Effect of rotation on the Self-Gravitational Instability of Dusty Plasma with the Dynamics of Charge Fluctuation

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Abstract - The effects of rotation and the attachment frequency of plasma particles to the grains on the self-gravitational instability of dusty plasma has been investigated incorporating the effect of dynamics of charge fluctuation. A general dispersion relation is obtained using the normal mode analysis with the help of relevant linearized perturbation equations of the problem. We study the effects of attachment frequency of plasma particles to the grains, rotation, dust debye length and dust –plasma frequency parameters on the growth rate of an unstable mode by choosing the arbitrary values of these parameters in the present problem. We found that dust-debye length and dust plasma frequency both have stabilizing influence on the growth rate of the system while the attachment frequency of plasma particles to the dust grains and rotation parameter for particular band of wave vector have destabilizing influence on the growth rate of the system

Key words: Attachment frequency,Charge currents, Charge fluctuation,Debye length,Dispersion relation, Linearized perturbation equations ,Normal mode analysis

1. INTRODUCTION

Dust particles exists everywhere in the universe besides electrons and ions. It is well known that nearly 99% of the universe is in the plasma state then it is often said that dust would make up most of remainder. Dark haloes in galaxies [1], ring and spoke formation in planetary system [2], structure of cometary tails [3], are all attributed to the presence of micron sized grains. Dust grains are present in the earth's magnetosphere and ionosphere in an uncontrolled manner and as controlled manner, in Tokamak plasmas and plasma arcs etc.The grains are generally composed of graphite, silicate and metallic compounds in cosmic environments. The sizes of dust grains vary between macroscopic (few cm) and microscopic (10^{-8} cm) scales. Dust grains in most of the astrophysical situations may be charged radiatively or plasma environment in which dust is immersed. The sizes and masses of the dust grains might depend on the plasma environment. e.g. The bigger and heavier sizes of grains may be due to coulombic coagulation[4].Once the dust is charged, it starts to react to electromagnetic as well as to ordinary gravitational effects. Various authors [5],[6],[7],[8],[9] have studied the collective behavior of dusty plasma with fixed charge on the grain and the waves and instabilities in such plasma are not very different from that of three-component ion-electron plasmas. With the consideration of charge fluctuation[10],[11],[12],[13],[14],[15],[16],[17],new collective feature has observed.Mukai[18] and Barbash[19] have suggested that dynamics of a dusty plasma can be studied in any of the following regimes (a) EM >>GM(gravitational force),(b) EM force ~ GF and(e)EM force << GF.The first case is related to the plasma processes like radiation, heating etc., the second case is thought to be the cause of Spoke's formation in Saturn's ring, and the last case corresponds to the formation of stars, clusters etc. suggested by Binney and Tremaine[20].GF~EM implies merely the balance of the two forces whose origin could be quite different. For example in the planetary rings, the self repulsion of the grain is balanced by the gravitational attraction of the planets for micron and submicron sized grains [21].

Several authors [22],[23],[24],[25],[26],[27] have studied the Jeans instability of dusty plasma. The Jeans instability of a dusty plasma with the inclusion of ion dynamics was studied by Avinash and Shukla[25] and found enhanced gravitational condensations of the grains. Later, Pandey and Dwivedi[26] showed that the proper inclusion of ion dynamics does not destabilize the Jeans mode any further but the collapse of the grains follows the same dynamics as the collapse of the neutral matter under gravity. The Jeans instability of a dusty of a dusty plasma in the presence of charge fluctuation and external magnetic field has been studied by Mohanta et al. [27] and found that the presence of a magnetic field alters the collapse criteria for the grains. Recently Shukla and Stenflo[28] have analyse the Jeans instability of a self gravitating dusty plasma with the inclusion of dust charge fluctuation inherent in the electrostatic interaction energy of two isolated dust grains where debye spheres overlaps.Pandey et al.[29] have studied the Jeans-Buneman instability in dusty plasma for nonrotating, unmagnetized case with the inclusion of charge fluctuation dynamics. More recently the Jeans instability in a drifting dusty plasma in the presence of secondary electron emission was studied by Sushmita Sarkar et al.[30].But all in the previous studies rotation of dust particles is not considered with charge dynamics of dust grains. So in present work we investigate homogeneous, unmagnetized, rotating plasma and, invoking'Jeans Swindle', ignore the zeroth order gravitational field. We consider the dusty plasma with electrons and ions in local thermal equilibrium and find that charge dynamics has a bearing on the gravitational collapse of the matter with the inclusion of rotation also.

