Astrophys Space Sci (2013) 347:109–117
DOI 10.1007/s10509-013-1497-z

ORIGINAL ARTICLE

Investigation of ion acoustic solitons (IAS) in a weakly relativistic magnetized plasma

B.C. Kalita · M. Deka

Received: 25 March 2013 / Accepted: 16 May 2013 / Published online: 1 June 2013

Abstract Compressive solitons of low and high amplitudes are established in this weakly relativistic and magnetized plasma model. The assigned direction of soliton propagation to the direction of the magnetic field, supplemented by the corresponding ion initial streaming speed ($v_{i\xi 0}$) determines the lower limit of the initial electron streaming speed ($v_{e\xi 0}$) in its interval of existence to produce solitons for a given value of the speed of light c. Further, lower limit of c specified by the corresponding energy (or temperature) to yield relativistic compressive solitons is also predicated. Interestingly, the increased initial streaming speed of electrons is found to play less effective role in the steepening growth of amplitudes of compressive solitons due to mode one than those corresponding to the mode two.

Keywords Solitary wave · Relativistic soliton

1 Introduction

The investigation of nonlinear phenomena in various forms is an attracting field of research in many physical situations. Solitons in magnetized and unmagnetized plasmas is a beautiful and amazing manifestation of nonlinear structure in nature. The formation of the nonlinear structures like ion acoustic solitons (IAS), electron acoustic solitons (EAS) and double layers are being pursued by many researchers throughout the world. Korteweg and de Vries (1895) (KdV) and Washimi and Taniuti (1966) studied initially solitary waves in plasmas considering simple models. With this initiation, numerous works (not referred here) are completed during the last three decades. In the last decade, consideration of relativistic and quantum effects in the formation of solitons in plasmas keeps open a new dimension. Otherwise, the advent of nanoscience has created wide scope to study the behavior of non-linear waves like solitary waves, particularly in plasmas with relativistic and quantum effects. Further, the presence of dust charges particularly in space plasma expands the domain of interest. For recent interest, it can be mentioned that Kundu et al. (2013) have established the existence of negative potential (rarefactive) solitons in magnetized nonthermal dusty electronegative plasma. The magnetic field is shown not to affect the amplitude of the solitary waves but the width is reported to decrease at the increase of $\vec{B}_0$. Further, stability is also shown to depend strongly on the external magnetic field. Again, Masud and Mamun (2012) have investigated dust acoustic solitary waves (DASW) through Zakharov-Kuznetsov (ZK) equation in an obliquely propagating magnetized dusty plasma with mobile negatively charged dusts, two temperature Maxwellian ions and non inertial electrons. Of course, small but finite amplitude DASW's of positive potential are shown to exist depending on the external magnetic field and ion-electron temperature ratio. Through the derivation of modified Gardner (mG) equation, Masud et al. (2013) have discussed Gardner solitons in a nonplanar (cylindrical and spherical) dusty plasma with static dust, inertial ions and two populations of Boltzmann electrons. Their numerical analysis shows that Gardner solitons are different from the KdV solitons for specific parametric ratios. Masud et al. (2012) have investigated dust ion acoustic waves in the same composition of plasmas with Gardner equation. DIA Gardner

B.C. Kalita
Department of Mathematics, Gauhati University, Guwahati
781 014 Assam, India

M. Deka (✉)
Department of Mathematics, Swadeshi Academy Jr. College,
Guwahati 781 005 Assam, India
e-mail: dekamanabendra@gmail.com