Effect of ion beam on evolution of ion acoustic nonlinear structures in a weakly relativistic magnetized plasma

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Ion beams are ubiquitous ingredient in degenerate dense plasma systems and are found to play a decisive role in the propagation of nonlinear waves in space and astrophysical environments. The ion beam concentration, magnetic field, and the ion beam streaming velocity are found to play a momentous role on the control of the amplitude and width of small amplitude excitations. Further, ion beams play a pivotal role to reproduce the plasma at the origin of neutron stars, white dwarfs and in the laboratory experiments [1]. These ion beams are also present in magnetized space plasma environment starting from the Earth's magnetosphere through the magnetosphere of different planets [2]. The flow of ion beams in supernova-driven plasmas (e.g., pulsars, and interstellar medium [3]). Study of nonlinear structures in relativistic degenerate plasmas can be carried out especially in astrophysical plasmas [2]. The energy spectrum of electrons in a plasma is broad range. On the basis of their wide energy distribution, they can be categorized as "free electrons" and "trapped electrons." The free electrons are the ones that have their energy greater than the wave potential energy and hence, they have the ability to easily escape out from the potential well. However, on the other hand the electrons having lesser energy as compared to the potential well get trapped inside the potential well. Such electrons are called trapped electrons. The idea of splitting the distribution function into free and trapped electrons was introduced long ago by Dawson [3]. The study of the nonlinear magneto-acoustic nonlinear structures with relativistic degenerate electrons depicts that due the density of the electrons, the frequency of the wave get changed and the amplitude of the wave is also get reduced. In the presence of a quantizing magnetic field, the evolution of ion acoustic solitary, rogue and rogue wave triplet occurs in a degenerate magnetoplasma composed of inertial ions, weakly relativistic ion beam, and trapped electrons. The Korteweg-de Vries (KdV) equation is obtained using the reductive perturbation approach to investigate the dynamics of IA solitary waves in a specific environment. Using appropriate transformations, the KdV equation is further changed into the nonlinear Schrödinger equation (NLSE). It is confirmed that different orders solutions of NLSE describe the variety of nonlinear structures such as IA rogue waves, rogue wave triplets, and super rogue waves. The characteristics of IA solitary waves, rogue waves, rogue wave triplets, and super rogue waves are studied under the influence of ion beam and other different plasma parameters. It is observed that different plasma parameters have great impact on the dynamics of IA solitary waves, rogue waves, rogue wave triplets and super rogue waves. The findings of this investigation might help researchers for better understanding of the properties of nonlinear structures in dense astrophysical areas like white dwarfs and neutron stars.

References

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