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Investigating ion acoustic waves in dusty plasmas containing hot ions, electrons and non-thermal positrons with Cairns distribution

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Abstract

This study investigated nonlinear ion acoustic solitons in a dusty plasma system, consisting of negatively charged dust particles, dynamic warms ions, electrons and positrons with non-thermal Cairns distributions. The nonlinear differential equation governing this system was obtained in two steps using the reductive perturbation method. In the first step, the nonlinear differential equation KdV was obtained considering lower-order exponents. The results showed the nonlinear coefficient of the mentioned equation was zero at the critical value $\beta_e = \beta_p = 0.33$ in the desired system and this equation could not describe the solitons propagated in the system. In the next step, the modified KdV equation was obtained like the previous section using the reductive perturbation method, concerning higher-order exponents. The results showed scattering coefficients were the same in both cases. However, the nonlinear coefficient was a little more complicated in the modified case. In both cases, static solutions of solitons were investigated, and the effect of various parameters, including a non-equilibrium of electrons and positrons, on the wave structure was examined in detail. The results revealed unlike Maxwell's distribution, in which only positive solitons could be propagated, both positive and negative solitons could be propagated in this system. Also, the presence of non-equilibrium particles could increase the soliton amplitude and width. The obtained results could be used in space and laboratory plasma systems.

Keywords: ion-acoustic waves, electron-positron-ion-dust plasma(EPID), Cairns distribution, non-thermal plasma

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