2. BASIC EQUATIONS

We consider a three component plasma having electrons, ions and charged dust grains with grains of equal radius and carrying identical charge due to the collisional attachment of the electrons and ions to the grain surface. We have neglected the effects of photoemission, secondary emission etc. in the present study. Due to the charging and discharging of the grains, source and sink terms occurs in the continuity and momentum exchange equations. We assumed that the gravitational potential is determined mainly by the grains because of the large mass difference between the plasma and the grains. Then the dynamics of the dusty plasma is described by the following equations with the consideration of [31]

Continuity equations:

$$\frac{\partial n_\alpha}{\partial t} + \nabla \cdot (n_\alpha \boldsymbol{v}_\alpha) = -\beta_\alpha (n_\alpha - n_{\alpha 0}), \qquad (1)$$

$$\frac{\partial n_g}{\partial t} + \nabla \cdot (n_g \boldsymbol{v}_g) = 0, \qquad (2)$$

Where α =e,i; g=grain. The subscript '0' means equilibrium quantities and $\beta_\alpha = I_\alpha n_g / q_\alpha n_\alpha$ is the attachment frequency of the plasma particles to the grains.

Equations of motion:

$$m_\alpha n_\alpha \frac{d\boldsymbol{v}_\alpha}{dt} = -T_\alpha \nabla n_\alpha - q_\alpha n_\alpha \nabla\phi - m_\alpha n_\alpha \nabla\psi - m_\alpha n_\alpha \beta_\alpha (\boldsymbol{v}_\alpha - \boldsymbol{v}_g), \quad (3)$$

$$m_g n_g \frac{d\boldsymbol{v}_g}{dt} = -T_g \nabla n_g - Q n_g \nabla\phi - m_g n_g \nabla\psi + 2 m_g n_g (\boldsymbol{v}_g \times \boldsymbol{\Omega}). \quad (4)$$

Charge equation:

$$\frac{dQ}{dt} = I_e(Q,\phi) + I_i(Q,\phi), \quad (5)$$

Where the currents are given by [34, 35]

$$I_e = -\pi a^2 e \sqrt{\frac{8T_e}{\pi m_e}} n_e \exp[\frac{e(\phi_g - \phi)}{T_e}], \quad (6)$$

$$I_i = \pi a^2 e \sqrt{\frac{8T_i}{\pi m_i}} n_i [1 - \frac{e(\phi_g - \phi)}{T_i}] \quad (7)$$

and the two Poisson's equation are

$$\nabla^2\phi = 4\pi e[n_e - n_i] - 4\pi Q n_g, \quad (8)$$

$$\nabla^2\psi = 4\pi G n_g m_g, \quad (9)$$

Where $\frac{d}{dt} = \frac{\partial}{\partial t} + \boldsymbol{v}\cdot\nabla$ and m, n, v, T, ϕ, ψ and Ω denotes the mass, number density, velocity, temperature, electrostatic and gravitational potential respectively, rotation of dust grains due to coriolis force. The potential difference between the grain surface potential and the background plasma potential is represented by quantity $(\phi_g - \phi)$ so that unperturbed charge Q_0 is given by $Q_0 = C(\phi_g - \phi)$ where *C* is the capacitance of the grain and is given by[32], $C = a\exp(-a/\lambda_D)$ with a as the radius of the grain. The exponential factor reflects the screening of the grain charge by the plasma particles. In equilibrium, electron and ion currents equal each other and thus the grain is at 'floating potential'. It may be noted that for $n_{e0}/n_{i0} \approx 1$ (a situation relevant to most of the planetary system [8] and interstellar media [7]), $\beta_e = \beta_i$ i.e. electrons and ions get attached to the grain at the same rate after the initial build up of a negative charge on the grain similar to the plasma particles near the sheath [33].The above set of equations (1)-(9) form the basic set of equations for the linear analysis.

