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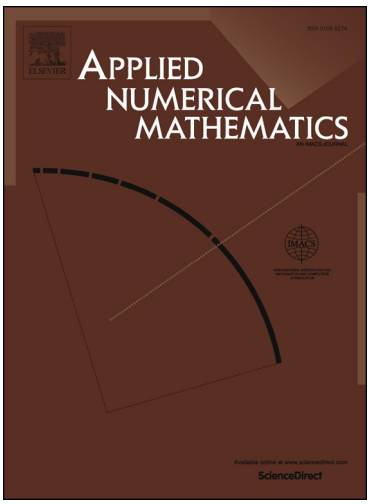

An explicit spectral collocation method for the linearized Korteweg-de Vries equation on unbounded domain

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An explicit spectral collocation method for the linearized Korteweg-de Vries equation on unbounded domain

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Abstract

In this paper, we present a stable and efficient numerical scheme for the linearized Korteweg-de Vries equation on unbounded domain. After employing the Crank-Nicolson method for temporal discretization, the transparent boundary conditions are derived for the time semi-discrete scheme. Then the unconditional stability of the resulting initial boundary problem is established. For spatial discretization, we construct a non-polynomial based spectral collocation method in which the basis functions are built upon a generalized Birkhoff interpolation. The interpolation error of the new basis is also investigated. Moreover, the basis functions build in two free parameters intrinsically which can be chosen properly so that the implicit time semi-discrete scheme collapses to an explicit scheme after spatial discretization. Numerical tests are performed to demonstrate the stability and accuracy of the proposed method.

Keywords: linearized Korteweg-de Vries equation, collocation method, non-polynomial basis functions, transparent boundary conditions, unbounded domain

1. Introduction

The Korteweg-de Vries (KdV) equation is a well known nonlinear dispersive partial differential equation (PDE) arised in many areas of physics. The original equation derived in 1895 by Korteweg and de Vries is used to model the unidirectional propagation of small amplitude long waves in a shallow channel. In canonical form, the KdV equation reads

$$u_t(x,t) + 6u(x,t)u_x(x,t) + u_{xxx}(x,t) = 0. \tag{1.1}$$

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