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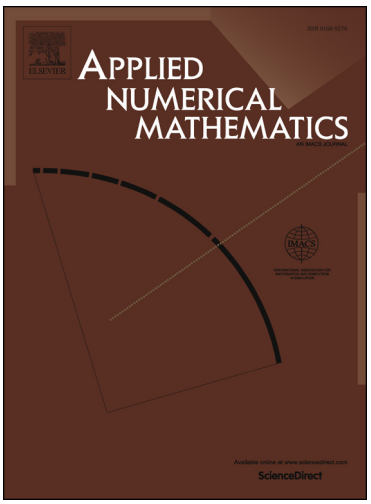

Error estimates of a trigonometric integrator sine pseudo-spectral method for the extended Fisher-Kolmogorov equation

Xin Li, Luming Zhang

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Error estimates of a trigonometric integrator sine pseudo-spectral method for the extended Fisher-Kolmogorov equation *

Xin Li[1,2] , Luming Zhang[1,†]
[1]Department of Mathematics, Nanjing University of Aeronautics and Astronautics, Nanjing, Jiangsu, 210016, P.R. China
[2]Department of Mathematics, Anhui Science and Technology University, Fengyang, Anhui, 233100, P.R. China

Abstract

In this article, a trigonometric integrator sine pseudo-spectral (TISP) method is presented for the extended Fisher-Kolmogorov equation. This method depends on a Gautschi-type integrator in phase space to the temporal approximation and the sine pseudo-spectral method to the spatial discretization. Rigorous error estimates are carried out in the energy space by utilizing the mathematical induction. The error bound shows the new scheme which established by the TISP method has second-order accurate in time and spectral-order accurate in space. Moreover, the new scheme is generalized to higher dimensions. The compact finite difference (CFD) scheme in one and two dimensions which supported by the method of order reduction are constructed as a benchmark for comparisons. Comparison results between two schemes are given to confirm the theoretical studies and demonstrate the efficiency and accuracy of TISP method in both one and multi-dimensional problems.

Keywords: Extended Fisher-Kolmogorov equation, Trigonometric integrator, Sine pseudo-spectral method, Error estimates, Compact finite difference scheme, Higher dimensions

1 Introduction

The Fisher-Kolmogorov (FK) equation is a kind of classical second-order diffusion equation which presented by Fisher and Kolmogorov to describe the diffusion of organisms and the interaction in adaption [1]. By adding an additional stabilizing fourth order derivative term, Coullet and Dee et al. [2] called the new model as the extended Fisher-Kolmogorov (EFK) equation. It arises in sorts of applications like pattern formation in

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†Corresponding author. E-mail: zhanglm@nuaa.edu.cn (Luming Zhang),garryxin@163.com (Xin Li)

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