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Dissipative Ion-Acoustic Solitary Waves

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Due to an excess in the fast part of the population, the velocity distribution in such plasmas may diverge from the typical thermal Maxwellian distribution and acquire a long-tail for high-velocity arguments. Such behaviour is well characterized by a (kappa) -type distribution function. In an unmagnetized electron-ion plasma with -distributed electron populations vulnerable to trapping, the combined effect of electron super thermality and phase-space trapping was first taken into consideration using the Schamel equation approach to model and characterize ion-acoustic solitary waves. Sultana and colleagues considered the combined impact of electron super thermality and trapping after that investigation. In this study, the fundamental characteristics of trapped superthermal electrons defined by a -type (non-Maxwellian) distribution were compared to damped ion-acoustic solitary waves. The impact of ion-neutral collisions was also considered, and as predicted, this resulted in wave dampening. An additional damping term was added to a nonlinear Schamel-type partial differential equation that was derived using the reductive perturbation method. The damped Schamel equation was numerically solved using the solitary wave solution of the standard (nondissipative) Schamel equation, and the fundamental properties of dissipative ion-acoustic solitary waves were examined. Solitary waves are also impacted by the number of trapped electrons in the plasma since their amplitude rises when there are more trapped electrons present; yet, somewhat counter-intuitively, their width remains the same.

The current study concentrated on the "simplest" fluid model for magnetized plasma, which excluded drift forces and assumed a constant magnetic field. To properly account for the non-negligible EB drift, for instance, a drift-kinetic method would call for the electrons to paint a more comprehensive picture. This research examined the so-called "trapping effect," which is the basic trapping scenario. However, it is possible that several electron transfers through the separatrix result from the filamentation process in the pattern's final state of pattern formation in the electron phase space, which then opens more possibilities for trapping. In that situation, it's possible that the electric wave potential can't be described in a closed algebraic form, leading to the emergence of brand-new nonlinear structures.

The findings in this study aim to advance knowledge of the key characteristics of nonlinear electrostatic perturbations in non-Maxwellian plasmas, considering electron trapping in phase space.

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KEYWORDS
Dissipative solitary waves, magnetized plasma, superthermal trapped electrons, kappa distribution, Schamel equation