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ORIGINAL ARTICLE

Nonlinear electrostatic excitations in electron-depleted electronegative dusty plasma with two-negative ion species

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Abstract Nonlinear electrostatic solitary and shock excitations in electron-depleted electronegative dusty plasma with two-negative ions are considered. Excitations properties and formation conditions are clearly explained. The relevancy of this investigation to space observations and laboratory experiments is pointed out.

Keywords Electrostatic solitary and shock excitations · Electron depletion · Dusty plasma

1 Introduction

In recent years it has been realized that the presence of negative ions is more important than previously considered. While it was long thought that multicomponent plasma could contain positive ions and one negative ion species in addition to electrons, it is now established that plasma with two- or more negative ion species could be presented both in space (Coates et al. 2007; Vuitton et al. 2009) and in laboratory experiments (Ichiki et al. 2001). Indeed, the presence of negative ions drastically change the properties of plasmas. On the other hand, the number of electrons decreases with the increase of negative ions according to the charge neutrality. The resulting decrease in the shielding effect produced by electrons, which is one of the main effects governing the behavior of plasmas, characterizes the specific phenomena of negative ion plasmas. Furthermore, the presence of negative dust impurities could lead to much electron density depletion since the electrons from the ambient plasma are attached onto the dust-grain surface and the plasma could be regarded as electron bite-outs. Such assumption could be of interest in some plasma environments such as in laboratory experiments (where the dust grains could be introduced as impurities as referred by Ichiki et al. 2001), in Earth's mesosphere (where the D-region plasma could suffer from electron density depletion as shown by Friedrich et al. 2010), F-ring of Saturn (Goertz 1989), etc. Actually, extensive work have been done to investigate the behavior of electrostatic excitations in multicomponent plasma with or without dust particles (e.g., Wong et al. 1975; Das and Tagare 1975; Das 1979; Watanabe 1984; Das and Singh 1991; El-Labany and El-Sheikh 1992; Moslem 1999; Ichiki et al. 2002; Tribeche et al. 2004, 2008; Sayed et al. 2008; Tribeche and Benzekka 2009; Mamun et al. 2009a, 2009b; El-Labany et al. 2011a, 2011b; Moslem et al. 2011; Tribeche and Benzekka 2011). However, to the authors knowledge, the possible nonlinear electrostatic structures in electron-depleted electronegative dusty plasma with two-negative ions are not investigated before, which is the goal of the present work.

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