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ORIGINAL ARTICLE

Large amplitude acoustic solitons in a warm electronegative dusty plasma with q-nonextensive distributed electrons

S. Ali Shan · N. Akhtar

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Abstract Linear and nonlinear analysis are presented for an electronegative dusty plasma system. Linear analysis shows that the dispersive nature of the plasma system changes considerably due to the presence of nonthermal q-nonextensive distributed electrons. The presence of both compressive and rarefactive Sagdeev solitons is investigated and shown that the addition of even a small population of dust particles will significantly modify the large amplitude Sagdeev solitons. The coexistence of both compressive and rarefactive solitons for a certain set of parameters is also noticed in such system. The effect of variation of entropic index q, θ_i (ratio of positive ion temperature to electron temperature), θ_n (ratio of negative ion temperature to electron temperature) and dust particles concentration (R) is elaborated with the help of suitable parameters.

Keywords q-Nonextensive distributed electrons · Electronegative dusty plasma · Q-Machine

1 Introduction

Nonlinear wave structures are fascinating and appealing manifestations of nature. Amongst such structures, solitons which develop as a result of balance between nonlinearity and dispersion, present characteristics of interaction between waves and plasmas. Such delicate beauty of nonlinear structures have attracted a large number of researchers as they offer a deep physical insight into the dynamics of nonlinear phenomena. Nonlinear wave structures have been observed through spacecraft instrumentation for the last many years. Moreover, space plasmas are of multi-species type and provide a rich source for studying nonlinear waves. There are various methods to do the nonlinear analysis of any plasma system, which simplify in the form of differential equations whose solutions can be sought out both analytically and numerically. Most significant methods include Sagdeev pseudo potential approach to study the fully nonlinear large amplitude solitons and Reductive Perturbation Method (RPM) to analyze the partially nonlinear small amplitude solitons.

So far, most of the research works have been conducted by assuming the thermal equilibrium in a plasma system. Whenever the plasma species are in thermal equilibrium, they follow the Maxwell Boltzmann distribution. But this ideal thermal equilibrium assumption is non longer valid where some external agents (e.g., force field present in natural space plasma environments, wave particle interaction, turbulence, etc.) disturb the thermal equilibrium of the plasma environments. Space plasma observations revealed the existence of non-Maxwellian distribution functions which incorporate the presence of highly energetic particles. Such distribution functions look to be carrying tails pointing towards the presence of significant population of higher than the average thermal energy plasma species. Both space plasma environments (e.g., planetary magnetospheres, astrophysical plasmas and the solar wind) and laboratory plasma systems may have such an excess of superthermal electron population due to velocity space diffusion, which

S. Ali Shan (✉) · N. Akhtar
Theoretical Plasma Physics Division, PINSTECH, P.O. Nilore, Islamabad 44000, Pakistan
e-mail: shaukatshan@gmail.com

S. Ali Shan
National Centre for Physics, Shahdra Valley Road, Islamabad 44000, Pakistan

S. Ali Shan · N. Akhtar
Department of Physics and Applied Mathematics (DPAM)
PIEAS, P.O. Nilore, Islamabad 44000, Pakistan