

Title: Exploring Soliton Solutions for Fractional Nonlinear Evolution Equations: A Focus on Regularized Long Wave and Shallow Water Wave Models with Beta Derivative

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Abstract: The fractional regularized long wave equation and the fractional nonlinear shallow-water wave equation are the noteworthy models in the domains of fluid dynamics, ocean engineering, plasma physics, and microtubules in living cells. In this study, a reliable and efficient improved F-expansion technique, along with the fractional beta derivative, has been utilized to explore novel soliton solutions to the stated wave equations. Consequently, the study establishes a variety of reliable and novel soliton solutions involving trigonometric, hyperbolic, rational, and algebraic functions. By setting appropriate values for the parameters, we obtained peakons, anti-peakon, kink, bell, anti-bell, singular periodic, and flat kink solitons. The physical behavior of these solitons is demonstrated in detail through three-dimensional, two-dimensional, and contour representations. The impact of the fractional-order derivative on the wave profile is notable and is illustrated through two-dimensional graphs. It can be stated that the newly established solutions might be further useful for the aforementioned domains.

Keywords: Improved F-expansion method; Beta derivative; Fractional regularized long wave equation; Fractional nonlinear shallow-water wave equation; Soliton solutions

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