3. LINEAR ANALYSIS AND DISCUSSION

We consider an infinite, homogeneous plasma and neglect the zeroth order electrostatic and gravitational potential. Whereas the neglect of zeroth order electrostatic potential is guaranteed by the existence of opposite charges, there is no such thing as opposite mass and thus, there is no way to make the gravitational potential disappear in zeroth order. Therefore, the problem of a self gravitating system is in general an eigenvalue problem. However, important physical insight can be gained by invoking 'Jeans Swindle' i.e. ignoring the zeroth order potential field of gravity. To remind, consider the gravitational instability of an infinite, homogeneous plasma characterized by

$$n_{e0} = n_{i0} + Zn_{g0,}\ \psi_0 = \phi_0 = 0,\ \boldsymbol{v}_{i0} = V_0\hat{x},\ \boldsymbol{v}_{e0} = \boldsymbol{v}_{g0} = 0\,,$$

where V_0 is the ion streaming velocity and Z=Q/e.The linearized set of equations are

$$\frac{\partial n_{\alpha 1}}{\partial t} + \nabla\cdot(n_{\alpha 1}\boldsymbol{v}_0 + n_{\alpha 0}\boldsymbol{v}_{\alpha 1}) = -\beta_{\alpha 0} n_{\alpha 1}\,, \tag{10}$$

$$\frac{\partial n_{g1}}{\partial t} + n_{g0}\nabla\cdot\boldsymbol{v}_{g1} = 0, \tag{11}$$

Where the perturbed quantities are represented by subscript 1

$$n_{\alpha 0}(\frac{\partial \boldsymbol{v}_{\alpha 1}}{\partial t} + \boldsymbol{v}_{\alpha 0}\cdot\nabla\boldsymbol{v}_{\alpha 1}) = -C_\alpha^2\nabla n_{\alpha 1} - \frac{q_\alpha n_{\alpha 0}}{m_\alpha}\nabla\phi_1 - n_{\alpha 0}\nabla\psi_1$$

$$-\beta_{\alpha 0}n_{\alpha 0}(\boldsymbol{v}_{\alpha 1} - \boldsymbol{v}_{g1}) - \beta_{\alpha 1}n_{\alpha 0}\boldsymbol{v}_{\alpha 0} - \beta_{\alpha 0}n_{\alpha 1}\boldsymbol{v}_{\alpha 0}\,, \tag{12}$$

$$\frac{\partial \boldsymbol{v}_{g1}}{\partial t} = -C_g^2\frac{\nabla n_{g1}}{n_{g0}} - \frac{Q_0}{m_g}\nabla\phi_1 - \nabla\psi_1 + 2(\boldsymbol{v}_{g1}\times\boldsymbol{\Omega})\,, \tag{13}$$

$$\frac{\partial Q_1}{\partial t} + \eta Q_1 = \left|I_{e0}\right|(\frac{n_{i1}}{n_{i0}} - \frac{n_{e1}}{n_{e0}})\,, \tag{14}$$

where $\eta = (e\left|I_{e0}\right|/C)(1/T_e + 1/w_0), w_0 = T_i - e\phi_{f0}$ with T_i as the ion temperature and ϕ_{f0} as the equilibrium floating potential of the grains and thermal velocity of α th species is represented by $C_\alpha = (T_\alpha/m_\alpha)^{1/2}$ and $\beta_{\alpha 1}$ is obtained from the definition of β_α by perturbing it around $\beta_{\alpha 0}$.Assuming that the perturbed quantities vary as $\exp[-i(\omega t - kx)]$,we get the following relation between fluctuation density and potentials:

$$[\omega^2 + \omega_j^2 - k^2C_g^2 - 2ik(\frac{\omega}{\boldsymbol{k}}\times\boldsymbol{\Omega})](\frac{n_{g1}}{n_{g0}}) = k^2\phi_1(\frac{Q}{m_g})\,, \tag{15}$$

$$[(\omega + i\beta_e)^2 - k^2C_e^2]\frac{n_{e1}}{n_{e0}} = -k^2\phi_1[(\frac{e}{m_e}) + \frac{\omega_j^2 - i\beta_e\omega}{\omega^2 + \omega_j^2 - k^2C_g^2 - 2ik(\frac{\omega}{\boldsymbol{k}}\times\boldsymbol{\Omega})}(\frac{Q}{m_g})]\,, \tag{16}$$

