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Nonlinear structures in electron beam plasma

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Over the last five decades, the study of nonlinear propagation of electrostatic excitations in the frame work of Korteweg-de Vries (KdV), Kadomstev–Perviashvili (KP), and Zakharov–Kuznetsov (ZK) equations have been reported for in different kinds plasma environments with charged particles obeying Maxwellian as well as non-Maxwellian velocity distributions. The transverse perturbations always exist in the higher-dimensional plasma system to study nonlinear structures. In the presence of anisotropy in the plasma system, the nonlinear structures and stability are modified under the influence of transverse perturbations.
The observations of inertial, drifting charged particles penetrating in various space and astrophysical plasma environments have led the researchers to investigate the influence of charged particle beams on nonlinear waves and structures formed in such environments. It has been indicated that the injection of drifting electrons in the upper layers of Earth's magnetosphere is caused by the solar wind. These electrons are considered to perturb the magnetospheric plasma and give rise to nonlinear waves and modify conditions for the existence of nonlinear structures. A number of satellite missions (the S3-3, Viking, GEOTAIL and POLAR) have confirmed the presence of electron beam in the upper layer of the magnetosphere, where a coexistence of two different electron populations (hot and cold electrons) occurs. The movement of electron beam through a plasma may generate stationary nonlinear localized electrostatic waves. Numerous experimental as well as theoretical studies have confirmed the change in the characteristics of nonlinear structures (e.g., solitons, shocks, double layers etc.) under the influence of energetic electron beam. Most of the astrophysical, space and laboratory environments have confirmed the occurrence of superthermal charged particles due to different mechanisms. Lorentzian distribution function is the most common distribution function used to illustrate such superthermal particles. Due to non-equilibrium behaviour the space possesses the non-Maxwellian distribution. Over the last many years, different non-Maxwellian distributions and hybrid non-Maxwellian distributions provides more general platform to analyse different kinds of nonlinear structures in space and astrophysical plasma environments. In the present investigation, the propagation properties of two-dimensional solitons, breathers and rogue waves have been studied in two temperature electrons plasma embedded with electron beam and hot electrons obeying non-Maxwellian distribution. The KP equation has been derived using reductive perturbation technique and its solution is numerically studied. The KP equation is transformed into nonlinear Schrödinger equation (NLSE) and its different order solutions are used to study the characteristics of breathers such as the Akhmediev breather and the Kuznetsov–Ma breather. It is observed that different polarity ion-acoustic solitons are observed under the influence of variation of beam density, beam velocity, and other plasma parameters. It is remarked that all different physical parameters have great influence on the characteristics of breather waves. The findings of this investigation may be of great importance to understand the nonlinear phenomena in the upper layer of the magnetosphere where two temperature electrons may exist.

References

[1] N.S. Saini and I. Kourakis, Plasma Phys. Cont. Fusion, **52**, 075009 (2010)
[2] N. S. Saini, N. Kaur, and T. S. Gill, Advances Space Res., **55**, 2873 (2015)