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ORIGINAL ARTICLE

Arbitrary amplitude double layers in a four component dusty plasma with kappa distributed electron

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Abstract Dust acoustic double layers are studied in a four component dusty plasma comprising positively and negatively charged dust grains, Boltzmann distributed ions and kappa distributed electrons. The conditions for existence of double layers are studied in detail using Sagdeev's method. Large amplitude double layers are obtained for a range of values of the plasma parameters.

Keywords Soliton · Pseudo-potential · Double-layers · Kappa distribution

1 Introduction

The Study of nonlinear waves in dusty plasma is one of the most rapidly growing area of plasma physics and it has been studied by several authors. Dust acoustic wave (DAW) is one such nonlinear wave which has been first predicted theoretically by Rao et al. (1990). Dust ion wave (DIW) has also been observed experimentally (D'Angelo 1995; Duan et al. 2001; Nakamura et al. 1999). The dust grain dynamics also gives several other eigen modes like dust ion acoustic waves (DIAS), dust-Berstain-Greene-Kruskal (DBGK) mode among others.

However most of the researchers have considered the negatively charged dust only. The consideration of negatively charged dust is valid when dust charging process by collection of plasma particles (viz. electrons and ions) is much more important than other charging processes. But the dust grains can be positively charged (Rosenberg and Mendis 1995; Fortov 1998; Rosenberg et al. 1999; Chow et al. 1993) by other important charging processes. A dust grain can be positively charged by three principal mechanisms. These are (i) Photo emission in the presence of a flux of ultraviolet photons, (ii) Thermionic emission induced by radiative heating, (iii) Secondary emission of electrons from the surface of the dust grains.

Examples of the existence of plasma with both positively and negatively charged dust particles can be found in several astrophysical plasmas like Earth's mesosphere (Havnes et al. 1996), Cometary tails (Horanyi 1996; Ellis and Neff 1991), Jupiter's magnetosphere (Horanyi et al. 1993; Ellis and Neff 1991; Horanyi 1996). Chow et al. (1993) explained the situations under which smaller dust particles become positively charged and larger particles become negatively charged. Sayed and Mamun (2007) investigated solitary waves in four component plasmas where they considered both positively and negatively charged dust particles. Chatterjee and Kundu (2008) studied the existence of refractive and compressive solitary waves in four component dusty plasma. Chatterjee and Roy (2008) also studied the nonthermal electron effect on the four component dusty plasma. Mandal et al. (2009) studied the double layers in four component dusty plasma.

In the last few years, the formation of double layers has been a topic of great interest. Double layers have been found in a variety of laboratory plasmas such as constricted plasmas (Langmuir 1929), Mercury discharges (Stangeby and Allen 1973), Q-machines (Sato et al. 1976), triple plasma devices (Coakley and Hershkowitz 1978) etc. The role of Double layers in astrophysics is considerable interest as double layers are thought to be present in the magnetosphere and are responsible for the acceleration of electrons in the upper

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