Astrophys Space Sci (2013) 348:501–510
DOI 10.1007/s10509-013-1593-0

ORIGINAL ARTICLE

Ion acoustic double layers in the presence of positrons beam and q-nonextensive velocity distributed electrons

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Received: 16 May 2013 / Accepted: 29 July 2013 / Published online: 22 August 2013

Abstract Linear and nonlinear studies are presented for an electron-ion plasma system which is being energized with an external beam of positrons. The electrons are assumed to follow the q-nonextensive velocity distribution. The growth rates of instability due to positron beam are analyzed numerically. The compressive and rarefactive double layers are studied in the system and it is found that by varying the entropic index parameter q, positron beam speed v_{po} and concentration of positrons p, the dynamics of nonlinear profile is changing quite effectively. The relevance of the work regarding to astrophysical space plasma is pointed out.

Keywords Double layers · Streaming instability · Positron beam · Positron showers

1 Introduction

The interest in the studies of plasma containing positrons has been invoked because they constitute the essential part of the astrophysical environments (e.g., active galactic nuclei (AGN), pulsar magnetospheres, solar flares and fireballs producing γ-ray bursts, etc. and early universe). Positrons and electrons have tendency to combine forming neutral plasmas with a dynamical symmetry between the charge species and hence such plasma system is unique. Many authors have studied and explored various aspects of such plasma systems in plasma physics history. Alfvén has discussed the role of electron-positron plasmas in astrophysical situations (Alfvén 1981). The annihilation of positrons in a plasma has also been studied in detail (Wolfer 1969; Gould 1972, 1989). Tsytovich and Wharton have discussed theoretically about different waves and instabilities in electron-positron plasma (Tsytovich and Wharton 1978). The methods have been developed to accumulate positrons in the laboratory and store a large number of them in electrostatic trap (Greaves and Surko 1995; Surko et al. 1988, 1989). Advances in positron trapping techniques have led to room-temperature plasmas of 10^7 positrons with lifetimes of 10^3 s (Greaves et al. 1994). The presence of electron–positron (e–p) plasmas in the early universe, active galactic nuclei and magnetosphere of pulsars have been reported (Miller and Witta 1987; Misner et al. 1973; Rees 1983). Linear and nonlinear wave structures like formation of solitons, double layers and vortices in e–p plasmas have been studied (Shukla 1993; Shukla and Stenflo 1993; Tajima and Taniuti 1990) with their applications. Lominadze et al. (1982) have investigated the effect of temperatures of pulsar radio-emissions in e–p plasmas. Gedalin et al. (1985) have looked into nonlinear wave conversion in e–p plasmas, where they studied the effects of the nonlinear Cerenkov as well as the cyclotron resonances in order to associate pulsar radio-emissions with their model for nonlinear conversion of high-frequency radiation in to the low-frequency region. The presence of ions can excite several low-frequency modes, which otherwise

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