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ORIGINAL ARTICLE

Cylindrical and spherical soliton collision of electron-acoustic waves in non-Maxwellian plasma

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Abstract Generation of quasielastic electron-acoustic (EA) waves head-on collision are investigated in non-planar (cylindrical/spherical) plasma composed of cold electrons fluid, hot electrons obeying nonthermal distribution, and stationary ions. The cylindrical/spherical Korteweg-de Vries (KdV) equations describing two bidirectional EA waves are derived and solved analytically. Numerical investigation have shown that only positive electron-acoustic (EA) structures can propagate and collide. The analytical phase shift $|\Delta_A|$ due to the non-Maxwellian (nonthermal) electrons is different from the Maxwellian case. Both the hot-to-cold electron number density ratio α and nonthermal parameter β have opposite effect on the phase shift behavior. The phase shift of the spherical EA waves is smaller than the cylindrical case, which indicates that the former is more stable for collision. The relevance of the present study to EA waves propagating in the Earth's auroral zone is highlighted.

Keywords Nonlinear wave propagation · Auroral zone plasma · Electrostatic waves

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1 Introduction

Electron-acoustic (EA) waves are one of the basic wave processes in plasmas and they have been studied for several decades both theoretically and experimentally. Potential studies on the propagation of EA waves shown a great deal of interest due to their importance in interpreting the electrostatic component of the broad-band electrostatic noise observed in the cusp region of the terrestrial magnetosphere (Tokar and Gary 1984; Singh and Lakhina 2001), in the geomagnetic tail (Schriver and Ashour-Abdalla 1989), in the dayside auroral acceleration region (Dubouloz et al. 1991; Pottelette et al. 1999) etc. The propagation of EA waves in a plasma system has been studied by several investigators in an unmagnetized two electron plasma (Dubouloz et al. 1991; Chatterjee and Roychoudhury 1995; Berthomier et al. 2000; Mamun and Shukla 2002; El-Taibany and Moslem 2005; El-Shewy 2011; Sabry and Omran 2013), as well as in magnetized plasma (Lashmore-Davies and Martin 1973; Mohan and Buti 1980; Dubouloz et al. 1993; Mace and Hellberg 2001; Mamun et al. 2002; Berthomier et al. 2003; Shukla et al. 2004; Tribeche and Sabry 2012; Shalaby et al. 2011; El-Labany et al. 2012). In the case of unmagnetized plasma, the EA waves have been observed in the laboratory when the plasma consisted of two species of electrons with

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