IJMS, Vol. 15, Nos. 3-4, (July-December 2016)

ISSN: 0972-754X

SHOCK WAVE PHENOMENA IN UNMAGNETIZED DUSTY PLASMAS

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Abstract: The nonlinear propagation of dust acoustic wave (DAW) and dust acoustic shock wave (DASW) in unmagnetized warm dusty plasmas system consisting of Maxwellian electrons and ions with the effect of dust charged fluctuation are studied using the reductive perturbation technique. The nonlinear waves (solitary and shock waves) has been observed in case of negative and positive charged dust grains form the stationary solution of the Korteweg-de Veries (KdV) equation and Burger's equation, also we observed the effect of without viscosity and with viscosity term is in the derivation of Burger equation. The fundamental properties of such nonlinear waves have been theoretically analyzed.

Keywords: Dusty plasma, Solitary wave, Shock wave and viscosity.

1. INTRODUCTION

Since the concept on studying the solitary waves (soliton dynamics) by the well known methods reductive perturbation technique [1], Sagdeev potential [2] developed by many heuristic observation in various plasma configuration (theoretically as an ideal model) [3] in Astroplasma [4] and supported by many experiments [5, 6]. All the observation depends on the plasma modally existing in different region of space plasmas [7, 8] and established many observations related in the satellite observation [9]. During 1990 another field of interest called as dusty plasmas has been boosting the studying of the dusty acoustic waves (DAW), first established probably by Rao *at al.*, [10] and supported by the experimentally by Barkan *et al.*, [11, 12]. The dusty plasmas condition has found more or less, every model of plasmas in space of the laboratory. And that is why the field has been growing first to explain many features in Astrophysics problems and highlights the salient features of nonlinear plasmas acoustic waves as of soliton dynamics [13], shock wave [14, 15], double layers [16, 17] Sheath formation in lab as well as in space which could explain a special features on the formation of nebulous (crystallization of dust clouds over the surface of moons and asteroids) [18-19] observation the solid body (e.g., moon) in astroplasma. In this article we consider unmagnetized dusty plasma with Maxwellian electrons and ions. In section I, the basic set equations of dust acoustic wave motion is stated. In section II, by using the reductive perturbation method (RPM) the KdV equation has been derived with soliton solution. In section III, by using the same method, we derived Burger equation without viscosity and with viscosity term. Figures, discussed and conclusions in section IV.

2. BASIC EQUATION

To study the non-linear plasma acoustic wave and shock wave, we assumed that the unmagnetized dust warm plasma, consisting of Maxwellian electrons and ions contaminated by the influence of dust-charge fluctuation. Following Das *et al.*, [20] the basic equation's, governing the dust charge grains are in fluid description, are the equations of continuity and momentum can be written in the following form

$$\frac{\partial n_d}{\partial t} + \nabla(n_d u_d) = 0 \tag{1}$$

$$n_d \frac{\partial u_d}{\partial t} + n_d u_d \frac{\partial u_d}{\partial x} + \sigma_d \frac{\partial p_d}{\partial x} = -s_d \frac{e n_d z_d}{m_d} \frac{\partial \phi}{\partial x} \tag{2}$$

$$\frac{\partial p_d}{\partial t} + u_d \frac{\partial u_d}{\partial x} + 3 p_d \frac{\partial u_d}{\partial x} = 0 \tag{3}$$

and supplemented by the Poisson's equation given by [15]

$$\nabla^2 \phi = 4\pi e(n_e - s_d z_d n_d - z_i n_i) \tag{4}$$

where m_d is the of the dust particle moving with the velocity u_d normalized with the dust-acoustic speed $C_d = (z_d T_i / m_d)^{\frac{1}{2}}$, and the particle number charge densities are n_α ($\alpha = i, e, d$), respectively for the ions, electrons and dust particle. The ion and dust charge numbers are given by $z_{i,\,d}$ and the $s_d = \pm 1$ depending on whether the dust particles are positively or negatively charged. The fluid pressure p_d, electrostatics potential ϕ, spatial variable x and time t. The electrostatic wave potential ϕ normalized by $(\frac{T_i}{e})^{\frac{1}{2}}$ and $\sigma_d = \frac{T_d}{T_e}$. All other symbols have their usual meanings.

