, magnetic fluid flows, and micro-scale flows. This special issue contains 11 carefully selected and peer-reviewed papers covering a variety of interesting topics, ranging from fundamental issues of LBM to practical applications in different areas. These original or review papers provide an excellent snapshot of the

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state-of-the-art of the method and its applications, and will be very valuable for researchers in this field.

All the papers in this special issue are by invitation. The authors of these invited papers are all very active and among top researchers in the LBM community. I would like to take this opportunity to express my sincere thanks to the authors for their substantive contributions. I am also grateful to all the reviewers who have contributed valuable time and expertise in reviewing the papers and substantially improving the quality of this special issue. Special thanks are dedicated to Prof. Chang Shu for his tremendous support and guidance in preparing this special issue.