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ORIGINAL PAPER

Dust ion acoustic double layers in a 4-component dusty plasma

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Abstract: In this paper, we study the Dust ion acoustic (DIA) solitons in an unmagnetised dusty plasma comprising of cold dust particles, electrons that follow Cairns distribution, warm inertial ions, and ion-beams of equal mass, using arbitrary amplitude technique. Our results show that it is possible for both rarefactive (negative) and compressive (positive) DIA solitary waves to coexist. Interestingly, double layers could not limit the existence of solitary waves. These results can therefore help to understand the mechanism for decelerating protons in the accretion flow onto neutron stars in a binary system at radial distances where the effect of magnetic field can be neglected.

Keywords: Solitons; Dusty plasma; Double layers

PACS Nos.: 52.35.Sb - Solitons BGK modes; 52.27.Lw - Dusty or complex plasmas; plasma crystals

1. Introduction

Over the years, dusty plasmas have received considerable attention from several authors [1–6]. This is because of their ubiquity in the universe [7] and a rich linear and nonlinear wave phenomena [8].

The first theoretical study on the existence of low frequency dust ion acoustic solitary waves (DIASWs) was conducted by Shukla and Silin in 1992 [1]. Since then, most studies on nonlinear dusty plasma waves have considered unmagnetised plasma models. In the case of the four component dusty plasma models, it is possible to obtain either rarefactive or compressive double layers. In the model by [2], existence of large amplitude electrostatic double layers in four-component collisionless and unmagnetised dusty plasma was investigated. The species considered were, electrons, two distinct positive ion species of different temperatures, and extremely heavy negatively charged dust particles and only compressive double layers were possible.

Later, [3] studied large amplitude double layers in a dusty plasma with an arbitrary streaming ion beam and found that both the temperature of dust and ion beam temperature play significant roles in determining the region of double layers. Therefore, the ion-beam plays a significant role in the formation of double layers.

Additionally, [4] studied DIASWs in a plasma with kappa-distributed electrons. They showed that negative dust supports solitons of both polarities while positive dust supports only positive potential solitons. Recently, [5] also studied arbitrary amplitude DIASWs and double layers in a kappa distributed electron plasma, and provided existence domains of arbitrary amplitude rarefactive double layers.

In this study, such structures as compressive and rarefactive double layers as well as solitons will be investigated for an electron population that follow Cairns distribution.

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