The physical variable f is now decomposed into its equilibrium part f_0 and the perturbed part (fluctuation part) $\overline{f}$ i.e., $f = f_0 + \overline{f}$. Thus we write $n_d = n_d^{(0)} + \overline{n}_d$, where $\overline{n}_d$ is the density perturbation of the dust fluid and $z_d = z_d^{(0)} + \overline{z}_d$, where $\overline{z}_d$ is the fluctuating part of the dust charged number. $n_d^{(0)}$ and $z_d^{(0)}$ are the mean value of these variables, respectively. The perturbed dust-charging equation can be written as [21, 22]

$$\frac{d\overline{Q}_d}{dt} + \eta \overline{Q}_d = |I_{e0}| \left(\frac{\overline{n}_i}{n_i^{(0)}} + \frac{\overline{n}_e}{n_e^{(0)}} \right) \tag{5}$$

with $Q_d = Q_d^{(0)} + \overline{Q}_d$, where $Q_d^{(0)}$ and $\overline{Q}_d$ are respectively the charged of the dust particle at equilibrium and perturbed states. Charged fluctuations on the dust particles are drive by the difference in the relative density fluctuations of ions $\overline{n}_i$ and electron $\overline{n}_e$ and the quantity η represents the natural decay rate of dust-charge [23]

$$\eta = \left(\frac{|eI_{e0}|}{C}\right)\left(\frac{1}{k_B T_e} + \frac{1}{\omega_0}\right) \tag{6}$$

where C is the capacity of the dust grain, $\omega_0 = k_B T_i - e\phi_{f0}$, $T_{e,\,i,\,d}$ are the temperatures of electrons, ions and dust and ϕ_{f0} is the equilibrium floating potential. The equilibrium electron (ion) current is I_{e0} $(= -I_{i0})$. The charge fluctuations decay because any devotion of gain potential from equilibrium potential is opposed by electron and ion currents into gain [24, 25] as described by Eq. (5). Using Eq. (6) in Eq. (5) can be written as

$$\frac{d\overline{z}_d}{dt} + \eta\overline{z}_d = -s_d(q_1\phi + q_2\phi^2) \tag{7}$$

with

$$q_1 = \left(\frac{|I_{e0}|}{k_B}\right)\left(\frac{z_i}{T_i} + \frac{1}{T_e}\right), \qquad q_2 = \left(\frac{|I_{e0}|e}{k_B^2}\right)\left(\frac{1}{T_e^2} + \frac{z_i^2}{T_i^2}\right) \tag{8}$$

Assuming electrons and ions to be Maxwellian, the Poisson equation (4) can be written as

$$\nabla^2\phi = \alpha\phi + \alpha'\phi^2 - 4\pi e s_d(z_d^{(0)}\overline{n}_d + \overline{z}_d n_d^{(0)} + \overline{n}_d\overline{z}_d) \tag{9}$$

where we have used that $\overline{\phi} = \phi$ for simplicity. The values of α and α' are given by,

$$\alpha = \frac{4\pi e^2}{k_B}\left(\frac{n_e^{(0)}}{T_e} + \frac{n_i^{(0)}z_i^2}{T_i}\right), \qquad \alpha' = \frac{2\pi e^2}{k_B^2}\left(\frac{n_e^{(0)}}{T_e^2} - \frac{n_i^{(0)}z_i^3}{T_i^2}\right). \tag{10}$$

3. DERIVATION OF KORTEWEEG-DE VIRES EQUATION

In order to study the properties of soliton dynamics, we, employ the reductive perturbation technique [1] to the basic equations and the stretched space and time variables, namely $\xi = \varepsilon^{\frac{1}{2}}(x - \lambda t)$ and $\tau = \varepsilon^{\frac{3}{2}}t$, where λ is the phase velocity and ε is a smallness parameter measuring strength of the dispersion [26]. The physical variables in Eqs. (1)-(3) and Eqs. (7) and (9), namely n_d, u_d, p_d, ϕ and z_d are expanded in power series written in general form as

