Finite-Resistivity Effects on Jeans Instability in Quantum Dusty Plasmas

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Abstract: This study examines Jeans instability in quantum dusty plasma, incorporating resistive effects, using the quantum magnetohydrodynamic (QMHD) model. Linearized perturbation equations are derived via normal mode analysis to obtain the general dispersion relation, enabling analysis of the instability growth rate and criteria. The dispersion relation is specialized for both longitudinal and transverse propagation modes to assess the impacts of resistivity and quantum effects. For transverse propagation, the gravitating mode's growth rate is influenced by resistivity and magnetic field strength, while the Jeans instability criterion is modified solely by the quantum term. In the longitudinal direction, the gravitating mode is altered by quantum corrections, and the non-gravitating Alfvén mode is affected by both finite electrical resistivity and quantum effects. Numerical calculations demonstrate that resistivity exerts a destabilizing influence on the Jeans instability growth rate, with quantum parameters further modulating it. These findings apply to astrophysical dusty structures such as white dwarf interiors and molecular clouds, as well as low-temperature laboratory plasmas. Typical values include a Jeans length of $\sim 10^5$ m and a gravitational collapse timescale of ~ 2.5 s.

Keywords: Jeans instability, Quantum dusty plasma, Resistive effects, Quantum magnetohydrodynamics (QMHD)

I Introduction

Dusty plasma is an important and active area of research because dust particles are ubiquitous in many astrophysical environments [1–4]. Considerable effort has been devoted to understanding collective processes in such plasmas [5,6]. When a plasma containing electrons, ions, and dust grains is cooled to very low temperatures, its behaviour changes significantly, as the de Broglie wavelength of the particles becomes comparable to the characteristic system length scales. In classical plasmas, quantum effects are negligible because the de Broglie wavelength is much smaller than the Debye length; however, in dense and cold plasmas this assumption no longer holds. Under these conditions, quantum corrections become essential, leading to what is known as quantum dusty plasma [7–9].

In this regime, the plasma exhibits Fermi–Dirac statistics instead of the classical Maxwell–Boltzmann description [10]. Quantum effects, such as quantum pressure and density correlations arising from quantum fluctuations, can strongly influence collective dynamics, especially in dense astrophysical objects. Quantum plasma effects are also relevant in modern microelectronic and laser–plasma systems, where highly charged dust contaminants are often present. Therefore, the study of quantum dusty plasmas is important for both astrophysical applications and laboratory and technological environments.

The presence of dust significantly modifies the process of gravitational collapse and therefore necessitates a re-examination of gravitational effects in astrophysical systems. In cosmic environments, self-gravity plays a crucial role in the formation of dusty molecular clouds, equilibrium structures, and associated collective phenomena. The Jeans instability in dusty plasmas has been extensively investigated in various physical contexts. Pandey et al. [11] analyzed both the linear and nonlinear regimes of Jeans instability in dusty plasmas, while Shukla and Verheest [12] examined its behavior in collisional dusty plasmas. Verheest et al. [13] studied the fragmentation of partially ionized, self-gravitating dusty clouds, and Pillay and Verheest [14] explored the influence of nonthermal ion distributions on the instability. The effects of thermal radiation in magnetized, self-gravitating dusty plasmas were discussed by Tsintsadze et al. [15] investigated the roles of dust temperature and fast ions.

More recently, quantum effects have been incorporated into studies of Jeans instability in dusty plasmas. Shukla and Stenflo [16] examined Jeans instability in quantum dusty plasmas, Masood et al. [17] developed a quantum hydrodynamic model including gravitational effects, and Sallimullah et al. [18] extended this analysis to magnetized quantum plasmas. Shan and Mushtaq [19] further investigated the influence of Fermi pressure in multi-component quantum plasmas. Notably, most of these studies on quantum dusty plasma have been based on a three-fluid description of the plasma components. Mahanta et al. [20] studied the Korteweg-de Vries-Burgers equation in collisional quantum magneto plasma incorporating light and heavy ions.