$$[(\overline{\omega} + i\beta_i)^2 - k^2C_i^2 + i\beta_i kV_0 + \chi\beta_i{}^2\frac{n_i}{Zn_g}(\frac{kV_0}{\omega + i\eta})]\frac{n_{i1}}{n_{i0}} = k^2\phi_1$$

$$\times[\left(\frac{e}{m_i}\right)-\frac{\omega_j^2-i\beta_i\overline{\omega}}{\omega^2+\omega_j^2-k^2C_g^2-2ik(\frac{\omega}{\boldsymbol{k}}\times\boldsymbol{\Omega})}(\frac{Q}{m_g})-\chi\beta_i{}^2\frac{n_i}{Zn_g}(\frac{kV_0}{\omega+i\eta})$$

$$\frac{[(\frac{e}{m_e})+\frac{\omega_j^2-i\beta_e\omega}{\omega^2+\omega_j^2-k^2C_g^2-2ik(\frac{\omega}{\boldsymbol{k}}\times\boldsymbol{\Omega})}(\frac{Q}{m_g})]}{(\omega+i\beta_e)^2-k^2C_e^2}], \tag{17}$$

Where

$\beta_{i1}=\beta_i((n_{g1}/n_{g0})-\chi(Q_1/Q)),\ \beta_{e1}=\beta_e((n_{g1}/n_{g0})+\chi(Q_1/Q))$ with $\chi=1/((T_i/e\phi_{f0})-1)$ [12].Then using equations (15)-(17) in the Poisson's equation leads to the following dispersion relation

$$1=(1+\frac{i\beta_e}{\omega+i\eta})A+(1+\frac{i\beta_i}{\omega+i\eta})B+\frac{\omega_{pg}^2}{\omega^2+\omega_j^2-k^2C_g^2-2i\omega\Omega\sin\theta} \tag{18}$$

where

$$A=\frac{\omega_{pe}^2+\frac{n_e}{Zn_g}\frac{\omega_{pg}^2(\omega_j^2-i\beta_e\omega)}{\omega^2+\omega_j^2-k^2C_g^2-2i\omega\Omega\sin\theta}}{(\omega+i\beta_e)^2-k^2C_e^2}, \tag{19}$$

$$B=\frac{\omega_{pi}^2-\frac{n_i}{Zn_g}\frac{\omega_{pg}^2(\omega_j^2+i\beta_i\overline{\omega})}{\omega^2+\omega_j^2-k^2C_g^2-2i\omega\Omega\sin\theta}-\chi\beta_i{}^2\frac{n_i}{Zn_g}(\frac{kV_0}{\omega+i\eta})[\delta\omega_{pe}^2+\frac{n_i}{Zn_g}\frac{\omega_{pg}^2(\omega_j^2-i\beta_e\omega)}{\omega^2+\omega_j^2-k^2C_g^2-2i\omega\Omega\sin\theta}}{[(\overline{\omega}+i\beta_i)^2-k^2C_i^2+i\beta_ikV_0+\chi\beta_i^2\frac{n_i}{Zn_g}(\frac{kV_0}{\omega+i\eta})} \tag{20}$$

where $\overline{\omega}=\omega-kV_0$ is the Doplar shifted frequency, $\omega_{p\alpha}^2=4\pi n_\alpha q_\alpha^2/m_\alpha$ is the plasma frequency of the α th species and $\delta=n_{e0}/n_{i0}$.Subscript 0 has been dropped from the equilibrium quantities. In the limit $\omega_{pg}\to 0,\ k\lambda_e<<1$ the above dispersion relation reduces to equation(18) of Bhatt and Pandey[12].To analyse the gravitational instability of a dusty plasma when the plasma particles are in thermal equilibrium and the thermal response of the plasma particles is much faster than the grain's response to the perturbations, we consider $kC_g<<\omega<<kC_i\leq kC_e$ where k is the wave number. Assuming $\beta_e=\beta_i=\beta$, we get the following dispersion relation:

