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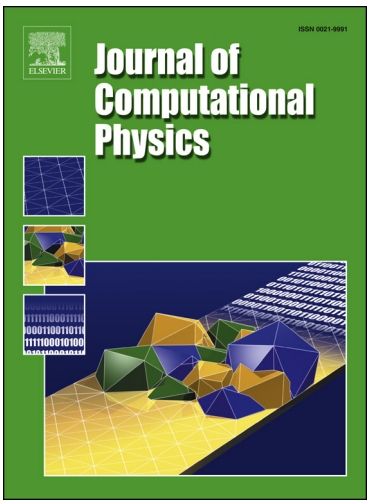

Finite difference/spectral approximations for the distributed order time fractional reaction-diffusion equation on an unbounded domain

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Finite difference/spectral approximations for the distributed order time fractional reaction-diffusion equation on an unbounded domain

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Abstract

The numerical approximation of the distributed order time fractional reaction-diffusion equation on a semi-infinite spatial domain is discussed in this paper. A fully discrete scheme based on finite difference method in time and spectral approximation using Laguerre functions in space is proposed. The scheme is unconditionally stable and convergent with order $\mathrm{O}(\tau^2 + \Delta\alpha^2 + N^{(1-m)/2})$, where τ, $\Delta\alpha$, N, and m are the time-step size, step size in distributed-order variable, polynomial degree, and regularity in the space variable of the exact solution, respectively. A pseudospectral scheme is also proposed and analysed. Some numerical examples are presented to demonstrate the efficiency of the proposed scheme.

Keywords: distributed order differential equation, fractional diffusion, spectral method, error estimate.
2010 MSC: Primary 65M12, 65M06, 65M70, 35R11.

1. Introduction

Fractional differential equations can be used to describe lots of phenomena in physics, economics, engineering, chemistry, biology, and other sciences [1], such as anomalous diffusion [2], relaxation and reaction kinetics of of polymers [3], image processing [4], bioengineering [5], continuous-time finance [6], etc.

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