Magnetohydrodynamics (MHD) is one of the most effective fluid frameworks for describing the macroscopic equilibrium, stability, and collective behavior of plasmas. Although plasma dynamics are inherently complex due to long-range Coulomb and Lorentz interactions, MHD successfully captures the dominant features in a simplified and tractable form. Classical MHD has been widely used to study Jeans instability in self-gravitating plasmas. Chandrasekhar [21] examined the influence of magnetic fields and rotation on gravitational instability, while Kossacki [22] analyzed magneto-gravitational instability in viscous, electrically conducting media. More recently, Andi et al. [23] examined the formation and properties of dust–acoustic shock waves in a quantum dusty magnetoplasma.

For dense and ultra-cold quantum plasmas, Haas [24] introduced a quantum magnetohydrodynamic (QMHD) model as a quantum extension of classical MHD. Using this framework, Lundin et al. [25] studied Jeans instability in magnetized quantum plasmas including spin effects, and Ren et al. [26] investigated the role of resistivity. The influence of finite Larmor radius corrections was analyzed by Sharma and Chhajlani [27]. These studies demonstrate the suitability of QMHD for investigating gravitational instabilities in quantum plasmas. The MHD approach has also been extended to dusty plasmas. Shukla and Rahman [28] developed a multi-component dusty MHD model under the assumption that the characteristic wave frequency is much smaller than the ion gyrofrequency. This effective one-fluid description has since been widely applied. For example, Masood et al. [29] examined modulational instability and soliton formation, Birk and Wiechen [30] studied shear-flow instabilities in magnetized dusty plasmas, and Masood [31] analyzed obliquely propagating dust magnetosonic waves. Thakur et al. [32] have used the quantum hydrodynamic model to study the stationary structures with lateral perturbations in multifluid plasma. Radiation-driven thermal instability in weakly ionized plasmas was explored by Baurah et al. [33], and Singla et al. [34] studied dust magnetosonic solitons in magnetized dusty plasma.

Motivated by the works of Tsintsadze et al. [15], Masood et al. [29], and Ren et al. [26], the present study addresses an important gap in the existing literature. Tsintsadze et al. [15] employed an MHD model to examine the Jeans instability in magneto-radiative dusty plasmas, while Masood et al. [29] investigated nonlinear coupling between dust Alfvén and dust acoustic waves in self-gravitating plasmas including radiation pressure and the Jeans term. Ren et al. [26] analyzed the Jeans instability of quantum plasmas with finite resistivity using a QMHD model, but their study was limited to electron–ion plasmas. None of these works considered the combined effects of quantum corrections and electrical resistivity on Jeans instability in quantum dusty plasmas.

In view of the relevance of these effects to the gravitational collapse of dense astrophysical dusty plasmas, we investigate the Jeans instability in quantum dusty magnetoplasmas using a quantum magnetohydrodynamic (QMHD) model for dust, including dissipative effects due to finite electrical resistivity. Quantum effects are incorporated through a modified equation of state and the inclusion of quantum diffraction via the Bohm potential. Recent studies on nonlinear plasma waves have also contributed to the understanding of such systems. Mukherjee [35] developed a modified KdV-Burgers framework for nonlinear plasma waves, Thakur [36] investigated differential configurational entropy in nonlinear self-similar optical rogue waves, and Khanam [37] studied ion acoustic solitary wave formation in warm dusty plasma with electron inertia. These works highlight the importance of nonlinear effects in plasma dynamics.

The paper is organized as follows: Section 2 presents the governing QMHD equations; Section 3 derives and analyzes the modified dispersion relation both analytically and numerically; and Section 4 provides concluding remarks.

II Formulation of model

The plasma consists of electrons, dust grains, and ions, governed by the effective one-fluid quantum magnetohydrodynamic (QMHD) equations for dusty plasma. Under the quasi-neutrality condition and given that dust grain temperatures are typically much lower than those of electrons and ions, gas dynamics can be neglected. Electron and ion inertia are disregarded to focus on low-frequency dust dynamics. The displacement current in Ampère's law is also omitted for the same reason. The system features an external uniform magnetic field along the z-direction, denoted as $\mathbf{B} = B_0\hat{e}_z$ where $\hat{e}_z$ is the unit vector along z. Although dust grains generally vary in mass, size, and charge, we assume for simplicity that all grains are identical in size, mass m_d, and charge q_d, and are mobile relative to the stationary electrons and ions. The quasi-neutrality condition is expressed as $n_{i0} = n_{e0} + Z_d n_{d0}$ where n_j represents the number density of species j ($j = i, e, d$ for ions, electrons, and dust grains, respectively). The governing QMHD equations for this dusty plasma system are as follows:

