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ORIGINAL ARTICLE

Dust acoustic localized structures in an electron depleted dusty plasma with two-suprathermal ion-temperature

Mehran Shahmansouri · Mouloud Tribeche

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Abstract Nonlinear dust acoustic (DA) localized structures are studied in two-suprathermal ion-temperature dusty plasma. The electron number density is assumed to be sufficiently depleted owing to the electron attachment during the dust charging process, i.e. $n_e \ll n_i$. The DA solitary waves and double-layers are investigated based on the pseudo-potential approach. It is found that the ion suprathermality may affect the spatial patterns as well as the nature of the DA structures.

Keywords Dust-acoustic waves · Suprathermal ions · Electron depletion · Solitary waves · Double-layers

1 Introduction

During the last two decades, nonlinear propagation of electrostatic excitations in dusty plasmas attracted a great deal of interest. This is because of their fundamental role in the study of different environments, such as the cometary tails, the planetary rings, the gossamer ring of Jupiter, the asteroid zones, the interstellar clouds, the earth's mesosphere and ionosphere, etc. (Horanyi and Mendis 1985, 1986; Goertz 1989; Mendis and Rosenberg 1992, 1994; Verheest 1996). Furthermore, it has been shown that the dust charge dynamics introduces new plasma eigenmodes, such as dust-acoustic (DA) mode (Rao et al. 1990; Melandso et al. 1993; Rosenberg 1993; Barkan et al. 1995; D'Angelo 1995), dust-ion acoustic mode (Shukla and Silin 1992; Alinejad 2011), dust cyclotron mode (Shukla and Rahman 1998), dust drift mode (Shukla et al. 1991; Mamun et al. 1999; Salimullah et al. 1999) and dust lattice mode (Melandso 1996; Farokhi et al. 2009a, 2009b; Shahmansouri and Farokhi 2012). Dust acoustic solitary waves have been studied by a number of authors in the last few decades, theoretically (Mamun 1999a, 1999b; Ghosh et al. 2001; El-Labany et al. 2002, 2008, 2010; Rahman et al. 2008; Pakzad 2010; Das and Devi 2010; Tribeche and Benzekka 2011) as well as experimentally (Barkan et al. 1995). Numerous observations of space plasmas indicate clearly the presence of suprathermal electron and ion species (for more details, see the recent review of Pierrard and Lazar 2010). To model and fit these early space observations, Vasyliunas (1968) was the first to introduce the so-called kappa (or generalized Lorentzian) velocity distribution functions. Suprathermal ions are present in different space and astrophysical plasma environments, viz., the ionosphere, mesosphere, magnetosphere, lower atmosphere, magneto-sheet, terrestrial plasma-sheet, radiation belts and auroral zones (Pierrard and Lazar 2010; Collier 1993; Maksimovic et al. 2000; Antonova et al. 2003; Mori et al. 2004).

It is well-known that deviations from the Maxwell-Boltzmann distribution may affect and modify the existence domain of nonlinear structures. Rubab and Murtaza (2006) and Tribeche et al. (2009) investigated arbitrary amplitude DA oscillations with suprathermal ions. Baluku and Hellberg (2008) studied the influence of kappa distributed electrons and/or ions on the formation of DA solitary waves. DA shock waves in coupled dusty plasma with kappa distributed ions have been investigated by Pakzad (2011). The existence and characteristics of DA solitons in a plasma with two-ion components, have been recently

M. Shahmansouri (✉)
Department of Physics, Faculty of Science, Arak University, Arak, P.O. Box 38156-8-8349, Iran
e-mail: mshmansouri@gmail.com

M. Tribeche
Faculty of Sciences-Physics, Theoretical Physics Laboratory, Plasma Physics Group, University of Bab-Ezzouar, USTHB, B.P. 32, El Alia, Algiers 16111, Algeria