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PII: S1018-3647(16)30349-4
DOI: http://dx.doi.org/10.1016/j.jksus.2016.10.001
Reference: JKSUS 413

To appear in: *Journal of King Saud University - Science*

Received Date: 12 July 2016
Accepted Date: 2 October 2016

Please cite this article as: A. Kazemi Nasab, Z. Pashazadeh Atabakan, A.I. Ismail, R.W. Ibrahim, A numerical method for solving singular fractional Lane-Emden type equations, *Journal of King Saud University - Science* (2016), doi: http://dx.doi.org/10.1016/j.jksus.2016.10.001

A numerical method for solving singular fractional Lane-Emden type equations

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Abstract

In this paper, a hybrid numerical method combining Chebyshev wavelets and a finite difference approach is developed to obtain solutions of singular fractional Lane-Emden type equations. The properties of the Chebyshev wavelets and finite difference approaches are used to convert the problem under consideration into a system of algebraic equations which can be conveniently solved by suitable algorithms. A comparison of results obtained using the present strategy and those reported using other techniques seems to indicate the precision and computational effectiveness of the proposed hybrid method.

Keywords: Chebyshev wavelets, finite difference method, Fractional Lane-Emden, Singular problems, Initial and boundary value problems.

1. Introduction

Certain phenomena in physics and engineering sciences can best be mathematically modelled using differential equations. The Lane-Emden equation is an ordinary differential equation which arises in mathematical physics. In astrophysics, the Lane-Emden equation is a dimensionless form of Poisson's equation for the gravitational potential of simple models of a star (Momoniat, 2006). Due to the singularity behavior at the origin, it is numerically challenging to solve the Lane-Emden problem, as well as other various linear and nonlinear singular initial value problems in quantum mechanics and astrophysics. This paper deals

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