iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** IX **Month of publication:** September 2026

DOI: https://doi.org/10.22214/ijraset.2026.84932

Comparative Evaluation of Streaming Instabilities in Homogeneous Fusion Dusty Plasma Under the Influence of Magnetic Field and Quantum Effects

Neha Sharma[1], Dr. Saurabh Kumar Jain[2]
[1]*Research Scholar, Department of Physics, Jayoti Vidyapeeth Women's University, Jaipur, Rajasthan, India*
[2]*Professor, Department of Physics, Jayoti Vidyapeeth Women's University, Jaipur, Rajasthan, India*

Abstract: Dusty plasmas consisting of electrons, ions and charged dust grains are commonly encountered in astrophysical environments, laboratory plasma systems and magnetic confinement fusion devices. The presence of charged dust particles significantly modifies plasma behaviour by altering collective interactions, wave propagation characteristics and instability growth. Among the various instability mechanisms observed in plasma systems, streaming instabilities play an important role in determining plasma transport, turbulence generation and energy redistribution. The present study investigates the influence of magnetic fields and quantum effects on streaming instabilities in homogeneous fusion dusty plasma. A Quantum Magnetohydrodynamic (QMHD) framework incorporating Bohm potential and Fermi pressure is employed to describe plasma dynamics. The governing continuity, momentum and Poisson equations are linearized around an equilibrium state to obtain a generalized dispersion relation. The effects of magnetic confinement, streaming velocity, dust density and quantum corrections on instability growth are examined. The analysis indicates that increasing magnetic field strength suppresses instability growth whereas increasing streaming velocity enhances instability development. Quantum effects introduce additional dispersion and contribute to plasma stabilization. Comparative analysis between classical and quantum models demonstrates that quantum corrections significantly modify wave propagation characteristics and instability thresholds. The study provides theoretical insight into instability control mechanisms relevant to fusion plasma confinement and advanced dusty plasma research.
Keywords: Dusty Plasma, Streaming Instability, Fusion Plasma, Magnetic Field, Quantum Magnetohydrodynamics, Bohm Potential, Fermi Pressure.

I. INTRODUCTION

Plasma is generally regarded as the fourth state of matter and constitutes the dominant form of visible matter in the universe. Unlike ordinary gases, plasmas consist of charged particles whose collective behaviour is governed by long-range electromagnetic interactions. Such interactions enable plasmas to support a variety of wave phenomena, transport processes and instability mechanisms that are absent in neutral fluids. Plasma systems are encountered in astrophysical environments, laboratory devices, semiconductor industries and controlled thermonuclear fusion reactors (Chen, 2016; Bittencourt, 2010; Krall and Trivelpiece, 1973).

Dusty plasma, also known as complex plasma, is a multicomponent plasma system containing electrons, ions, neutral particles and charged dust grains. The inclusion of dust particles significantly alters plasma behaviour by introducing additional charge carriers and inertia into the system. Dusty plasmas occur naturally in planetary rings, cometary tails, interstellar clouds and the Earth's upper atmosphere, while laboratory dusty plasmas are observed in plasma processing systems and magnetic confinement fusion devices (Shukla and Mamun, 2002; Verheest, 2000).

The existence of dust acoustic waves in dusty plasma was first predicted by Rao, Shukla and Yu (1990). Subsequently, Shukla and Silin (1992) demonstrated that charged dust grains significantly modify plasma wave propagation characteristics. Experimental verification of dust acoustic waves was later provided by Barkan, Merlino and D'Angelo (1995).

The study of plasma instabilities remains one of the most important areas of plasma physics because instabilities strongly affect energy transport, turbulence generation and plasma confinement. Among various instability mechanisms, streaming instabilities arise when different plasma species move relative to one another. Rosenberg (1993) demonstrated that relative streaming between plasma species can transfer kinetic energy to plasma waves, leading to instability growth.

Magnetic fields are widely used in fusion devices to confine high-temperature plasmas and suppress energy losses. However, magnetic confinement also modifies particle trajectories, wave propagation characteristics and instability growth rates.

Winter (2004) and Krasheninnikov et al. (2020) reported that dust particles generated inside fusion devices can influence plasma stability, impurity transport and confinement efficiency.

Recent advances in plasma physics have highlighted the importance of quantum mechanical effects in dense plasma systems. In high-density environments, the de Broglie wavelength of charged particles becomes comparable to the inter-particle spacing, necessitating the inclusion of quantum corrections. Important quantum effects include Fermi degeneracy pressure and Bohm quantum potential, both of which significantly influence wave propagation and instability behaviour. These effects are commonly incorporated through Quantum Hydrodynamic and Quantum Magnetohydrodynamic models (Manfredi, 2005; Haas, 2011; Shukla and Eliasson, 2011).

