

Title: Dynamical analysis of optical soliton solutions for CGL equation with Kerr law nonlinearity in classical, truncated M-fractional derivative, beta fractional derivative, and conformable fractional derivative types

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Abstract: The study of optical soliton solutions plays a vital role in nonlinear optics. The foremost area of optical solitons research encompasses around optical fiber, telecommunication, meta-surfaces and others related technologies. The aim of this work is to integrate optical soliton solutions of the complex Ginzburg-Landau (CGL) model with Kerr law nonlinearity, also showing the effect of diverse fraction derivative and comparing it with the classical form. Here, the local derivative is used as the conformable wisdom known as the truncated M-fractional derivative, beta fractional derivative, and conformable fraction derivative. We also deliberated on some assets satisfied by the derivative. The CGL model is useful to describe the light propagation in optical communications, optical transmission, and nonlinear optical fiber. Under the right circumstances, the affectionate unified scheme is implemented for the complex Ginzburg-Landau model to generate the optical wave pattern. For $\alpha_1 = 2\alpha_2$, the unified scheme generates the solution of CGL model in terms of hyperbolic, trigonometric, and rational function solutions. This scheme provides some novel optical solitons such as periodic waves, periodic with rogue waves, breather waves, different types of periodic rogue waves, a singular soliton solution, and rogue with the periodic wave for the special value of the free parameters. For $\alpha_2 = \rho + 6\alpha_1/8$, the unified scheme generates the solutions of CGL model in terms of hyperbolic, trigonometric, and rational function solutions. This scheme offers some fresh optical solitons such as periodic rogue waves, multi-rogue waves, double periodic waves, and periodic waves. In numerical argument, the wave patterns are offered with 3-D and density plots. To test the stability of the obtained solutions, we show diverse fractional forms such as beta time fractional, and conformable time fractional derivative and compare these fractional derivatives with their classical form in 2D plots. The investigation reveals innovative and explicit solutions, providing insight into the dynamics of the related physical processes. This paper provides a comprehensive examination of the obtained solutions, emphasizing their distinct features and depictions using unified technique. These findings are especially advantageous for specialists in the fields of nonlinear science and mathematical physics, providing significant insights into the behavior and development of nonlinear waves in various physical situations.

Keywords: CGL model Kerr law nonlinearity Unified scheme Optical soliton solutions

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