Astrophys Space Sci (2012) 338:279–285
DOI 10.1007/s10509-011-0930-4

ORIGINAL ARTICLE

Positron acoustic solitary waves interaction in a four-component space plasma

E.F. El-Shamy · W.F. El-Taibany · E.K. El-Shewy · K.H. El-Shorbagy

Received: 11 October 2011 / Accepted: 10 November 2011 / Published online: 30 November 2011

Abstract The characteristics of the head-on collision (HOC) between two positron acoustic solitary waves (PASWs) in a four component electron-positron-ion (EPI) space plasma have been investigated theoretically, using the extended Poincaré-Lighthill-Kuo (PLK) method. The analytical phase shifts after the collision of the two solitary waves occurs are derived. Numerically, the influences of the cold/hot positron parameters on the phase shifts are explicitly investigated. The present theory is applied to analyze the formation and the interaction of localized coherent PASWs structures in space plasmas (pulsar environments).

Keywords Head-on collision · Extended Poincaré-Lighthill-Kuo (PLK) method · Positron acoustic solitary wave · Two-temperature positron · Electron-positron-ion plasma

E.F. El-Shamy
Department of Physics, College of Science, King Khalid University, Abha, P.O. 9004, Kingdom of Saudi Arabia
e-mail: emadel_shamy@hotmail.com

W.F. El-Taibany (✉)
Department of Physics, College of Science for Girls in Abha, King Khalid University, Abha, P.O. 960, Kingdom of Saudi Arabia
e-mail: eltaibany@hotmail.com

W.F. El-Taibany (✉)
e-mail: eltaibany@kku.edu.sa

E.K. El-Shewy
Department of Physics, Faculty of Science, Mansoura University, Mansoura, Egypt

K.H. El-Shorbagy
Department of Mathematics, Faculty of Science, King AbdulAziz University, Jeddah, Kingdom of Saudi Arabia

K.H. El-Shorbagy
Plasma Physics and Nuclear Fusion Department, Nuclear Research Center, Atomic Energy Authority, Cairo, Egypt

Present address:
E.F. El-Shamy · W.F. El-Taibany
Department of Physics, Faculty of Science, Damietta Branch, Mansoura University, New Damietta, P.O. 34517, Egypt

Present address:
E.K. El-Shewy
Department of Physics, Science and Arts College in Al-Rass, Qassim University, Qassim, Kingdom of Saudi Arabia

1 Introduction

During the last few years, there have been a lot of activities in the field of pair (electron–positron) plasma. Electron–positron plasmas have received a great deal of attention due to its importance not only in plasma astrophysics (i.e., in early universe, in active galactic nuclei (Miller and Witta 1987; Wang and Durouchoux 2011), in magnetospheres of pulsars (Shukla 1985), polar regions of neutron stars (Michel 1991), intense laser fields (Berezhiani et al. 1992)), but also in laboratory experiments in which the positrons can be used to probe the particle transport in tokamak plasmas (Greaves et al. 1994; Helander and Ward 2003). In fact, positrons are created in the interstellar medium when the atoms become interacted by the cosmic ray nuclei (Adrani et al. 2009). The annihilation, which takes place in the interaction of matter (electrons) and anti-matter (positrons), usually occurs at much longer characteristic time scales compared with the time in which the collective interaction between the charged particles takes place (Surko and Murphy 1990).

On the other hand, a great deal of attention has been devoted to the study of different types of collective processes and instabilities in electron-positron-ion (EPI) plasmas (Verga and Ferro Fontán 1984; Shukla et al. 1986;