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ORIGINAL ARTICLE

Head-on collision of dust acoustic solitary waves with variable dust charge and two temperature ions in an unmagnetized plasma

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Abstract The head-on collision of dust acoustic solitary waves (DASWs) in an unmagnetized dusty plasma with single electrons, two-temperature ions, variable dust charge is investigated using the extended Poincaré-Lighthill-Kuo (PLK) method. The effects of the dust charge fluctuation and two temperature ion are studied. It is found that the dust charge fluctuation and two temperature ion have the significant role on the phase shift.

Keywords Solitary waves · DASWs · PLK method · Head-on · Dust charge variation

1 Introduction

The interplay between plasmas and charged dust grains has opened up a new and fascinating research area, that of a dusty plasma. A dusty plasma is a normal electron-ion plasma with an additional charged component of small micron-sized particulate. The study of different types of nonlinear phenomena processes in dusty plasma is demanding due to its presence in comet tails, asteroid zones, planetary ring, interstellar medium, and the lower part of the Earth's ionosphere and magnetosphere (Goertz 1989; Horanyi and Mendis 1986a, 1986b; Mendis and Rosenberg 1992, 1994; Northrop 1992; Verheest 1996). This extra component, which increases the complexity of the system even further, is responsible for modifying the collective behavior of a plasma and generating new modes like dust ion acoustic (DIA) waves (Shukla and Silin 1992), dust-acoustic (DA) waves (Rao et al. 1990) etc. Many researchers have also observed dust acoustic solitary waves (DASWs) (Chatterjee and Jana 2005; Das and Chatterjee 2009; Maitra and Roychoudhury 2003; Pakzad 2009, 2010a, 2010b; Sahu and Tribeche 2011; Sen et al. 2008) and dust ion acoustic solitary waves (DIASWs) (Chatterjee et al. 2011; Gupta et al. 2001; Shalaby et al. 2010; Rahman and Mamun 2011; Sayeed and Mamun 2007) in one dimensional and unmagnetized plasma by considering three component dusty plasma composed of electrons, ions and negatively charged dust grains. Most of these works have considered an unmagnetized dusty plasma system containing dust grains of constant negative charge. In fact constant dust charge is not realistic in nature. The variable dust charge is more closer to the reality rather than the constant dust charge which is inadequate to describe important nonlinear phenomena. The assumption that the dust grains have constant negative charge in such a plasma system virtually represents a plasma with heavy species of negative ions. However, the dust grain charge varies according to the local plasma currents owing into the grain surface. Thus the grain charge is a variable that has to be determined self-consistently by its charging currents. A great deal of attention (Ghosh et al. 2004; Mamun and Hassan 2000; Sarkar et al. 2011; Tribeche and Shukla 2011; Xue 2003) have been paid to study the nonlinear phenomenon in dusty plasma taking dust charge variation into account rather than the constant dust charge. In most practical dusty plasma, a gas flow which is usually introduced, can charge quickly keeping relatively low temperature. But it is found that the dust charge fluctuation along with two temperature ions has been more interesting rather than single ions temperature. A great interest (Goswami and Buti 1976; Luo and Zhang 2004; Xie et al. 2000; Tagore and Chutia 1999; Zhang and Wang 2006) is done to study the nonlinear phenomenon. Tagore and Chutia (1999) have been stud-

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