$$\omega^2=\frac{k^2\lambda_D^2\omega_{pg}^2}{1+k^2\lambda_D^2+\frac{i\beta}{\omega+i\eta}}-\omega_j^2+k^2C_g^2+2i\omega\Omega\sin\theta, \tag{21}$$

where $\lambda_D = \lambda_e \lambda_i / [\lambda_e^2 + \lambda_i^2]^{1/2}$ is the effective plasma Debye length with $\lambda_{e,i} = (T_{e,i} / 4\pi n_{e,i} e^2)^{1/2}$.The dispersion relation (21) modified due to the inclusion of rotation of dust particles with the simultaneous presence of charge fluctuation. In the absence of rotation, dispersion relation (21) coincides with that of Mohanta et al. [27] without the external magnetic field for cold dust grains. It is clear from the relation (21) that rotation of dust particles plays major role in the gravitational condensation process with the consideration of charge fluctuation. From the analysis regarding equation (21) of [29] it is clear that the attachment of the grains causes enhancement of the gravitational condensations. By solving equation (21) perturbatively and calculating interesting root by treating $\eta \sim \beta < \omega$ in the presence of rotation of dust particles with dust charge fluctuation dynamics, the estimation of effect of rotation of dust particles on the gravitational condensation process is possible. From the analysis [29] it is also clear that the attachment frequency leads to the enhancement of the growth rate, since attachment of the plasma particles reduces the repulsive potential well of the grain, facilitating the condensation. We can also find the expression for Jeans length from equation (21). From equation(21) the modified Jeans wave number is given as

$$(k_j)^2 = \frac{-\dfrac{[\eta\lambda_D^2\{\omega_{pg}^2 - \omega_j^2\} + C_g^2(\beta+\eta)]}{\eta C_g^2 \lambda_D^2} \pm \sqrt{\left(\dfrac{[\eta\lambda_D^2\{\omega_{pg}^2 - \omega_j^2\} + C_g^2(\beta+\eta)]}{\eta C_g^2 \lambda_D^2}\right)^2 + 4\dfrac{(\beta+\eta)}{\eta C_g^2 \lambda_D^2}}}{2} \tag{22}$$

From expression (22) it is clear that the Jeans wave number of this system is modified by the parameters ω_{pg}, λ_D, η and β .In the ISM, structure formation is mainly due to the unstable modes, thus we analyse the effect of attachment frequency of the plasma particles to the grains β ,rotation of dusty plasma Ω ,effective plasma Debye length λ_D and dust plasma frequency ω_{pg} on the growth rate of unstable mode by choosing the arbitrary values of these parameters in the present problem. We write the dispersion relation (21) in nondimensional form in terms of self-gravitation as

$$\sigma^{*2} + \frac{k^{*2}\lambda_D^{*2}\omega_{pg}^{*2}}{1 + k^{*2}\lambda_D^{*2} - \dfrac{\beta^*}{\sigma^* - \eta^*}} + 2\sigma^*\Omega^*\sin\theta + k^{*2} - 1 = 0$$

Where the various non-dimensional parameters are defined as

$$k^* = \frac{kC_g}{\omega_j}, \sigma^* = \frac{\sigma}{\omega_j}, \lambda_D^* = \frac{\omega_j \lambda_D}{C_D}, \omega_{pg}^* = \frac{\omega_{pg}}{\omega_j}, \Omega^* = \frac{\Omega}{\omega_j}, \beta^* = \frac{\beta}{\omega_j}, \eta^* = \frac{\eta}{\omega_j}$$