$$\frac{\partial\rho}{\partial t} + \nabla\cdot(\rho\mathbf{v}) = 0 \tag{1}$$

$$\rho\frac{d\mathbf{v}}{dt} = -\nabla p + \frac{1}{\mu_0}(\nabla\times\mathbf{B})\times\mathbf{B} + \rho\nabla\phi + \frac{\hbar^2}{2m_d}\nabla\left(\frac{\nabla^2\sqrt{\rho}}{\sqrt{\rho}}\right) \tag{2}$$

$$\frac{\partial\mathbf{B}}{\partial t} = \nabla\times(\mathbf{v}\times\mathbf{B}) + \eta\nabla^2\mathbf{B} \tag{3}$$

$$\nabla^2\phi = 4\pi G\rho \tag{4}$$

where $\rho = m_d n_d$ is the dust mass density, $\mathbf{v}$ is the dust fluid velocity, p is the dust pressure, $\mathbf{B}$ is the magnetic field, ϕ is the gravitational potential, η is the electrical resistivity, $\hbar$ is the reduced Planck constant, m_d is the dust grain mass, and G is the gravitational constant. The quantum correction appears as the Bohm potential term in Eq. (2).

III Linearized perturbation equations and dispersion relation

To perform linearization, we express all space- and time-dependent variables as the sum of their equilibrium and perturbed components as:

$$\begin{aligned}\rho = \rho_0 + \rho_1, \quad \mathbf{v} = 0 + \mathbf{v}_1, \quad p = p_0 + p_1,\\ \mathbf{B} = B_0\hat{e}_z + \mathbf{B}_1, \quad \phi = \phi_0 + \phi_1\end{aligned} \tag{5}$$

Subscript '0' denotes equilibrium quantities, while subscript '1' represents perturbations. We analyze a magnetized quantum plasma characterized by $\mathbf{B} = B_0\hat{e}_z$. Assuming all perturbed quantities vary harmonically as $\exp[i(\mathbf{k}\cdot\mathbf{r} - \omega t)]$ (where ω is the frequency and $\mathbf{k}$ is the wave vector), we substitute Eq. (5) into the governing equations (1)–(4). Dropping the equilibrium subscript '0', the linearized perturbed equations become:

$$-i\omega\rho_1 + \rho(i\mathbf{k}\cdot\mathbf{v}_1) = 0 \tag{6}$$

$$-i\omega\mathbf{v}_1 = -\frac{v_A^2}{B_0} i\mathbf{k}\times\mathbf{B}_1 - i\mathbf{k}c_s^2\frac{\rho_1}{\rho} + i\mathbf{k}\phi_1 + i\mathbf{k}\frac{H_d^2}{4}k^2\frac{\rho_1}{\rho} \tag{7}$$

$$-i\omega\mathbf{B}_1 = i\mathbf{k}\times(\mathbf{v}_1\times\mathbf{B}_0) - \eta k^2\mathbf{B}_1 \tag{8}$$

$$-k^2\phi_1 = -4\pi G\rho_1 \tag{9}$$

where $v_A = B_0/\sqrt{\mu_0\rho}$ is the dust Alfvén velocity, $c_s = \sqrt{p/\rho}$ is the dust acoustic speed, and $H_d = \hbar/(m_d v_A)$ is the quantum diffraction parameter. Note that we have used the relation $p_1 = c_s^2\rho_1$ for isothermal perturbations.

