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ORIGINAL ARTICLE

Effect of ion kinematic viscosity on large amplitude dust ion acoustic solitary waves

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Abstract Nonlinear dust ion acoustic solitary waves (DIASW) in dusty plasma are studied incorporating kinematic viscosity, using Sagdeev's pseudopotential approach. The effects of kinematic viscosity and the nonextensive parameter q on the features of DIASW are investigated in some detail.

Keywords Plasma waves · Solitons in plasma · Nonextensive distribution · Pseudo-potential

1 Introduction

Wave propagation in dusty plasmas plays a key role both in space and in laboratory experiments (Verheest 2000; Shukla and Mamun 2002). Dusty plasmas consist of finite-sized charged dust particulates along with electrons and ions. The three important properties of dusty plasmas are namely (a) the dust particulates are massive (billions times heavier than the protons) and their sizes range from nanometers to millimeters, so the time-scales associated with the dust and the ion motion differ significantly, (b) Due to the presence of electron and ion currents the charges can fluctuate onto the dust grain surface, (c) the finite size of the dust grains makes dusty plasmas nonideal. The existence of the low-frequency electrostatic dust acoustic waves (DAWs), was predicted by Rao et al. (1990) in an unmagnetized dusty plasma. Later, the characteristic behavior of dust particles in dusty plasmas have been investigated theoretically and experimentally by several authors (Rao 1998; Xie et al. 2000; El-Labany et al. 2004; Moslem 2005).

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The study of nonlinear waves in dusty plasmas has become a most popular topic of research after the observation of Bliokh and Yarashenko (1985), who first theoretically predicted such waves while dealing with waves in Saturn's ring. Latter, nonlinear wave phenomena in dusty plasma in several new eigen modes like as dust-acoustic wave (DAW) (Rao et al. 1990; Barkan et al. 1995), dust ion-acoustic wave (DIAW) (Shukla and Silin 1992; Shukla et al. 1992; Merlino et al. 1998), dust lattice (DL) waves (Melandso 1996; Farokhi et al. 1999), Dust-Berstain-Greene-Kruskal (DBGK) mode (Tribeche et al. 2000; Tribeche and Zerguini 2004), Shukla-Verma mode (Shukla and Verma 1993), Dust drift mode (Shukla and Silin 1992; Shukla et al. 1992) etc. are studied extensively. Recently Masud et al. (2012) have derived the gardner soliton in planar geometry with bi-Maxwellian electrons in dusty plasma. Also Masud et al. (2013a) have investigated DIASW with two electron temperatures in dusty plasma by deriving the Burgers equation. Masud et al. (2013b) have studied the nonlinear propagation of DIASW in an unmagnetized dusty plasma. The study of DIASW and their multi-dimensional instability in a magnetized nonthermal dusty electronegative plasma is done by Kundu et al. (2013).

Many researchers studied solitary waves and double layers in plasma. However these studies are based on the assumption of Maxwell-Boltzmann distributed electrons and ions. But such distribution is valid for the macroscopic ergodic equilibrium state and also this distribution is inadequate to describe the long range interactions in unmagnetized collision less plasma where the non equilibrium stationary state exists. Space plasma observations (Shukla et al. 1986; Ghosh and Bharuthram 2008; Ghosh et al. 2008; Pakzad 2009a, 2009b) clearly indicate the presence of ions and electrons which are far away from their thermodynamic equilibrium. In space plasma environment like planetary

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