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ORIGINAL ARTICLE

The role of undirected relativistic electrons with inertia in the formation of weakly relativistic ion acoustic solitons in magnetized plasma

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Abstract Existence of both subsonic and supersonic compressive solitons of interesting characters is established in this magnetized plasma model with non relativistic ions and relativistic electrons. The small supersonic range for the generation of compressive solitons is shown to confine near the vicinity of the direction of the magnetic field. It is predicted that the relativistic variation of electron's mass is responsible for the expansion of Sagdeev potential to result increase in soliton's amplitude and decrease in its width.

Keywords Relativistic solitons · Magnetized plasma

1 Introduction

The investigation of solitary waves in plasma beginning from seventies of the twentieth century, takes a new turn in modern times. The solitary wave is a fascinating structure in space laboratory for research which is also experimentally studied in terrestrial atmosphere. The formation of solitary waves in plasmas consisting of some of the species of ions, negative ions, electrons, ion-electron beams, positrons etc. engulfs a wide range of investigation either in simple or multi-component models. The introduction of relativistic and quantum effects in plasmas with various compositions transforms the field of research into a thrust area. It is also intensified by the advent of nanoscience which has created wide scope to study the behavior of nonlinear waves like solitary waves particularly in plasmas. Besides, the presence of dust charged particles in space plasma further intensifies this research field of investigation. Earlier, solitary waves were studied with simple and multi-component plasmas by many authors (not reported here) without consideration of relativistic and quantum effects.

Various properties of solitary waves in different media are studied by means of some nonlinear differential equations and by the energy integral. The Korteweg-de-Varies (KdV) equation is commonly used. Interestingly, the set of hydrodynamic blood flow equations, of course not in plasma, yields KdV equation which admits soliton solution. The volume of the blood sent by heart in the form of pressure waves is stored in the expanded region of arteries which is proportional to the area of soliton solution. The amplitudes and widths are found to strongly depend on the modulus of elasticity E. This is a glaring example of application of soliton solution in real life.

In the earth's auroral zone, Matsumato et al. (1994) have detected electrostatic solitary waves supported by ion beams from the data of GEOTAIL. Dombeck et al. (2001) have also observed solitary waves in earth's auroral zone within solar atmosphere.

Chain and Clemmow (1975) and Shukla et al. (1984) have investigated high power laser interaction for the Langmuir and electromagnetic waves with the inclusion of relativistic effect as an important prerequisite. The concept of nonlinear relativistic effect is essential in many astronomical phenomena similar to above, which is also reported by Arons (1979). The high power source of space composition and challenges of new ideas have invited to incorporate relativistic and quantum effects in many nonlinear phenomena like waves. In the fields of pulsar radiation and in solid state plasma, wave propagation with electron positron plasma is

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