From the linearized equations and assuming $\mathbf{k} = k_x\hat{e}_x + k_z\hat{e}_z$ we derive expressions for the three components of the perturbed dust velocity $\mathbf{v}_1$. These can be expressed in matrix form as:

$$X_{mn}Y_n = 0, \quad m,n = 1,2,3 \tag{10}$$

Setting the determinant of the coefficient matrix in Eq. (10) to zero yields the general dispersion relation:

$$\omega^6 - \omega^4\left[k^2(v_A^2 + c_s^2 + c_q^2) - \omega_J^2 + i\eta k^2\left(\omega + \frac{k_z^2 v_A^2}{\omega}\right)\right] + \cdots = 0 \tag{11}$$

where $c_q^2 = \frac{\hbar^2 k^2}{4m_d^2}$ is the quantum correction, $\omega_J^2 = 4\pi G\rho$ is the Jeans frequency, and we omit higher-order terms for brevity. In the absence of resistivity ($\eta = 0$) and quantum effects ($c_q = 0$), Eq. (11) recovers the Jeans instability for dusty plasma from Tsintsadze et al. [15], without radiative effects. The full dispersion relation incorporates the combined effect of non-zero resistivity, magnetic field, gravity, and quantum diffraction. Expanding Eq. (11) produces a sixth-degree polynomial in ω. System instability can be analyzed under two propagation geometries: perturbations parallel to the magnetic field and perturbations perpendicular to the magnetic field.

III.a Transverse propagation: $\mathbf{k}\perp\mathbf{B}_0$ $(k_z = 0)$

Substituting $k_z = 0$ into Eq. (11) yields the cubic dispersion relation:

$$\omega^3 + i\eta k^2\omega^2 - \omega\left[k^2(v_A^2 + c_s^2 + c_q^2) - \omega_J^2\right] - i\eta k^2\left[k^2(c_s^2 + c_q^2) - \omega_J^2\right] = 0 \tag{12}$$

Equation (12) describes a gravitating mode modified by magnetic field effects (dust Alfvén velocity), resistivity, and quantum corrections. In the absence of resistivity, it simplifies to:

$$\omega^3 - \omega\left[k^2(v_A^2 + c_s^2 + c_q^2) - \omega_J^2\right] = 0 \tag{13}$$

This dispersion relation agrees with Eq. (19) from Zamanian et al. [25], excluding intrinsic dust magnetization (which they modeled via Hall MHD with dust magnetic moments). Neglecting quantum corrections here recovers Eq. (20) from Tsintsadze et al. [15]. The constant term of Eq. (13) gives the Jeans instability criterion:

$$k^2(c_s^2 + c_q^2) < \omega_J^2 \tag{14}$$

Equation (12), being cubic, has three roots whose nature (real positive, negative, or complex) determines perturbation behavior: growing (unstable), damped, or oscillatory. For a cubic equation there exists at least one positive real root. Thus, when the constant term of Eq. (12) is negative, at least one positive root exists, indicating instability. The instability criterion follows directly from this constant term:

$$k^2(c_s^2 + c_q^2) < \omega_J^2 \tag{15}$$

The system governed by Eq. (12) becomes unstable when the above criterion holds, matching the condition derived by Ren et al. [26] for electron-ion quantum plasma. Notably, the resistivity parameter does not alter the Jeans instability criterion in magnetized, quantum dusty plasma. However, resistivity modifies the growth rate through its influence on the dispersion relation.

The influence of electrical resistivity and quantum corrections on Jeans instability growth rates in dusty plasma can be examined numerically. We first normalize Eq. (12) using the following dimensionless parameters:

$$\omega^* = \frac{\omega}{\omega_J}, \quad k^* = \frac{kc_s}{\omega_J}, \quad \eta^* = \frac{\eta\omega_J}{c_s^2}, \quad H_d^* = \frac{H_d\omega_J}{c_s} \tag{16}$$

Using the normalization (16), we express Eq. (12) in dimensionless form, scaled by the dust plasma Jeans frequency and dust acoustic speed as:

$$\omega^{*3} + i\eta^* k^{*2}\omega^{*2} - \omega^* \left[k^{*2}(1+\beta+H_d^{*2}k^{*2}/4) - 1\right] - i\eta^* k^{*2}\left[k^{*2}(1+H_d^{*2}k^{*2}/4) - 1\right] = 0 \tag{17}$$

where $\beta = v_A^2/c_s^2$.

To investigate resistivity and quantum correction effects on Jeans instability growth rates for transverse propagation, we numerically solve Eq. (17). Growth rates are computed for varying dimensionless dust quantum parameter H_d^* and resistivity η^*.