$$S = S^{(0)} + \varepsilon S^{(1)} + \varepsilon^2 S^{(2)} + \varepsilon^3 S^{(3)} + \ldots \tag{11}$$

we get $S^{(0)} = 0$ for λ and u_d. Using the stretching coordinates and the perturbation scheme, to the first order in ε, we get the following set of relation

$$\left.\begin{aligned} n_d^{(1)} &= s_d \frac{\left(\frac{\alpha}{2}+\frac{q}{\eta}\right)}{4\pi e z_d^{(0)}}\phi^{(1)}, \qquad & u_d^{(1)} &= s_d \lambda \frac{\left(\frac{\alpha}{2}+\frac{q}{\eta}\right)}{4\pi e n_d^{(0)} z_d^{(0)}}\phi^{(1)}, \\ p_d^{(1)} &= 3 s_d p_d^{(0)} \frac{\left(\frac{\alpha}{2}+\frac{q}{\eta}\right)}{4\pi e n_d^{(0)} z_d^{(0)}}\phi^{(1)}, \qquad & z_d^{(1)} &= -s_d \frac{q_1}{\eta}\phi^{(1)} \end{aligned}\right\} \tag{12}$$

From relations (11), the phase velocity of the wave can be written as

$$\lambda^2 = \frac{3 p_d^{(0)} \sigma_d}{n_d^{(0)}} + \omega_{pd}^2 \left(\frac{\alpha}{2}+\frac{q}{\eta}\right)^{-1} \tag{13}$$

with dust plasma frequency $\omega_{pd}^2 = (\frac{4\pi e^2 n_d^{(0)} z_d^{(0)2}}{m_d})$ and $q = 4\pi e n_d^{(0)} q_1$.

To the next order of ε, we get

$$\frac{\partial n_d^{(1)}}{\partial \tau} - \lambda \frac{\partial n_d^{(2)}}{\partial \xi} + n_d^{(0)} \frac{\partial n_d^{(2)}}{\partial \xi} + \frac{\partial (n_d^{(1)} u_d^{(1)})}{\partial \xi} = 0 \tag{14}$$

$$\begin{aligned} n_d^{(0)} \frac{\partial u_d^{(1)}}{\partial \tau} - \lambda n_d^{(0)} \frac{\partial u_d^{(2)}}{\partial \xi} + \sigma_d \frac{\partial p_d^{(2)}}{\partial \xi} &= -\frac{\partial s_d e n_d^{(0)} z_d^{(0)})}{m_d} \frac{\partial \phi^2}{\partial \xi} \\ &\quad - \frac{s_d e z_d^{(0)}}{m_d} n_d^{(1)} \frac{\partial \phi^{(1)}}{\partial \xi} - \frac{s_d e n_d^{(0)}}{m_d} z_d^{(1)} \frac{\partial \phi^{(1)}}{\partial \xi} \end{aligned} \tag{15}$$

$$\frac{\partial p_d^{(1)}}{\partial \tau} - \lambda \frac{\partial p_d^{(2)}}{\partial \xi} + u_d^{(1)} \frac{\partial p_d^{(1)}}{\partial \xi} + 3 p_d^{(1)} \frac{\partial u_d^{(1)}}{\partial \xi} + 3 p_d^{(0)} \frac{\partial u_d^{(2)}}{\partial \xi} = 0 \tag{16}$$

$$\frac{\partial^2 \phi^{(1)}}{\partial \xi^2} = \alpha \phi^{(2)} + \alpha' (\phi^{(1)})^2 - 4\pi e s_d (2 z_d^{(0)} n_d^{(2)} + 2 n_d^{(0)} z_d^{(2)} + z_d^{(1)} n_d^{(1)}) \tag{17}$$

$$z_d^{(2)} = -s_d \left(\frac{q_1}{\eta}\phi^{(2)} + \frac{q_2}{\eta}(\phi^{(1)})^2\right) \tag{18}$$

