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Fractional Calculus : applications and numerical challenges

Magda Rebelo[a]

[a] Institution:Nova School of Science and Technology and NOVA MATH- Center for Mathematics and Applications , Universidade Nova de Lisboa

E-mail: msjr@fct.unl.pt

Abstract

Fractional calculus, a branch of mathematics dealing with derivatives and integrals of non-integer orders, has emerged as a powerful tool for modeling complex physical phenomena. In this talk we focus on two specific phenomena: anomalous diffusion and viscoelasticity. Anomalous diffusion, characterized by non-Gaussian and non-Fickian behaviors, challenges the conventional understanding of diffusion processes. On the other hand, viscoelasticity describes the time-dependent response of materials to external forces, encompassing both viscous and elastic properties. We will delve into recent advancements in fractional calculus techniques that are specifically tailored for modeling anomalous diffusion processes, which classical diffusion equations fail to effectively capture. Furthermore, we will examine the integration of viscoelasticity into fractional calculus models ([1],[2]), enabling a more precise representation of real-world systems with time-dependent responses.

Through the exploration of theoretical developments, numerical methods ([3], [4]), and experimental investigations, we aim to shed light on the synergy between fractional calculus, anomalous diffusion, and viscoelasticity.

Keywords Fractional Calculus, anomalous diffusion, viscoelasticity, numerical methods.

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