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ORIGINAL ARTICLE

Observing the result of external magnetic field with nonextensivity on DA waves for two temperature electrons in a dusty plasmas

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Abstract This theoretical investigation has been made on dust-acoustic (DA) waves containing nonextensivity of electrons being two different temperatures, negatively charged dust grains, and Maxwellian ions. The Zakharov-Kuznetsov (Z-K) equation has been derived and numerically solved to analysis the basis features. It is observed that the characteristics of the DA solitary waves (DASWs) are significantly modified by the external magnetic field with the different temperatures for electrons followed by the nonextensive distribution. The results obtained from this analysis can be employed in understanding the nature of plasma waves both in laboratory and space plasma system.

Keywords DA solitary waves · Negatively charged dust grains · Reductive perturbation method · Maxwellian ions · Nonextensivity of electrons with two temperature · External magnetic field · Z-K equation

1 Introduction

In these days plasma has made a great deal of interest for research works. A number of effects (like temperature, degeneracy, nonthermal, vortex, etc. (Mamun and Shukla 2001; Mamun 2008; Roy et al. 2012; Shukla and Mamun 2002)) considered to study the characteristics as well as basic features of the propagation of both linear and nonlinear waves in laboratory and space plasmas. Among the young plasma scientists the term 'nonextensive plasmas' has made a great deal of interest. The thermodynamical variable entropy is considered to be an extensive property, i.e., the value of the term under consideration depends on the amount of material (plasma species) present in the system. At first Constantino Tsallis proposed a new formula for the entropy in 1988 which is a generalization of the traditional Boltzmann-Gibbs entropy (for a limiting case) (Tsallis 1988). Originally the generalized entropy resulted non-extensive term in absence of correlations; therefore the name came out as "non-extensive statistical mechanics". In the last decade the Tsallis' entropy (Tsallis 1988) has found many applications in plasma physics, as well as astrophysical plasmas, fractals, turbulence, finance, systems with long-range correlations and complex plasma systems. Now-a-days, nonextensive (Tsallis 1988) plasma has made interests to the plasma scientists because of its wide range of applications in astrophysical and cosmological plasmas. The parameter q which is related to the generalized entropy is linked to the dynamics of the plasma species of the system and provides a measure of the degree of correlation. Therefore thermodynamics/thermostatistics should be applied to plasma systems which may be rightly viewed as systems endowed with long-range interactions, and where non-equilibrium stationary states may exist. Again, the rudimentary concept of nonextensive entropy (Eslami et al. 2011; Tribeche et al. 2010), as well as the nonextensive behaviour of electrons and ions (characterizing by the parameter q) have been successfully employed in plasma physics (Pakzad and Tribeche 2011; Tribech and Shukla 2011). It is important to note that $q = 1$ corresponds to Maxwellian distribution. The distribution for

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