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ORIGINAL ARTICLE

Ion acoustic solitary waves in electron-positron-ion magneto-rotating Lorentzian plasmas

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Abstract Nonlinear ion acoustic solitary wave structures in electron-positron-ion (e-p-i) magnetized rotating plasmas is studied. The electron and positron species are assumed to be nonthermal and follow the kappa distribution function. The Korteweg de Vries (kdV) equation is derived by employing the reductive perturbation technique for solitary wave in the nonlinear regime. The variation in the amplitude and width of the solitary wave are discussed with the effects of positron concentration, temperature ratio of kappa distributed electrons to positrons, spectral index of the positrons, direction of propagation of the wave with magnetic field and effective gyrofrequency of the rotating nonthermal plasmas. The numerical results are also presented for illustration.

Keywords Solitons · Rotating plasmas · KdV · Pulsars · Magnetized plasmas

1 Introduction

The electron-positron (e-p) plasmas are believed to exist around astrophysical objects such as active galactic nuclei (AGN), quasars, neutron stars/pulsars (Beskin 2006). The nonlinear propagation of electrostatic waves in an electron-positron (e-p) plasma has drawn attention of many researchers due to existence of electrostatic waves in the early universe, active galactic nuclei and in the magnetosphere of neutron stars (Michel 1982, 1991; Akhter et al. 2013). It has been investigated by many researchers that the characteristic of ion acoustic solitary wave is modified in the presence of positrons (Hussain et al. 2013a). Popel et al. (1995) studied the ion acoustic solitary wave structures in e-p-i plasmas and observed that the presence of positrons diminishes the amplitude of the electrostatic solitary wave structures. Berezhiani and Mahajan (1994) studied the large-amplitude localized structures in e-p-i plasmas. The authors revealed the fact that stable structures can be generated in e-p-i plasmas. Nejoh (1996) reported that the amplitude of the solitary wave structures are affected by the ion temperature in an e-p-i plasma. Alinejad et al. (2006) studied the properties of stationary structures in e-p-i plasmas and found that the positron density affects the amplitude of the solitary wave. It has also been reported that the presence of positrons in electron ion plasma changes the propagation characteristics of magnetoacoustic waves (Hussain et al. 2013b).

Rotating plasmas play a pivot role in problems encountered in plasma devices in laboratory as well as in space plasmas (Hussain 2012). It has been reported long time ago that Coriolis force generated from rotation might have an important contribution in cosmic phenomena and other astrophysical environments. Rotation plays an appreciable role in the interaction of the weak magnetic field with the Coriolis force in the interior of the sun for waves with very long wavelengths. It has been investigated experimentally as well as theoretically that Coriolis force, however small in magnitude, has an effective role in plasma waves. For example, when a star is transformed into a neutron star, the moment of inertia decreases strongly, thus, the conservation of angular momentum causes a high rotation of the star. Under the condition of frozen in force lines, magnetic flux is also conserved thus, the field varies in proportion to r^2 where r is the radius of the star. Therefore, the neutron star should

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