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ORIGINAL ARTICLE

Weakly relativistic solitary waves in multicomponent plasmas with electron inertia

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Abstract Existence of compressive relativistic solitons is established in an arbitrary ξ-direction, inclining at an angle to the direction of the weak magnetic field ($\omega_{pi} \gg \omega_{Bi}$) in this plasma compound with ions, relativistic electrons and relativistic electron beams. It is observed that the absolute linear growth of amplitudes of compressive solitons is due to inactive role of the weak magnetic field and the initial streaming speeds of relativistic electrons, electron beams, and Q_b(ion mass to electron beam mass). Besides, the small initial streaming of electrons is found to be responsible to generate relatively high amplitude compressive solitons. The non-relativistic ions in the background plasma, but in absence of electron-beam drift and in presence of weak magnetic field are the causing effect of interest for the smooth growth of soliton amplitudes in this model of plasma.

Keywords Relativistic solution

1 Introduction

Investigation of nonlinear phenomena in various media and fields is the thrust area of research of modern times. The nonlinear solitary waves in plasmas under various physical situations are being studied throughout the world with increasing interests. Besides, theoretical results are supplemented by laboratory experiments also. Small amplitude solitary waves were first described by Korteweg-de Vries (KdV) employing reductive perturbation method. Of course, with full nonlinearity, finite but large amplitude solitary wave was studied by Sagdeev (1966) through pseudopotential method. Numerous works have been published (not mentioned here) in this direction with the help of both the methods. Based on the works of Washimi and Taniuti (1966), ion acoustic solitary waves were studied theoretically by Zakharov and Kuznetsov (1974), Tagare (1972), Shukla and Yu (1976), Yu et al. (1980), Ivanov (1981), Kalita et al. (1986) and many others in magnetized and unmagnetized plasmas. Das et al. (2007) have studied ion acoustic solitons with vortex-like velocity distribution, deducing the Schamel's modified KdV-Zakharov-Kuznetsov equation in magnetized plasma. Recently, Abelsalam et al. (2008) have observed the fully nonlinear ion acoustic solitary waves in collision less dense/quantum electron-positron-ion plasma.

The formation of solitary waves in interplanetary space is found to be drastically influenced by ions and electron beams in plasmas. Witt and Lotko (1983) and Al'per (1990) have shown the existence of nonlinear ion-acoustic waves, when an electron beam is injected into the plasma. It is important to report, that an electron beam component is frequently observed in regions of space where ion-acoustic waves exist.

In space plasma, high energy ion beam is observed to occur in the plasma sheet boundary layer of earth's magnetosphere and in Van-Allen radiation belts. Ion acoustic solitons in an ion-beam plasma system had been investigated theoretically by Abrol and Tagare (1979), Gresillon and Dovell (1975), experimentally by Ohnuma et al. (1971, 1973), Ohnuma and Fujita (1976) and Okutsu et al. (1978). Kalita et al. (1993) have studied the formation of ion-acoustic solitons in a magnetized ion-beam plasma system without consider-

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