We examine the influence of the dust quantum parameter on the growth rate of the Jeans instability, as illustrated in Figure 1, for a fixed value of the electrical resistivity parameter. The dimensionless acoustic speed and resistivity are held constant at $\beta = 1$, $\eta^* = 1$ respectively. The figure presents three curves corresponding to different values of the dust quantum parameter: $H_d^* = 0.3$, 0.5, and 0.8. It is evident from Figure 1 that an increase in the dust quantum parameter leads to a reduction in the growth rate, indicating that quantum effects associated with dust play a stabilizing role in the instability. Although all curves initially attain the same maximum growth rate, noticeable differences emerge at later stages, where larger values of H_d^* suppress the growth more effectively. Hence, the dust quantum parameter acts as a stabilizing agent for the Jeans instability.

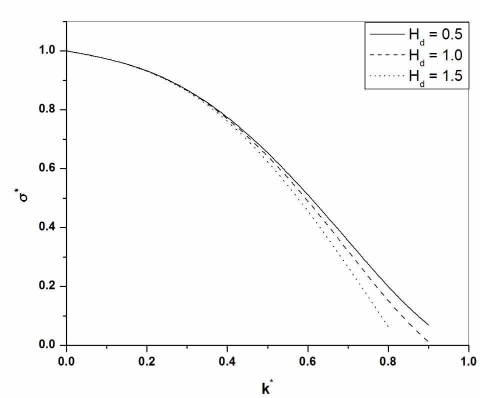

Figure 1: The normalized growth rate of Jeans instability versus normalized wavenumber for various values of the dust quantum parameter H_d^* for dusty fluid in transverse propagation. The values of constant parameters are $\beta = 1$, $\eta^* = 1$.

Figure 2 illustrates the variation of the instability growth rate (ω^*) with the normalized wave number k^* for different values of the dimensionless resistivity parameter η^*. The dimensionless dust acoustic speed and the dust quantum parameter are kept fixed at $\beta = 1$, $H_d^* = 0.5$ respectively. The three curves correspond to increasing resistivity: $\eta^* = 1$, 3, and 5. It is observed that the growth rate increases as the resistivity parameter increases, indicating that electrical resistivity enhances the instability. This demonstrates that resistive effects contribute to the destabilization of the Jeans mode. Therefore, the resistivity parameter plays a significant destabilizing role in the gravitational instability of quantum magnetoplasmas.

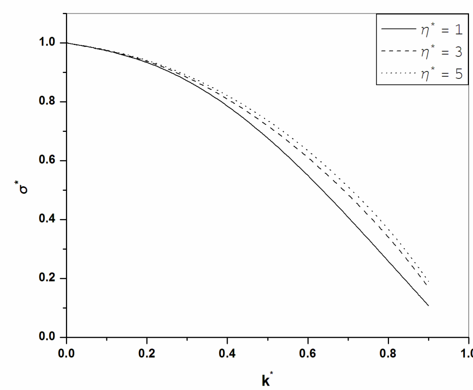

Figure 2: The normalized growth rate of Jeans instability versus normalized wavenumber for various values of the electrical resistivity parameter η^* for dusty fluid in transverse propagation. The values of constant parameters are $\beta = 1$, $H_d^* = 0.5$.

III.b Longitudinal propagation: $\mathbf{k} \parallel \mathbf{B}_0$ ($k_x = 0$, $k_z = k$)

In this case, we assume all perturbations align parallel to the magnetic field direction and consider only the wave mode that propagates along the field. Substituting $k_x = 0$ into Eq. (11), we obtain:

$$\left[\omega^2 - k^2 v_A^2 \left(1 + \frac{i\eta k^2}{\omega}\right)^{-1}\right] \left[\omega^2 - k^2(c_s^2 + c_q^2) + \omega_J^2\right] = 0 \tag{18}$$

From Eq. (18), it follows that when the wave propagates along the direction of magnetic field, two independently propagating waves emerge: the Alfvén wave and the gravitational wave.

Equation (18) factors into two independent terms. The first factor yields:

$$\omega^2 - k^2 v_A^2 \left(1 + \frac{i\eta k^2}{\omega}\right)^{-1} = 0 \quad \Rightarrow \quad \omega^2 + i\eta k^2 \omega - k^2 v_A^2 = 0 \tag{19}$$

Equation (19) represents a stable non-gravitating Alfvén mode modified due to resistivity. The presence of quantum corrections has no influence in this mode.