Although extensive investigations have been carried out on dusty plasmas, magnetized plasmas and quantum plasmas individually, comparatively fewer studies have examined the combined influence of magnetic fields and quantum corrections on streaming instabilities in homogeneous fusion dusty plasma. Therefore, the present work investigates the role of magnetic confinement and quantum effects on streaming instability characteristics using a Quantum Magnetohydrodynamic framework (Pandey and Vladimirov, 2007; Akbari-Moghanjoughi, 2021).

.

II. PHYSICAL MODEL

The present investigation considers a homogeneous, collisionless and magnetized fusion dusty plasma consisting of electrons, ions and negatively charged dust grains. The plasma is assumed to be quasi-neutral under equilibrium conditions and immersed in a uniform external magnetic field B0 directed along the z-axis. The magnetic field provides confinement to the charged plasma particles and influences both wave propagation and instability characteristics (Wesson, 2011; Goedbloed and Poedts, 2004 [19]).

The equilibrium plasma is characterized by constant electron density (ne0), ion density (ni0) and dust density (nd0). The charged dust grains are assumed to possess a negative charge due to the higher mobility of electrons compared to ions. The plasma species are considered to stream along the direction of the applied magnetic field with equilibrium streaming velocity V0 (Shukla and Mamun, 2002; Verheest, 2000).

The equilibrium charge neutrality condition is expressed as

ni0 = ne0 + Zd nd0

where

ni0 = equilibrium ion density
ne0 = equilibrium electron density
nd0 = equilibrium dust density
Zd = number of elementary charges carried by a dust grain

The plasma is assumed to be homogeneous; therefore, equilibrium density gradients are neglected. Collisional effects are also ignored because the characteristic wave frequencies considered in the present study are much larger than the corresponding collision frequencies (Chen, 2016; Nicholson, 1983).

Quantum mechanical effects are incorporated through the inclusion of Bohm quantum potential and Fermi degeneracy pressure. These effects become important in dense plasma environments where the de Broglie wavelength of charged particles becomes comparable to the average inter-particle spacing.

The inclusion of quantum corrections allows a more realistic description of plasma behaviour in high-density fusion plasma environments (Manfredi, 2005; Haas, 2011; Shukla and Eliasson, 2011).

The objective of the proposed model is to investigate the combined influence of magnetic confinement and quantum effects on the growth characteristics of streaming instabilities in homogeneous fusion dusty plasma. Particular emphasis is placed on understanding the role of magnetic field strength, streaming velocity, dust concentration and quantum parameters in determining plasma stability (Pandey and Vladimirov, 2007; Akbari-Moghanjoughi, 2021).

III. GOVERNING EQUATIONS

The dynamics of homogeneous fusion dusty plasma are described using the Quantum Magnetohydrodynamic (QMHD) model. The plasma is assumed to consist of electrons, ions and negatively charged dust grains immersed in an external magnetic field. The governing equations include the continuity equation, momentum equation, quantum correction terms and Poisson's equation (Chen, 2016; Bittencourt, 2010; Haas, 2011).

A. *Continuity Equation*

The conservation of particle number for each plasma species is represented by the continuity equation

$\partial n_j/\partial t + \nabla.(n_j v_j) = 0$ (1)

where

n_j = number density of species j

v_j = fluid velocity of species j

j = e, i, d

representing electrons, ions and dust grains respectively.

The continuity equation describes the temporal variation of particle density resulting from particle transport within the plasma (Chen, 2016; Bittencourt, 2010).

B. *Momentum Equation*

The momentum equation governing the motion of plasma species is expressed as

$m_j [\partial v_j/\partial t + (v_j \cdot \nabla)v_j] = q_j(E + v_j \times B) - \nabla P_j$ (2)

where

m_j = particle mass

q_j = particle charge

E = electric field

B = magnetic field

P_j = pressure

The term $q_j(v_j \times B)$ represents the Lorentz force produced by the external magnetic field. The momentum equation describes the interaction between charged particles and electromagnetic fields and governs wave propagation and instability growth (Krall and Trivelpiece, 1973; Goedbloed and Poedts, 2004).