Eliminating $n_d^{(2)}$, $u_d^{(2)}$, $\phi^{(2)}$, $p_d^{(2)}$ form Eq's (14)-(18) and using Eq's (12) and (13) to obtain the standard Korteweg-de Veries (KdV) equation

$$\frac{\partial \phi^{(1)}}{\partial \tau} + \lambda \phi^{(1)} \frac{\partial \phi^{(1)}}{\partial \xi} + B \frac{\partial^3 \phi^{(1)}}{\partial \xi^3} = 0 \tag{19}$$

where the nonlinear coefficient A and dispersive term B are

$$A = \frac{s_d \omega_{pd}^2}{4\pi e n_d^{(0)} z_d^{(0)} \lambda} + \frac{3}{2} \frac{s_d \sigma_d p_d^{(0)} \left(\frac{\alpha}{2} + \frac{q}{\eta} \right)}{\pi e \lambda (n_d^{(0)})^2 z_d^{(0)}} - \left(\lambda - \frac{3\sigma_d p_d^{(0)}}{n_d^{(0)} \lambda} \right) \frac{\left(\frac{\alpha'}{2} + \frac{q'}{\eta} \right)}{\left(\frac{\alpha}{2} + \frac{q}{\eta} \right)}$$

$$- \frac{s_d z_d^{(0)} q}{m_d \lambda \left(\frac{\alpha}{2} + \frac{q}{\eta} \right) \eta} + \frac{s_d e z_d^{(0)}}{2 m_d \lambda} \tag{20}$$

$$B = \left(\lambda - \frac{3\sigma_d p_d^{(0)}}{n_d^{(0)} \lambda} \right) \frac{1}{4 \left(\frac{\alpha}{2} + \frac{q}{\eta} \right)} \tag{21}$$

where $q' = 4\pi e n_d^{(0)} q_2$.

The solitary wave solution of equation (15) is

$$\phi^{(1)} = \phi_m \sec h^2 \left(\frac{\chi}{\omega} \right). \tag{22}$$

The quantities $\phi_m = \frac{3M}{A}$ and $\omega = 2 (\frac{B}{M})^{\frac{1}{2}}$ are the amplitude and width of the solitary waves, respectively. The soliton profile depends on the nonlinear coefficient A and dispersive term B, which are function of plasmas parameters. By substituting λ, α, α' and

$$\frac{q}{\eta} = 4\pi r_d n_d^{(0)} \left[\frac{(T_i + T_e) T_{eff}}{T_i (T_e + T_{eff})} \right], \quad \frac{q'}{\eta} = \frac{4\pi r_d n_d^{(0)}}{k_B} \left[\frac{(T_i^2 - T_e^2) T_{eff}}{T_e T_i^2 (T_e + T_{eff})} \right] \quad \text{and} \quad T_{eff} = T_i - \frac{e^2 z_d}{k_B r_d}$$

in Eq. (18), it is possible to express the nonlinear coefficient A in terms of the plasmas parameter. For the particular values of dust density, A will be zero. That is the critical dust density n_{dc}. If can be shown that $n_d < n_{dc}$ ($n_d > n_{dc}$) one gets $A < 0$ ($A > 0$) that signifies the existence of rarefactive (compressive) solitary waves.

4. DERIVATION OF THE BURGER EQUATION WITHOUT VISCOCITY AND WITH VISCOSITY

We study the effect of dissipation on the wave propagation using another pair of stretched space and time variables, $\xi = \varepsilon(x - \lambda t)$, $\tau = \varepsilon^2 t$ applied to the same set of governing equations as above. By changing growth rate of ε, we have reduced the strength of dispersion. Following similar calculations used to obtain the KdV equation, one arrives at the same set of equations as Eqs. (12), (13) for the lowest order of ε. However, for the higher order of ε, one obtains the Eqs. (14)-(16) are same as before and

$$\alpha\phi^{(2)} + \alpha'(\phi^{(1)})^2 = 4\pi e s_d (2z_d^{(0)} n_d^{(2)} + 2n_d^{(0)} z_d^{(2)} + z_d^{(1)} n_d^{(1)}) \tag{23}$$

$$z_d^{(2)} = -s_d \left(\frac{q_1}{\eta} \phi^{(2)} + \frac{q_2}{\eta} (\phi^{(1)})^2 \right) - \frac{\lambda}{\eta} \frac{\partial z_d^{(1)}}{\partial \xi} \tag{24}$$