The second factor of Eq. (18) equated to zero gives:

$$\omega^2 - k^2(c_s^2 + c_q^2) + \omega_J^2 = 0 \tag{20}$$

The dispersion relation in Eq. (20) describes a gravitating mode that incorporates quantum corrections to the self-gravitational instability in quantum dusty plasma. Without these quantum corrections, it reduces to the result obtained by Kossacki [22] for electron-ion plasma. Similarly, in the absence of quantum effects, the relation aligns with the dispersion relation derived by Tsintsadze et al. [15].

In this scenario, the system's behavior—whether growing, damped, or oscillatory—depends on the roots of Eq. (20). These roots are determined by the equation's coefficients, which are influenced by quantum effects. As a second-degree equation, Eq. (20) yields two roots. Specifically, if the constant term is negative, at least one root is positive, rendering the system unstable. The instability condition can thus be readily derived from this constant term:

$$k^2(c_s^2 + c_q^2) < \omega_J^2 \tag{21}$$

This represents the Jeans instability criterion, modified by dust quantum corrections. The system described by Eq. (20) becomes unstable when this condition holds—a result identical to that derived by Ren et al. [26] for the electron-ion case. Notably, the resistivity parameter has no influence on the Jeans instability condition in quantum magnetized dusty plasma for perturbations propagating along the magnetic field. However, the quantum effects modify the growth rate in the dispersion relation, while resistivity exerts no such impact.

Since the Jeans instability criterion remains independent of resistivity, the critical Jeans length and gravitational collapse timescale are similarly unaffected by this parameter. Quantum effects become significant in extremely dense, low-temperature plasmas. In certain astrophysical environments, such as regions with mass densities of 10^7–10^9 kg/m^3 and temperatures $T \sim 10^5$–10^7 K, these effects are crucial. Using typical parameters from neutron star, magnetar, and white dwarf interiors—with dust mass assumed as $m_d = 10^9 m_i$—the critical Jeans length scales as $\sim 10^2$ m. Thus, systems larger than ~ 100 m become unstable. The corresponding gravitational collapse timescale, calculated via $\tau \sim 1/\sqrt{4\pi G\rho}$, is approximately 2.5 s.

To examine the influence of quantum corrections on the Jeans instability growth rate, we numerically analyze the dispersion relation in Eq. (20). This equation is normalized using the relations from Eq. (16) as:

$$\omega^{*2} - k^{*2}\left(1 + \frac{H_d^{*2} k^{*2}}{4}\right) + 1 = 0 \tag{22}$$

To examine the growth rate of instability for longitudinal wave propagation, we numerically solve for the roots of the dispersion relation in Eq. (22). These roots are analyzed as a function of the wavenumber k^*, considering various parameter values particularly different values of the dust quantum parameter.

In Figure 3, we examine the influence of the dust quantum parameter H_d^* by plotting the growth rate of the Jeans gravitational instability as a function of the dimensionless wave number k^*. Figure 3 clearly illustrates the effect of the quantum parameter on the instability growth rate in the presence of finite resistivity. The solid curve corresponds to $H_d^* = 0.5$, while the dashed and dotted curves represent $H_d^* = 1.0$ and $H_d^* = 1.5$, respectively. It is evident from the figure that an increase in the quantum parameter leads to a reduction in the growth rate of the Jeans instability. This indicates that the finite quantum effects exert a stabilizing influence on the self-gravitating quantum plasma. Therefore, the quantum parameter plays a significant role in the gravitational collapse process, and increasing its value tends to drive the system toward stabilization.

IV Conclusions

This study examines the Jeans instability in a finitely conducting, magnetized quantum dusty fluid through normal mode analysis. The general dispersion relation is derived for both longitudinal and transverse propagation modes.