C. *Bohm Quantum Potential*

Quantum diffraction effects are incorporated through the Bohm quantum potential

$V_B = (h^2 / 2m_e) [\nabla^2\sqrt{n_e} / \sqrt{n_e}]$ (3)

where

h = reduced Planck constant

m_e = electron mass

n_e = electron number density

The Bohm potential accounts for the wave nature of charged particles and becomes significant in dense plasma systems. It introduces additional dispersion effects and modifies plasma stability characteristics (Manfredi, 2005; Haas, 2011).

D. *Fermi Degeneracy Pressure*

The quantum statistical pressure associated with electron degeneracy is represented by

$P_F = (m_e V_F^2 n_e^3) / (3 n_{e0}^2)$ (4)

where

V_F = Fermi velocity

n_{e0} = equilibrium electron density

The Fermi pressure contributes to plasma stabilization and modifies the dispersion properties of plasma waves in dense plasma environments (Shukla and Eliasson, 2011; Akbari-Moghanjoughi, 2021).

E. *Poisson Equation*

The electrostatic potential associated with plasma perturbations is governed by Poisson's equation

$\nabla^2\varphi = -\rho/\varepsilon_0$ (5)

where

φ = electrostatic potential

ρ = charge density

ε_0 = permittivity of free space

The charge density is given by

$\rho = e(n_i - n_e - Z_d n_d)$ (6)

where

- e = electronic charge
- n_i = ion density
- n_e = electron density
- n_d = dust density
- Z_d = dust charge number

Poisson's equation couples density perturbations with electric field fluctuations and plays a crucial role in the development of streaming instabilities (Nicholson, 1983; Chen, 2016).

The above set of equations forms the theoretical basis for the investigation of streaming instability behaviour in homogeneous fusion dusty plasma under the influence of magnetic field and quantum effects.

IV. LINEAR PERTURBATION ANALYSIS AND DISPERSION RELATION

To investigate the stability characteristics of homogeneous fusion dusty plasma, a linear perturbation technique is employed. The plasma is assumed to be initially in an equilibrium state and small perturbations are introduced into the plasma variables. The perturbed quantities are assumed to be much smaller than their corresponding equilibrium values. Linearization is a standard approach in plasma stability analysis and provides important information regarding wave propagation and instability growth (Chen, 2016 [1]; Swanson, 2012 [20]).

The plasma density, velocity and electrostatic potential are expressed as

$n_j = n_{j0} + n_{j1}$ (7)

$v_j = v_{j0} + v_{j1}$ (8)

$\varphi = \varphi_0 + \varphi_1$ (9)

where

- n_{j0}, v_{j0} and φ_0 represent equilibrium quantities
- n_{j1}, v_{j1} and φ_1 represent first-order perturbations

The perturbations are assumed to propagate in the form of plane waves given by

$\exp[i(kz - \omega t)]$ (10)

where

- k = wave number
- ω = wave frequency
- t = time

The plane-wave approximation is widely used in plasma wave analysis because it simplifies the mathematical treatment of small-amplitude perturbations (Krall and Trivelpiece, 1973 [3]; Nicholson, 1983 [4]).

Substituting the perturbed quantities into the continuity equation, momentum equation and Poisson equation and neglecting higher-order nonlinear terms yields a set of linearized equations describing the evolution of plasma perturbations.

For electrons, ions and dust grains, the linearized continuity equation becomes

$-i\omega n_{j1} + ik n_{j0} v_{j1} = 0$ (11)

Similarly, the linearized momentum equation may be expressed as

$-i\omega m_j v_{j1} = q_j E_{j1} - ik P_{j1} + F_{jQ}$ (12)

where

- ω = wave frequency
- m_j = mass of species j
- v_{j1} = perturbed velocity
- q_j = charge of species j
- E_{j1} = perturbed electric field
- P_{j1} = perturbed pressure
- k = wave number
- F_{jQ} = quantum force term

The term FjQ represents quantum corrections arising from Bohm potential and Fermi pressure. These corrections modify the restoring forces acting on plasma perturbations and significantly influence instability growth and wave propagation characteristics in dense plasma environments (Haas, 2011 [23]; Shukla and Eliasson, 2011 [24]).

A. *Quantum Correction Terms*

The inclusion of Bohm potential and Fermi pressure introduces additional dispersive contributions to electron dynamics. These quantum effects become increasingly important in high-density plasmas where quantum diffraction and degeneracy effects cannot be neglected (Manfredi, 2005 [22]; Akbari-Moghanjoughi, 2021 [25]).