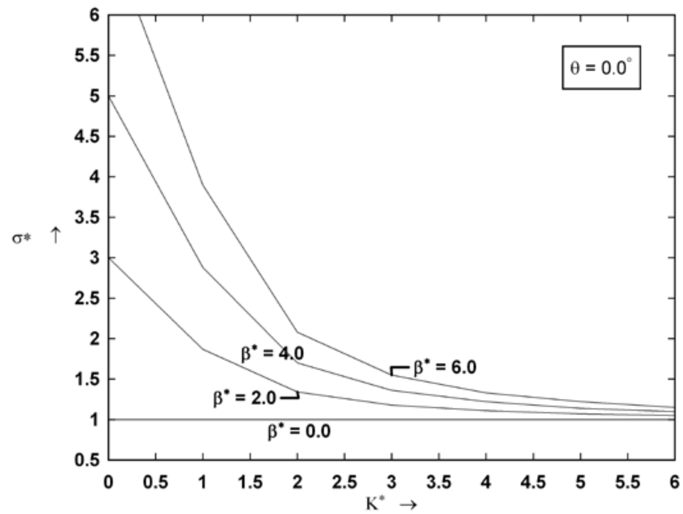

Figure 1. The growth rate (Positive real value of σ^*) is plotted against the non dimensional wave number $K^*$with variation in the attachment frequency β^*. The values of constant parameters λ_D^*, Ω^*,ω_{pg}^*,η^* are taken as 1 with $\theta = 0.0^\circ$.

In figures 1-6, we have depicted the non dimensional growth rate versus nondimensional wave number for various arbitrary values of the attachment frequency(β^*), rotation(Ω^*),effective debye length(λ_d^*) and dust plasma frequency(ω_{pg}^*).Figure 1 is plotted for the growth rate of an unstable mode(positive real roots of σ^*)against the wave number (k^*)with variation in parameter in the longitude mode of propagation. We find that the growth rate of the instability increases with increase in β^*.The peak value of the growth rate is affected by the presence of the (dimensionless attachment frequency of the plasma particles of the grains) β^* and the growth rate is minimum for the case of β^*=0 and it increases by increasing β^*.Hence the β^* has a destabilizing influence on the growth rate of instability.

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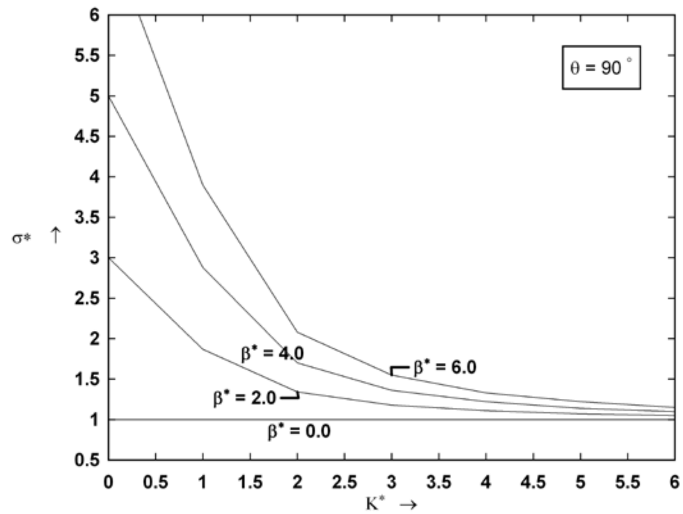

Figure 2. The growth rate (Positive real value of σ^*) is plotted against the non dimensional wave number $K^*$with variation in the attachment frequency β^*. The values of constant parameters λ_D^*, Ω^*,ω_{pg}^*,η^* are taken as 1 with $\theta = 90^\circ$.

Similarly in fig. 2, we have depicted the growth rate of instability against wave number for different values of dimensionless attachment frequency of the plasma particles of the grains) β^* in the transverse mode of propagation. From the curves we find that the β^* has a same effect on the growth rate as that of longitudinal mode of propagation. Thus the effect of β^* parameter is found to destabilize the system in both longitudinal and transverse mode of propagation.

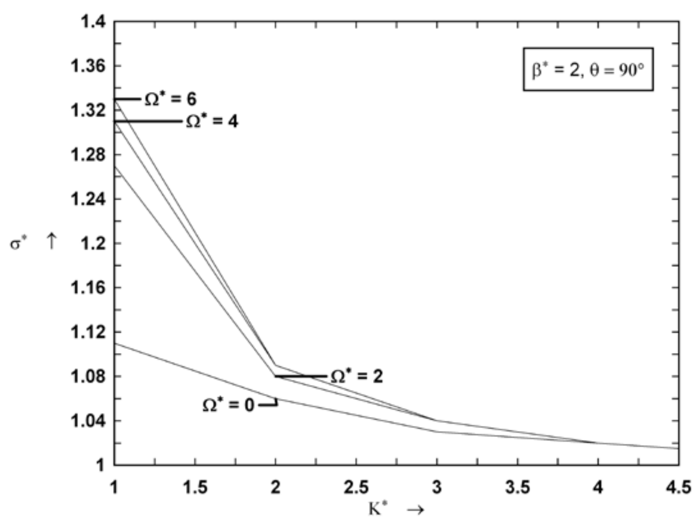

Figure 3. The growth rate (Positive real value of σ^*) is plotted against the non dimensional wave number $K^*$with variation in the roation Ω^*. The values of constant parameters λ_D^*, β^*,ω_{pg}^*, are taken as 2 with $\theta = 90^\circ$, η^* =1.

