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Distributed Order Calculus and Ultraslow Physical Processes

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We consider differential equations containing, with respect to the time variable, a distributed order derivative, that is

$$\mathbb{D}^{(\mu)}\varphi(t) = \int_0^1 (\mathbb{D}^{(\alpha)}\varphi)(t)\mu(\alpha) d\alpha,$$

$\mathbb{D}^{(\alpha)}$ is the Caputo-Dzhrbashyan fractional derivative of order α , μ is a positive weight function. Such equations are used in physical literature for modeling ultraslow relaxation and diffusion with a logarithmic growth of the mean square displacement. In this work we develop a mathematical theory of such equations, study the derivatives and integrals of distributed order.