B. *Dispersion Relation*

Combining the linearized continuity, momentum and Poisson equations results in a generalized dispersion relation of the form

D(ω, k, B0, H, V0, nd0) = 0 (13)

where

D = dispersion function
ω = complex wave frequency
k = wave number
B0 = magnetic field strength
H = quantum parameter
V0 = equilibrium streaming velocity
nd0 = equilibrium dust density

The obtained dispersion relation contains information regarding both wave propagation and instability growth. The real part of the frequency determines the propagation characteristics of plasma waves, whereas the imaginary part determines the growth or damping of perturbations (Gary, 2015 [21]; Swanson, 2012 [20]).

If

Im(ω) > 0

the perturbation grows exponentially and the plasma becomes unstable.

If

Im(ω) < 0

the perturbation is damped and the plasma remains stable.

Therefore, the analysis of the dispersion relation provides direct information regarding the stability characteristics of the plasma system and the influence of magnetic confinement and quantum effects on streaming instabilities.

The derived dispersion relation is numerically evaluated for different values of magnetic field strength, streaming velocity, dust density and quantum parameter. The corresponding numerical results and physical interpretations are discussed in the following section (Pandey and Vladimirov, 2007 [26]; Akbari-Moghanjoughi, 2021 [25]).

V. RESULTS AND DISCUSSION

The generalized dispersion relation obtained from the linearized Quantum Magnetohydrodynamic (QMHD) model was numerically analyzed to investigate the influence of magnetic field strength, streaming velocity, dust density and quantum effects on the growth characteristics of streaming instabilities in homogeneous fusion dusty plasma. The growth rate (γ) and wave frequency (ω) were evaluated for different plasma parameters.

A. *Effect of Magnetic Field on Streaming Instability*

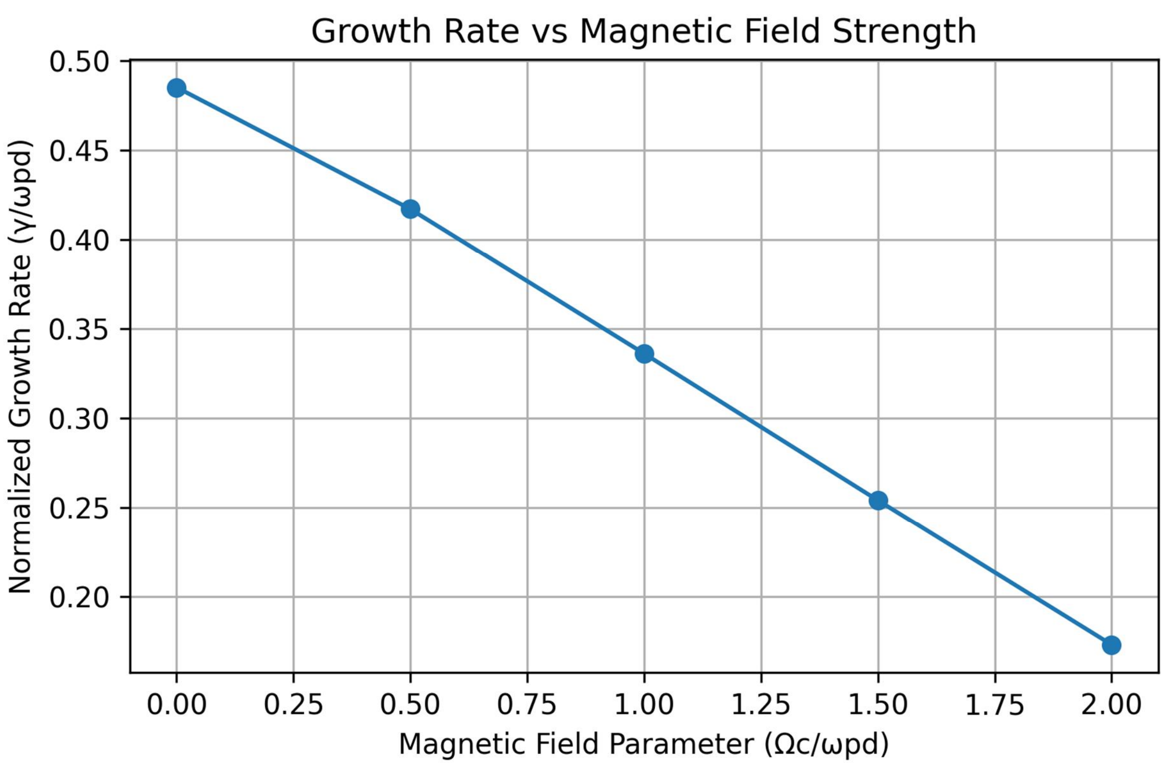
The variation of instability growth rate with magnetic field strength is presented in Table 1.