In fig. 3 the effect of rotation on the growth rate in the transverse direction is shown by depicting the curves between σ^* and k^* for various values of Ω^*.We find that the growth rate of the instability increases with increase in Ω^*.The peak value of the growth rate is affected by the presence of rotation parameter and it is minimum for a non-rotational system and the peak value of the growth rate increases by increasing Ω^*.Hence a rotation parameter of medium can be made unstable with increasing rotation parameter.

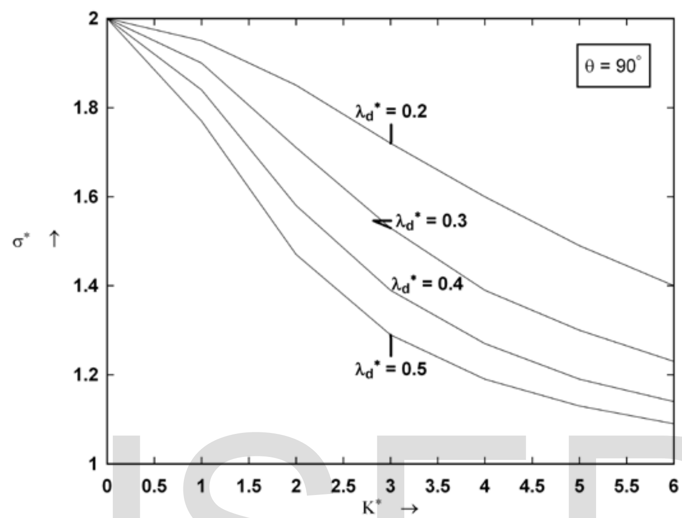

Figure 4. The growth rate (Positive real value of *σ) is plotted against the non dimensional wave number *K**with variation in the effective debye length λ_D*. The values of constant parameters Ω*, β*,ω_{pg}*, are taken as 1 with θ = 90̊ , η* =1.**

Fig. 4 depicts influence of effective debye length (λ_d^*) on the growth rate of instability (σ^*) against wave number (k^*).From the curves we find that the effective debye length has a reverse effect on the growth rate compared to that of the rotation parameter and parameter of the attachment frequency of the plasma particles to the grains. In other words, due to an increase in the effective debye length parameter of plasma system (λ_d^*), the growth rate of the instability decreases. Thus, the effective debye length parameter has damping influence on the growth rate of the system. The peak value of the growth rate is unaffected by the presence of effective debye length parameter. Hence the effective debye length has a stabilizing effect in the transverse mode of propagation.

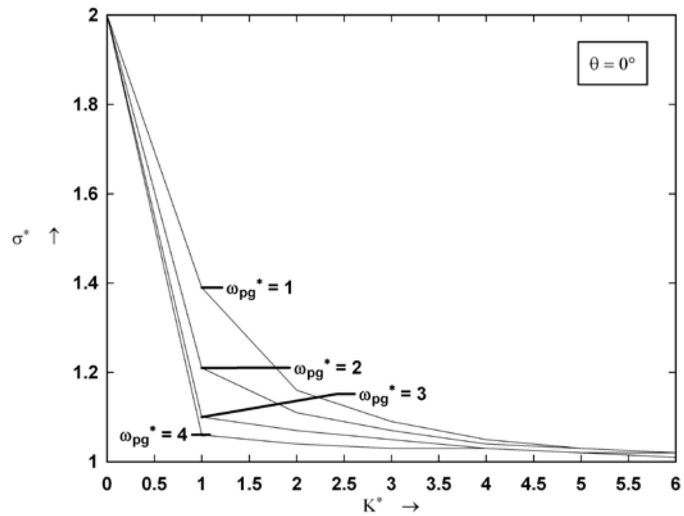

Figure **5. The growth rate (Positive real value of σ*) is plotted against the non dimensional wave number $K^*$with variation in the grain plasma frequency ω_{pg}*. The values of constant parameters Ω*, β^*, λ_D* , are taken as 1 with θ = 0.0̊ , η* =1.**