Repeating the same procedure to eliminate $n_d^{(2)}, u_d^{(2)}, \phi^{(2)}, p_d^{(2)}$ from Eqs. (14)-(16), (23), (24) and using (12) and (13) we obtain the Burgers' equation,

$$\frac{\partial \phi^{(1)}}{\partial \tau} + A\phi^{(1)} \frac{\partial \phi^{(1)}}{\partial \xi} = C \frac{\partial \phi^{(1)}}{\partial \xi^2} \tag{25}$$

where the value of A is the same as before and C is given by

$$C = \left(\lambda^2 - \frac{3p_d^{(0)} \sigma_d}{n_d^{(0)}} \right) \frac{q}{2\eta^2 \left(\frac{\alpha}{2} + \frac{q}{\eta} \right)} \tag{26}$$

Burger equation is well studied equation presenting a hierarchy of solutions including rational and trigonometric solution. One of its solutions can be written as

$$\phi^{(1)} = \phi_m \left\{ 1 - \tanh\left(\frac{\xi}{\omega} \right) \right\} \tag{27}$$

where $\chi = (\xi - Ut)$ and $\phi_m = \frac{U}{A}, \omega = 2\frac{C}{U}$ are the amplitude and width of the shock wave respectively. The electrostatic shock profile, caused by the balance between nonlinear coefficient A and dissipation coefficient B. It is clear from Eqs. (25) that shock potential profile is positive (negative) when A is positive (negative).

Next, we study the effect of dissipation on the wave propagation using the same pair of stretched space and time variables, applied to the same set of governing equations as above with viscosity term in Eq. (2). Following similar calculations used to obtain the KdV equation, one arrives at the same set of equations as Eqs. (12), (13) for the lowest order of ε. However, for the higher order of ε, one obtains

$$\frac{\partial n_d^{(1)}}{\partial \tau} - \lambda \frac{\partial n_d^{(2)}}{\partial \xi} + n_d^{(0)} \frac{\partial u_d^{(2)}}{\partial \xi} + \frac{\partial (n_d^{(1)} u_d^{(1)})}{\partial \xi} = 0 \tag{28}$$

$$n_d^{(0)} \frac{\partial u_d^{(1)}}{\partial \tau} - \lambda n_d^{(0)} \frac{\partial u_d^{(2)}}{\partial \xi} + \sigma_d \frac{\partial p_d^{(2)}}{\partial \xi} = -\frac{s_d e n_d^{(0)} z_d^{(0)}}{m_d} \frac{\partial \phi^{(2)}}{\partial \xi} - \frac{s_d e z_d^{(0)}}{m_d} n_d^{(1)} \frac{\partial \phi^{(1)}}{\partial \xi}$$
$$- \frac{s_d e n_d^{(0)}}{m_d} z_d^{(1)} \frac{\partial \phi^{(1)}}{\partial \xi} + n_d^{(0)} \frac{\partial u_d^{(1)}}{\partial \xi^2} \tag{29}$$

$$\frac{\partial p_d^{(1)}}{\partial \tau} - \lambda \frac{\partial p_d^{(2)}}{\partial \xi} + u_d^{(1)} \frac{\partial p_d^{(1)}}{\partial \xi} + 3 p_d^{(1)} \frac{\partial u_d^{(1)}}{\partial \xi} + 3 p_d^{(0)} \frac{\partial u_d^{(2)}}{\partial \xi} = 0 \tag{30}$$

$$\alpha \phi^{(2)} + \alpha' (\phi^{(1)})^2 = 4\pi e s_d (2 z_d^{(0)} n_d^{(2)} + 2 n_d^{(0)} z_d^{(2)} + z_d^{(1)} n_d^{(1)}) \tag{31}$$

$$z_d^{(2)} = -s_d \left(\frac{q_1}{\eta} \phi^{(2)} + \frac{q_2}{\eta} (\phi^{(1)})^2 \right) - \frac{\lambda}{\eta} \frac{\partial z_d^{(1)}}{\partial \xi} \tag{32}$$

