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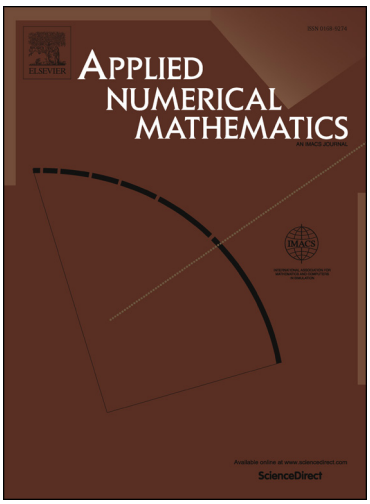

High order compact finite difference schemes on nonuniform grids

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High Order Compact Finite Difference Schemes on Nonuniform Grids

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Abstract

In this paper we consider high-order compact finite difference schemes constructed on 1D non-uniform grids. We apply them to parabolic and Schrödinger equations. Stability of these schemes is investigated by using the spectral method. Computer experiments are applied in order to find critical grids for which the stability condition is violated. Such grids are obtained for the Schrödinger problem, but not for the parabolic problems. Numerical examples supporting our theoretical analysis are provided and discussed.

Keywords: finite difference schemes, non-uniform grids, high-order approximation, stability, convergence

1. Introduction

Application of non-uniform grids to approximate mathematical models based on PDEs is a standard approach in computational science. The main aim of non-uniform grids is to adapt the grid to changes of the solution and to distribute the obtained degrees of freedom in such a way that the approximation error would be minimized. It is well known that approximation and stability are two basic requirements to get a convergent discrete algorithm [1, 8].

In this paper, we solve one-dimensional parabolic and Schrödinger equations. We construct and investigate the stability of two high-order compact finite difference schemes. We note that the second scheme is derived using finite element method technique. It is well-known that for the standard second order finite difference schemes it is possible to derive them also by using the finite element approach. For high-order case these schemes are not coinciding