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An advanced moving particle semi-implicit method for accurate and stable simulation
of incompressible flows

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Abstract

An advanced moving particle semi-implicit (MPS) method for the simulation of incompressible flows that provides enhanced accuracy and stability is proposed. Up to now, existing high-order accurate MPS pressure gradient schemes **suffer** from instability produced by attractive pressure gradient while some stabilized pressure gradient schemes have the shortcomings of large discretization error. We propose a high-order stabilized gradient model in which first-order Taylor-series consistency is ensured and stability is guaranteed by purely repulsive pressure gradient. Laplacian model and divergence model are modified and enable accurate and stable solution for the pressure Poisson equation (PPE). The proposed MPS scheme provides a more accurate and stable simulation of incompressible flows. Several two-dimensional numerical simulations are presented to demonstrate the enhanced performance of the proposed MPS method.

Keywords:

MPS method; Particle method; Accuracy; Gradient model; Laplacian model

1. Introduction

Particle methods have been proven to be useful in the simulation of incompressible flows. They are suitable for simulations of free-surface incompressible flows and multi-phase flows. The shape of the surface and interface is directly obtained from the set of computational particles. As a result, no additional effort is necessary to capture or track the interface, and the free surface or interface is always represented clearly in these particle-based methods. Typical particle methods include the smoothed particle hydrodynamics (SPH) method [1], moving particle semi-implicit (MPS) method [2] and

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