Repeating the same procedure to eliminate $n_d^{(2)}$, $u_d^{(2)}$, $\phi^{(2)}$, $p_d^{(2)}$ from Eqs. (28)-(32), and using (12) and (13), we obtain the Burgers' equation,

$$\frac{\partial \phi^{(1)}}{\partial \tau} + A \phi^{(1)} \frac{\partial \phi^{(1)}}{\partial \xi} = C' \frac{\partial^2 \phi^{(1)}}{\partial \xi^2} \tag{33}$$

where the value of A is the same as before and C' is given by

$$C' = \left(\lambda^2 - \frac{3 p_d^{(0)} \sigma_d}{n_d^{(0)}} \right) \frac{q}{2\eta^2 \left(\frac{\alpha}{2} + \frac{q}{\eta} \right)} + \frac{1}{2} \tag{34}$$

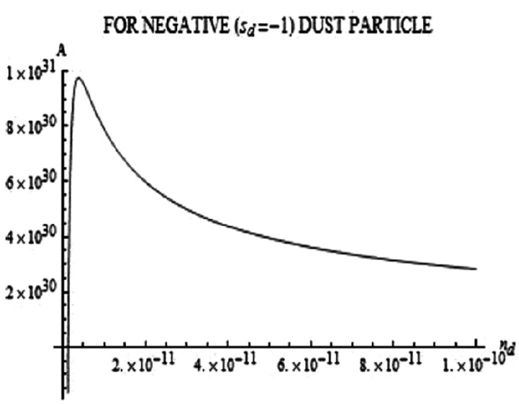
The shock wave solution of the equation (34) is

$$\phi^{(1)} = \phi_m \left\{ 1 - \tanh\left(\frac{\xi}{\omega} \right) \right\} \tag{35}$$

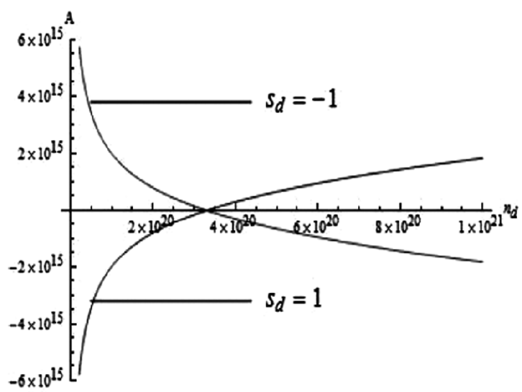
where $\phi_m = \frac{U}{A}$, $\omega = 2\frac{C'}{U}$ are the amplitude and width of the shock wave respectively. It can be clearly seen from Eq. (26) (without viscous) and Eq. (34) (with viscous) that, the difference of dissipation coefficient term of above two Burger equation is half.

5. RESULT AND DISCUSSION

In Fig. 1, the nonlinear coefficient A is plotted against the dust density n_d for different values of plasma parameter. For negative dust particle ($s_d = -1$), it can be clearly seen form Fig. 1, A becomes large negatively as $\lambda \to \infty$ i.e., $n_d^{(0)} \to 0$ and $\lambda \to 0$ i.e., $n_d \to \infty$. For positive dust particle ($s_d = 1$), when $\lambda \to \infty$ i.e., $n_d^{(0)} \to 0$ the nonlinear coefficient A becomes large negatively and positively large when $\lambda \to 0$ i.e., $n_d^{(0)} \to \infty$. For warm negative dusty plasma we observed two critical points from Fig. 1, (i) $n_{dc1} = 2 \times 10^{-12}$ (approximately) and from (ii) $n_{dc2} = 3.25 \times 10^{20}$. Therefore Eq. (19) has rarefactive solitary waves for $n_d < n_{dc1}$ & $n_{dc2} < n_d$ and compressive solitary waves for $n_{dc1} < n_d < n_{dc2}$ in negative dust particle ($s_d = -1$). From figure 1 (ii), we observed that in case of positive dust particle, $A = 0$ for same as $n_{dc2} = 3.25 \times 10^{20}$. So will get rarefactive solitary waves and compressive solitary waves for $n_d < n_{dc2}$ and $n_{dc2} < n_d$ respectively. In Fig. 2, (iii) ($s_d = -1$) and (iv) ($s_d = 1$) we observed formation of narrow solitons (compressive and rarefactive) of very large amplitude for dust density $n_d = 0.1$. In Fig. 3(v), we observed that, the shock wave profile are negative in negative and positive dust for small values of dust density (like $n_d = 1 \times 10^{-13}$). In Fig. 4(vii), for negative dust particle without viscosity, we observed the narrow shock wave profile at $n_d = 0.5$ comparer to figurer 4(viii) with viscosity and both shock wave are compressive shock wave but opposite character.

