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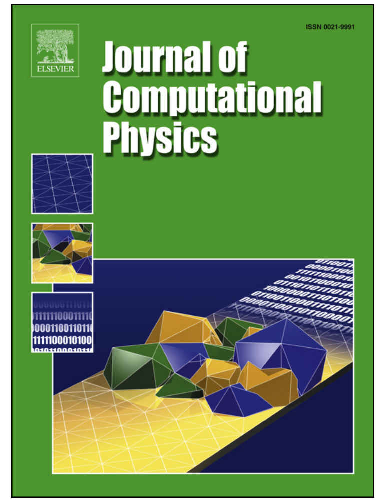

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A new splitting scheme to the discrete Boltzmann equation for non-ideal gases on non-uniform meshes

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Abstract

We present a novel numerical procedure for solving the discrete Boltzmann equations (DBE) on non-uniform meshes. Our scheme is based on the Strang splitting method where we seek to investigate two-phase flow applications. In this note, we investigate the onset of parasitic currents which arise in many computational two-phase algorithms. To the best of our knowledge, the results presented in this work show, for the first time, a spectral element discontinous Galerkin (SEDG) discretization of a discrete Boltzmann equation which successfully eliminates parasitic currents on non-uniform meshes. With the hope that this technique can be used for applications in complex geometries, calculations are performed on non-uniform mesh distributions by using high-order (spectral), body-fitting quadrilateral elements. Validation and verification of our work is carried out by comparing results against the classical 2D Young-Laplace law problem for a static drop.

Keywords: Multiphase, Spectral-element method, Discontinuous Galerkin method, Lattice Boltzmann method

1. Introduction

Flows with interfaces between two phases are ubiquitous in nature and industry: rain drops falling on plant leaves, inkjet printing, and steam-water mixtures in a boiling water reactor (BWR). The interface represents a rapid but smooth transition of physical quantities between the bulk fluid values. Microscopic, long-range interactions among molecules along the interface place these fluids in tension. An accurate representation of the surface tension is critical when performing simulations of complex phenomena such as jet/droplet breakup or coalescence. Over the last few decades, one major challenge in modelling the surface tension has been the existence of parasitic or spurious currents. According to Lafaurie *et al.* [1], these currents are described as a "small amplitude velocity field due to a slight unbalance between stresses in the interfacial region." Such currents may persist indefinitely thereby preventing the achievement of a true equilibrium state, and, possibly creating oscillations strong enough to entirely destroy the interface.

The lattice Boltzmann method (LBM) [2] does not directly solve the Navier-Stokes equations

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