In fig.5 the dimensional growth rate (σ^*) is plotted against dimensionless wave number (k^*) for various values of dust plasma frequency (ω^*_{pg}) in the longitudinal mode of propagation. We find that an increase in the dust-plasma frequency decreases the growth rate of the system. The peak value of the growth rate is unaffected by the presence of dust plasma frequency. Hence the dust plasma frequency has a stabilizing effect in the longitudinal mode of propagation.

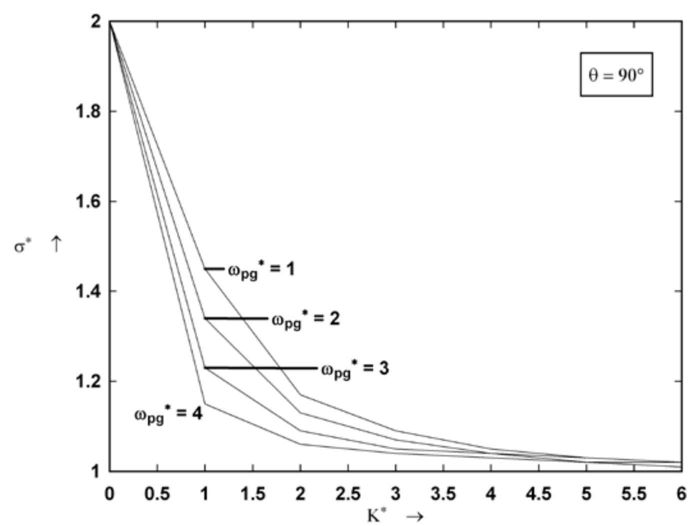

Figure 6. The growth rate (Positive real value of σ*) is plotted against the non dimensional wave number $K^*$with variation in the grain plasma frequency ω_{pg}*. The values of constant parameters Ω*, β^*, λ_D* , are taken as 1 with θ = 90̊ , η* =1.

In fig. 6 the dimensionless growth rate is plotted against wave number for various values of the dust-plasma frequency in the transverse mode of propagation. From the curves we find that the dust plasma frequency has a same effect on the growth rate of instability in the transverse mode of propagation as that in the longitudinal mode of propagation.

Thus, the dust plasma frequency is found to stabilize the system in both the longitudinal and transverse mode of propagation.

4. CONCLUSION

In the present paper, we have investigated the problem of a self-gravitational instability of dusty plasma with charge fluctuation dynamics, considering the effect of rotation. The general dispersion relation is obtained, which is modified due to the presence of these parameters. The dispersion relation is reduced into the nondimensional form in the terms of self gravitation to show the effects of various parameters as $\beta^*, \Omega^*, \lambda_d^*$ and ω_{pg}^* on the growth rate of instability (σ^*) against wave number(k^*) for both longitudinal mode and transverse mode of propagation.

From the curves it is found that the attachment frequency of the plasma particles to the grains (β) and rotation (Ω) show same effects on the growth rate of instability and the growth rate increases with increasing attachment frequency β and Ω and the peak value of the growth rate is affected by the presence of attachment frequency of plasma particles to the grains and rotation.

Thus both (β and Ω) have a destabilizing influence. From the curves it is also found that effective debye length parameter(λ_d) and dust plasma frequency ω_{pg} have a reverse effect on the growth rate compared to that of the attachment frequency of plasma particles to the grains(β) and rotation parameter(Ω).In other words, the attachment frequency of plasma particles to the grains and rotation parameter have a destabilizing influence, while the effective debye length(λ_d) and dust plasma frequency (ω_{pg})both have a stabilizing role on the growth rate of the system.

It is also observed that the effect of the attachment frequency of plasma particles to the grains has a unstabilizing influence on the system in both the longitudinal and transverse modes of propagation. The effect of dust plasma frequency parameter is found to stabilize the system in both the longitudinal and transverse modes of propagation.

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