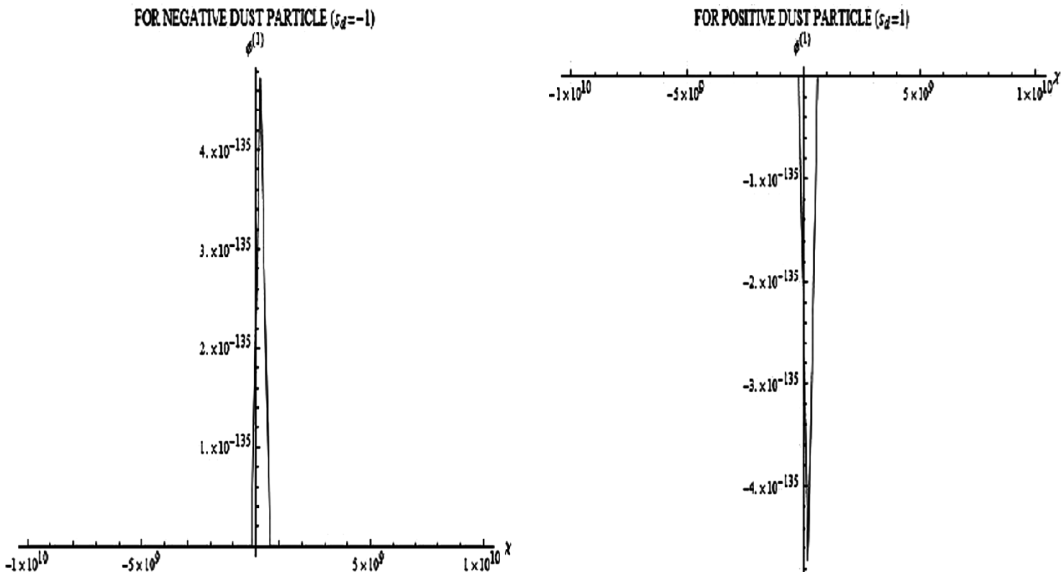


(i)



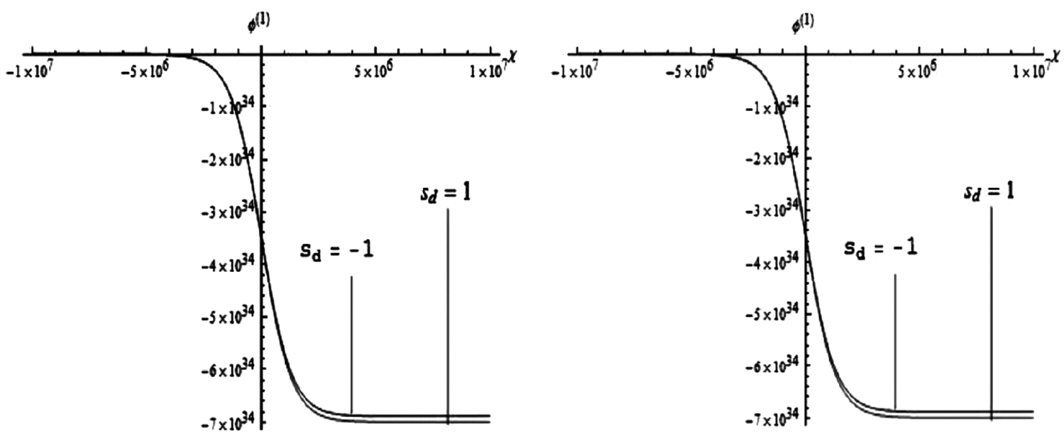
(ii)