In the transverse propagation mode, the gravitating mode couples with the Alfvén mode, which is altered by the resistivity parameter. The Jeans instability criterion in the transverse direction is unaffected by resistivity but modified by the quantum parameter. Numerical analysis reveals that the

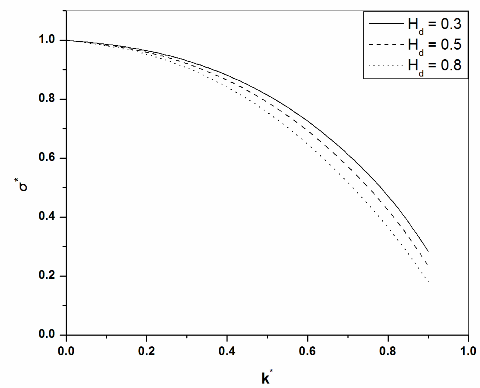

Figure 3: The normalized growth rate of Jeans instability versus normalized wavenumber for various values of the dust quantum parameter H_d^* for dusty fluid in longitudinal propagation.

resistivity parameter promotes instability, while the quantum parameter stabilizes the growth rate of Jeans gravitational instability.

In the longitudinal propagation mode, two distinct modes emerge: a non-gravitating Alfvén mode influenced by finite electrical resistivity, and a gravitating mode affected by quantum effects. The Jeans instability criterion remains unaltered by resistivity but is modified by quantum corrections. Graphical results confirm that the quantum parameter exerts a stabilizing influence on the Jeans instability growth rate.

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References

[1] P.K. Shukla and A.A. Mamun. *Introduction to Dusty Plasma Physics*. Institute of Physics Publishing, Bristol, 2002.

[2] V.E. Fortov, A.V. Ivlev, S.A. Khrapak, and G.E. Morfill. Complex (dusty) plasmas: Current status, open issues, perspectives. *Physics Reports*, 421(1):1–103, 2005.

[3] A. Roychowdhury, S. Banerjee, and S. Chandra. Stationary formation of dust-ion acoustic waves in degenerate dusty plasma at critical regime. *The African Review of Physics*, 15:0021, 2021.

[4] Suman Dey et al. Two-stream plasma instability as a potential mechanism for particle escape from the venusian ionosphere. *Pramana*, 96(4):1–9, 2022.

[5] D.A. Mendis. Progress in the study of dusty plasmas. *Plasma Sources Science and Technology*, 11(3A):A219, 2002.

[6] F. Verheest. *Waves in Dusty Space Plasmas*. Kluwer Academic, Dordrecht, 2000.

[7] Saeed-ur Rehman. Linear and nonlinear quantum ion acoustic waves in a plasma with positive, negative ions and fermi electron gas. *Physics of Plasmas*, 17(6):062303, 2010.

[8] J. Goswami, S. Chandra, J. Sarkar, and B. Ghosh. Quantum two stream instability in a relativistically degenerate magnetised plasma. *AIP Conference Proceedings*, 2319:030005, 2021.

[9] S. Chandra, C. Das, and J. Sarkar. Evolution of nonlinear stationary formations in a quantum plasma at finite temperature. *Zeitschrift für Naturforschung A*, 76(4):329–339, 2021.

[10] F. Haas, L.G. Garcia, J. Goedert, and G. Manfredi. Quantum ion-acoustic waves. *Physics of Plasmas*, 10(10):3858–3866, 2003.

[11] B.P. Pandey, K. Avinash, and C.B. Dwivedi. Jeans instability of a dusty plasma. *Physical Review E*, 49(6):5599, 1994.

[12] P.K. Shukla and F. Verheest. Jeans instability in collisional dusty plasmas. *Astrophysics and Space Science*, 262(2):157–162, 1998.

[13] F. Verheest, P.K. Shukla, G. Jacobs, and V.V. Yaroshenko. Jeans instability in partially ionized self-gravitating dusty plasmas. *Physical Review E*, 68(2):027402, 2003.

[14] S.R. Pillay and F. Verheest. Effect of non-thermal ion distributions on the jeans instability in dusty plasmas. *Journal of Plasma Physics*, 71(2):177–184, 2005.

[15] N.L. Tsintsadze, R. Chaudhary, H.A. Shah, and G. Murtaza. Jeans instability in a magneto-radiative dusty plasma. *Journal of Plasma Physics*, 74(6):847–856, 2008.

[16] P.K. Shukla and L. Stenflo. Jeans instability in a self-gravitating dusty plasma. *Proceedings of the Royal Society A*, 462(2066):403–407, 2006.

