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ORIGINAL ARTICLE

Large amplitude double layers in a dusty plasma with nonthermal electrons featuring Tsallis distribution

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Abstract The problems of large amplitude double layers are discussed using Sagdeev's pseudo-potential technique for a dusty plasma comprising two temperature isothermal ions and nonextensive nonthermal velocity distributed electron. For different sets of plasma parameter values, the Sagdeev potential $V(\phi)$ has been plotted. It is found that nonextensive q parameter plays a significant role in determining the shape and size of large amplitude double layers. Also, it is observed that the existence of large amplitude double layers depends on different plasma parameters.

Keywords Tsallis distribution · Nonthermal electron · Pseudo-potential · Double-layers

1 Introduction

Dust and plasmas are omnipresent in the universe. They play significant roles in space plasma, astrophysical plasma, laboratory plasma and environment such as planetary rings, cometary tails and interstellar clouds (Horanyi and Mendis 1985; Sheehan et al. 1990). Dusty plasmas also play a vital role in our understanding of different types of new and interesting aspects in other fields such as low temperature physics, radio-frequency plasma discharge, coating and etching of thin films and plasma crystal. Such plasmas are also investigated in laboratory experiments (Sheehan et al. 1990; Bouchoule et al. 1991). The study of nonlinear waves in dusty plasma is one of the most rapidly growing areas of plasma physics. No wonder, several authors have shown their interest in the field. 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 wave (DIAS), Dust-Berstain-Greene-Kruskal (DBGK) mode among others.

In the last few years, the formation of double layers has been a topic of great interest. A double layer consists of two equal and oppositely charged layers with a resulting strong electric field between them. Double layers have been observed in the upper ionosphere and lower magnetic sphere above the earth's auroral regions. The first research into space charge layers was conducted by Langmuir (1927). Chan (1987) and Leung (1987) found double layers experimentally. Double layers play an important and fundamental role in astrophysical phenomena. It is also believed that double layers have important effects in practical plasma problems such as the development of high power gas lasers and in opened fusion device. During the last few years considerable work, both theoretical and experimental have been done on double layers in both magnetized and unmagnetized plasma. Recently, Roy et al. (2012a) studied the effect of kappa distributed electrons on arbitrary amplitude double layers in a four-component dusty plasma. Roy et al. (2012b) also studied the large amplitude double layers in dusty plasma consisting of two temperature isothermal ions and q distributed electrons. Ghosh et al. (2012) have studied the solitary waves and double layers on non planar geometry. Also, Tribeche et al. (2012a) have studied the arbitrary amplitude dust acoustic double layers in warm dusty plasma

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