Figure 1: (i) The Variation of Nonlinear Coefficient *A* with Small Values of Dust Density n_d for Negative Dust Particle and (ii) The Variation of Nonlinear Coefficient *A* with Small Values of Dust Density n_d for Negative and Positive Dust Particle



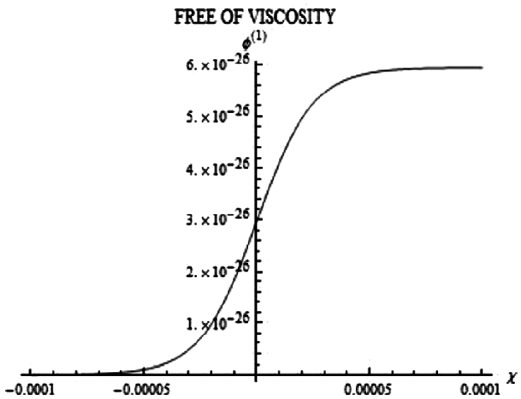
(iii) **(iv)**

Figure 2: (iii) The Graph $\phi^{(1)}$ vs χ Showing the Formation of Compressive Soliton for $n_d = 0.1$ with Different Plasma Parameter in Negative Dust Particle. (iv) The Graph $\phi^{(1)}$ vs χ Showing the Formation of Compressive Soliton for $n_d = 0.1$ with Different Plasma Parameter in Positive Dust Particle

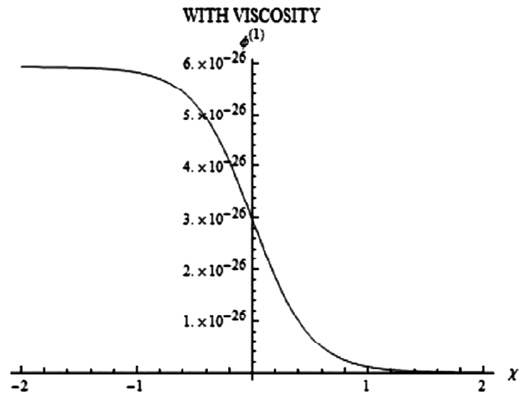


(v) Free of Viscosity **(iv) With Viscosity**

Figure 3: Variation of DA Shock Wave Potential $\phi^{(1)}$ with Spatial Coordinate χ where $n_d = 1 \times 10^{-13}$ and with Different Plasma Parameter in Negative and Positive Dust Particle i.e., ($s_d = -1$ & $s_d = 1$)



(vii)



(viii)

Figure 4: Variation of DA Shock Wave Potential $\phi^{(1)}$ with Spatial Coordinate χ where $n_d = 0.5$ and with Different Plasma Parameter in Negative Dust Particle ($s_d = -1$)

6. CONCLUSIONS

We have studied the formation of nonlinear structures (solitons and shock wave) in unmagnetized dusty plasmas with Maxwellian electrons and ions and entering influence component of pressure with the help of KdV and Burger equation without viscosity and with viscosity. It is shown that for negative dusty plasma system, there are two critical dust densities n_{dc} at which it is not possible to obtain soliton and shock like structure. For negative dusty plasma we will get rarefactive, compressive, again rarefactive soliton and for positive dusty plasma, first rarefactive then compressive soliton. By solving Burger equation gives the shock wave depends on the nonlinear coefficient A and dissipation coefficient C. For negative (positive) dusty plasma, shock wave are negative (rarefactive) for small values of dust density which are less then critical dust density $n_{dc1} = 2 \times 10^{-12}$ and does not affect by viscosity term. The dissipation coefficient C of Burger equation will be negative without viscosity and the dissipation coefficient C' of Burger equation will be positive with viscosity for dust density $n_{dc1} < n_d < n_{dc2}$ in negative dust particle. That is why, both the cases we observed compressive shock wave behavior but narrow and opposite character comparer to shock wave profile with viscosity in negative dusty plasma where n_d lies between n_{dc1} & n_{dc2}. For positive dusty plasma we will get compressive shock wave behavior with same difference with non-viscosity and viscosity term for dust density $n_d > n_{dc2}$.

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