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ORIGINAL ARTICLE

# Nonextensive dust acoustic shock structures in complex plasmas

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**Abstract** Nonlinear dust acoustic (DA) shock waves are studied in a nonextensive charge varying complex plasma. A burger-like equation the coefficients of which is significantly modified by nonextensivity and dust charge fluctuation is derived. It is found that the influence of particle (electrons and ions) nonextensivity and dust charge fluctuation affect the basic properties of the collisionless DA shock wave drastically.

**Keywords** Dust-acoustic waves · Nonextensive electrons/ions · Shock waves

## 1 Introduction

Complex plasmas as mixture of electrons, ions and dust particles have attracted a great deal of attention in the last two decades. The presence of dust particles significantly modifies the plasma collective behavior. The dust grains dynamics introduces new eigenmodes, such as dust-acoustic (DA) mode (Rao et al. 1990; Barkan et al. 1995), dust-ion acoustic mode (Shukla and Silin 1992; Shahmansouri and Alinejad 2012), dust cyclotron mode (Shukla and Rahman 1998), dust drift mode (Shukla et al. 1991) and dust lattice mode (Melandso 1996; Farokhi et al. 2009; Shahmansouri and Farokhi 2012). Rao et al. have first theoretically predicted the existence of very low-frequency dust acoustic waves (DAWs) in a multi-components dusty plasma. Barkan et al. (1995) and Thompson et al. (1999) have experimentally observed DAWs in laboratory dusty plasmas. The DAW phase velocity is much smaller than the electron and ion thermal speeds. The nonlinear properties of DAWs have been studied by a number of authors due to their occurrence in laboratory as well as astrophysical and space plasmas (Rao et al. 1990; Melandso et al. 1993; Rosenberg 1993; Barkan et al. 1995; D'Angelo 1995; Mamun 1999a, 1999b; Ghosh et al. 2001; El-Labany et al. 2010; Baluku and Helberg 2008; Rahman et al. 2008; Das and Devi 2010; Eslami et al. 2011; Amour et al. 2012; Shahmansouri and Tribeche 2012, 2013; Sahu and Tribeche 2012; Shahmansouri 2013a, 2013b). Spatial observations clearly indicate that astrophysical and space plasmas have non-Maxwellian particles distribution functions (Vasyliunas 1968; Leubner 1982). However, most of the studies on DAWs have been confined to Maxwell-Boltzmann distributed particles. Maxwellian distributions may be inadequate to describe systems endowed with long-range interactions. A generalization of the Boltzmann-Gibbs (BG) statistics has then been proposed (Tsallis 1988) and successfully applied to a number of systems endowed with long-range interactions. A parameter $q$ measures the strength of the nonextensivity. The associated velocity distribution which is called $q$-distribution has been applied to various systems (Tribeche and Shukla 2011; Sahu 2011; El-Awady and Moslem 2011). To model the nonextensive effects, the following $q$-distribution function has been adopted (Silva et al. 1998)

$$f_{e,i}(v) = C_{q_{e,i}}\left(1-(q_{e,i}-1)\frac{m_{e,i}v^2+2Q_{e,i}\phi}{2T_{e,i}}\right)^{\frac{1}{(q_{e,i}-1)}}, \quad (1)$$

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