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Solitonic excitations in quantum plasma in a weakly relativistic regime

N Nargesi[1], S Miraboutalebi[1], L Rajaei[2*], and K Samavati[1]

1. Department of Physics, Islamic Azad University, North Tehran Branch, Tehran, Iran
2. Department of Physics, University of Qom, Qom, Iran

E-mail: l-rajaei@qom.ac.ir

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Abstract

This paper studies the excitation of solitonic waves in a quantum plasma model within the weak relativistic regime. The model leads to a fourth-order nonlinear differential equation, which, due to its nonlinearity, introduces new and intriguing phenomena in the dynamics of the plasma environment. We successfully obtained stable and stationary solitonic solutions using the hyperbolic secant Sech-method without resorting to any simplifications. This approach, commonly known as the Tanh- method, is referred to as the sech- method here because the sech function is employed in deriving the solutions. The obtained stable and stationary solitonic waves are significant because they propagate with a constant size and shape in a highly dispersive plasma environment. These waves reveal bounded soliton waves for the vector potentials. Also, the density changes due to the influence of the thermal quantum effects are studied. It is observed that the group velocity of the solitonic solutions of the vector potential affects the density changes. The outcomes of this study and the dealing approach with this context help us better understand the dynamical phenomena of quantum plasmas.

Keywords: quantum plasma, solitonic wave, weak relativistic plasma, Sech method

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