

Accepted Manuscript

Relaxation and diffusion models with non-singular kernels

HongGuang Sun, Xiaoxiao Hao, Yong Zhang, Dumitru Baleanu

PII: S0378-4371(16)30753-1

DOI: <http://dx.doi.org/10.1016/j.physa.2016.10.066>

Reference: PHYSA 17624

To appear in: *Physica A*

Received date: 28 June 2016

Revised date: 3 October 2016

Please cite this article as: H. Sun, X. Hao, Y. Zhang, D. Baleanu, Relaxation and diffusion models with non-singular kernels, *Physica A* (2016), <http://dx.doi.org/10.1016/j.physa.2016.10.066>

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.



Relaxation and diffusion models with non-singular kernels

HongGuang Sun^a, Xiaoxiao Hao^a, Yong Zhang^{a,b,*}, Dumitru Baleanu^{c,d}

a. Institute of Soft Matter Mechanics, Department of Engineering Mechanics, Hohai University, 1 XiKang Road, Nanjing, Jiangsu 210098, China

b. Department of Geological Sciences, University of Alabama, Tuscaloosa, AL 35487, USA

c. Department of Mathematics, Cankaya University, Ankara, Turkey

d. Institute of Space Sciences, Magurele-Bucharest, Romania

Corresponding author: yzhang264@ua.edu (Yong Zhang)

Abstract

Anomalous relaxation and diffusion processes have been widely quantified by fractional derivative models, where the definition of the fractional-order derivative remains a historical debate due to its limitation in describing different kinds of non-exponential decays (e.g. stretched exponential decay). Meanwhile, many efforts by mathematicians and engineers have been made to overcome the singularity of power function kernel in its definition. This study first explores physical properties of relaxation and diffusion models where the temporal derivative was defined recently using an exponential kernel. Analytical analysis shows that the Caputo type derivative model with an exponential kernel cannot characterize non-exponential dynamics well-documented in anomalous relaxation and diffusion. A legitimate extension of the previous derivative is then proposed by replacing the exponential kernel with a stretched exponential kernel. Numerical tests show that the Caputo type derivative model with the stretched exponential kernel can describe a much wider range of anomalous diffusion than the exponential kernel, implying the potential applicability of the new derivative in quantifying real-world, anomalous relaxation and diffusion processes.

Key words: Anomalous relaxation and diffusion, Non-singular kernel, Stretched exponential function kernel, Memory characterization, Mean squared displacement

Download English Version:

<https://daneshyari.com/en/article/5103486>

Download Persian Version:

<https://daneshyari.com/article/5103486>

[Daneshyari.com](https://daneshyari.com)