Derivative-Free Interface Tracking Method for Liquid-Vapor Phase-Change Heat Transfer

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Wednesday, December 7, 2016
221 MEC
1:00 to 2:25pm

Abstract

The heat transfer mechanisms involving the liquid-vapor phase change provide ample cooling for many industrial application because of the considerable heat transfer associated with the latent heat of the liquid. By using numerical tools, the phenomena that are difficult to observe experimentally due to complicated physical processes during boiling such as very small spatial scales and fast temporal changes can be successfully studied. The mass, momentum, and energy conservation equations must incorporate the effects of surface tension, latent heat, interfacial mass flow rate, abrupt change of material properties, and phase interface dynamics. One of the most challenging problems in numerical simulations of thermal liquid-vapor phase change is accurate representation of the motion of the phase interface maintain local mass conservation of each phase. In this talk, I will present a derivative-free, thermal two-phase lattice Boltzmann equation (LBE) method to model liquid-vapor phase change problems using a sharp interface energy solver. The sharp interface treatment of internal energy equation helps to find the interfacial mass flow rate where no free adjustable parameter is needed in the calculations. The proposed model is verified against available theoretical solutions of several widely-used benchmark problems and some nucleate and film boiling problems at elevated temperatures and pressures. Mass conservative hybridization of the recently proposed derivative-free conservative phase field and Cahn-Hilliard models will also be discussed.

About the Speaker:

Dr. Lee is an associate professor in the Department of Mechanical Engineering at City University of New York (CUNY) and an associate editor of Computers & Fluids. He is a core faculty member of the CUNY Energy Institute and a guest faculty of the Mathematics and Computer Science (MCS) Division at the Argonne National Laboratory. He received his B.S. and M.S. degrees from the Seoul National University, and Ph.D. degree in Mechanical Engineering from the University of Iowa. Dr. Lee is the recipient of the 2005 J.H. Wilkinson Fellowship from the MCS Division at Argonne and the 2009 Faculty Development Grant from NRC. His research expertise is in the areas of multiphase/multiscale computational fluid dynamics and high-order methods for the lattice Boltzmann equation. His research program has been funded by ACS, DOE, NASA, NRC, and NSF.

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