[17] W. Masood, M. Sallimullah, and H.A. Shah. A quantum hydrodynamic model for multicomponent quantum magnetoplasma with jeans term. *Physics Letters A*, 372(46):6757–6760, 2008.

[18] M. Sallimullah, M. Jamil, H.A. Shah, and G. Murtaza. Jeans instability in a quantum dusty magnetoplasma. *Physics of Plasmas*, 16(1):014502, 2009.

[19] S.A. Shan and A. Mushtaq. Role of jeans instability in multi-component quantum plasmas in the presence of fermi pressure. *Chinese Physics Letters*, 28(7):075204, 2011.

[20] D. Mahanta, S. Chandra, and J. Sarma. Impact of ion pressure anisotropy in collisional quantum magneto-plasma with heavy and light ions. *East European Journal of Physics*, (3):143–159, 2024.

[21] S. Chandrasekhar. *Hydrodynamic and Hydromagnetic Stability*. Clarendon Press, Oxford, 1961.

[22] K. Kossacki. On the magnetogravitational instability of a homogeneous, infinite, viscous and rotating medium with finite electrical conductivity. *Acta Astronomica*, 11:83, 1961.

[23] M.L. Andi, D. Dorranian, and S. Saviz. On the formation and propagation of dust acoustic shock waves in a magnetic quantum dusty plasma. *Indian Journal of Physics*, 99:3083–3093, 2025.

[24] F. Haas. A magnetohydrodynamic model for quantum plasmas. *Physics of Plasmas*, 12(6):062117, 2005.

[25] J. Lundin, M. Marklund, and G. Brodin. Modified jeans instability criteria for magnetized systems. *Physics of Plasmas*, 15(7):072116, 2008.

[26] H. Ren, Z. Wu, J. Cao, and P.K. Chu. Jeans instability in quantum magnetoplasma with resistive effects. *Physics of Plasmas*, 16(7):072101, 2009.

[27] P. Sharma and R.K. Chhajlani. The effect of finite larmor radius corrections on jeans instability of quantum plasma. *Physics of Plasmas*, 20(9):092101, 2013.

[28] P.K. Shukla and H.U. Rahman. Magnetohydrodynamics of dusty plasmas. *Physics of Plasmas*, 3(1):430–432, 1996.

[29] W. Masood, H.A. Shah, N.L. Tsintsadze, and M.N.S. Qureshi. Dust alfven ordinary and cusp solitons and modulational instability in a self-gravitating magneto-radiative plasma. *European Physical Journal D*, 59(3):413–420, 2010.

[30] G.T. Birk and H. Wiechen. Shear flow instabilities in magnetized partially ionized dense dusty plasmas. *Physics of Plasmas*, 9(3):964–970, 2002.

[31] W. Masood, H.A. Shah, A. Mushtaq, and M. Salimullah. Linear and nonlinear properties of an obliquely propagating dust magnetosonic wave. *Journal of Plasma Physics*, 75(2):217–229, 2009.

[32] S. Thakur, C. Das, and S. Chandra. Stationary structures in a four component dense magnetoplasma with lateral perturbations. *IEEE Transactions on Plasma Science*, 50(6):1545–1556, 2022.

[33] M.B. Baruah, S. Chatterjee, and M.P. Bora. Radiation condensation instability in a plasma with ionization and recombination. *Astrophysics and Space Science*, 325(2):217–222, 2010.

[34] S. Singla, S. Chandra, and N.S. Saini. Simulation study of dust magnetosonic excitations in a magnetized dusty plasma. *Chinese Journal of Physics*, 85:524–535, 2023.

[35] S. Mukherjee. A theoretical model for nonlinear plasma waves using a modified kdv-burgers framework. *Natural Sciences and Applied Technology*, 2(2):RA–25–PS–205, 2025.

[36] P. Thakur. Differential configurational entropy in nonlinear self-similar optical rogue wave. *Natural Sciences and Applied Technology*, 2(2):44, 2025.

[37] R. Khanam. Ion acoustic solitary wave formation in a warm, unmagnetized dusty plasma with electron inertia. *Natural Sciences and Applied Technology*, 2(1):RA–25–MS–101, 2025.

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