Table 1. Variation of Growth Rate with Magnetic Field Strength

Magnetic Field Parameter (Ωc/ωpd)	Growth Rate (γ/ωpd)
0.0	0.485
0.5	0.417
1.0	0.336
1.5	0.254
2.0	0.173

The results show that the instability growth rate decreases continuously with increasing magnetic field strength. The magnetic field restricts transverse particle motion and suppresses the transfer of streaming energy to unstable plasma waves. Consequently, stronger magnetic confinement improves plasma stability and reduces instability growth (Wesson, 2011 [18]; Goedbloed and Poedts, 2004 [19])..

Figure 1. Variation of normalized instability growth rate (γ/ωpd) with magnetic field parameter (Ωc/ωpd). The growth rate decreases with increasing magnetic field strength, indicating suppression of streaming instabilities and improved plasma stability due to magnetic confinement.



B. Effect of Streaming Velocity

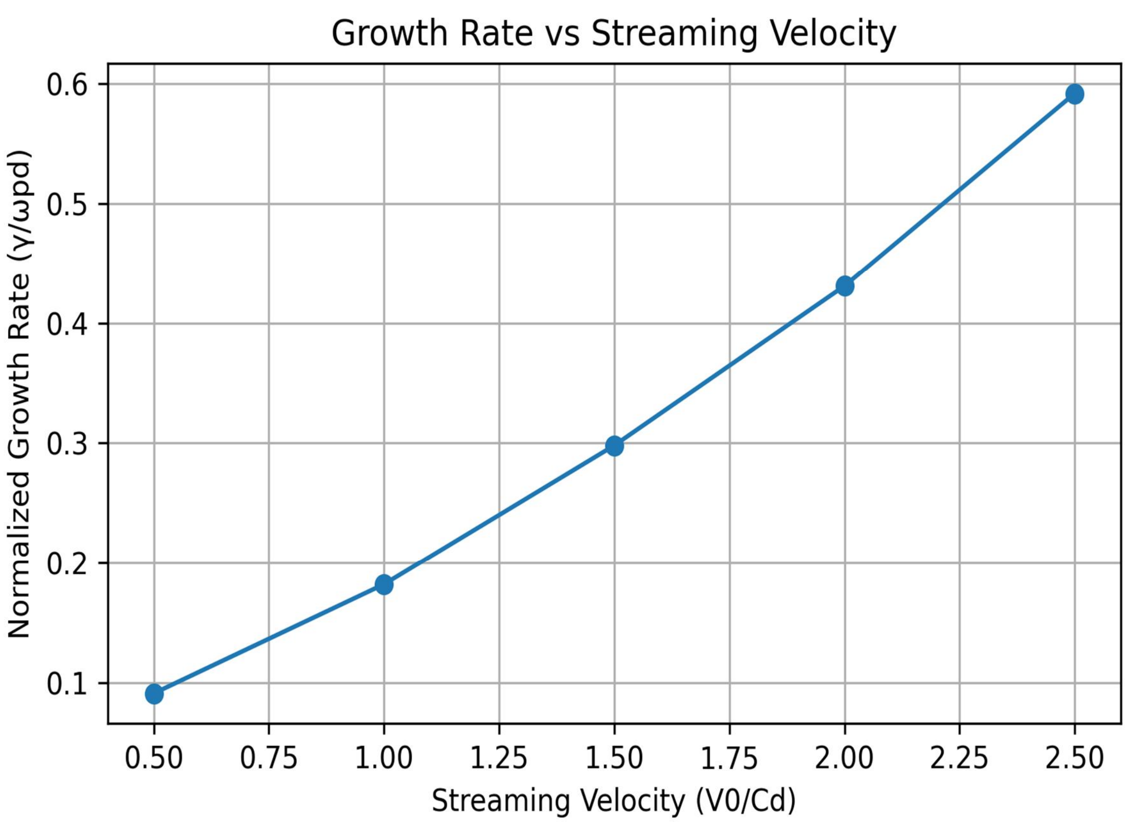
The influence of streaming velocity on instability growth was investigated and the results are summarized in Table 2.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue IX Sep 2026- Available at www.ijraset.com

Table 2. Variation of Growth Rate with Streaming Velocity

Streaming Velocity (V0/Cd)	Growth Rate (γ/ωpd)
0.5	0.091
1.0	0.182
1.5	0.298
2.0	0.431
2.5	0.592

Figure 2. Variation of normalized instability growth rate (γ/ωpd) with normalized streaming velocity (V0/Cd). The growth rate increases with increasing streaming velocity, indicating that higher streaming energy enhances the development of unstable plasma modes.

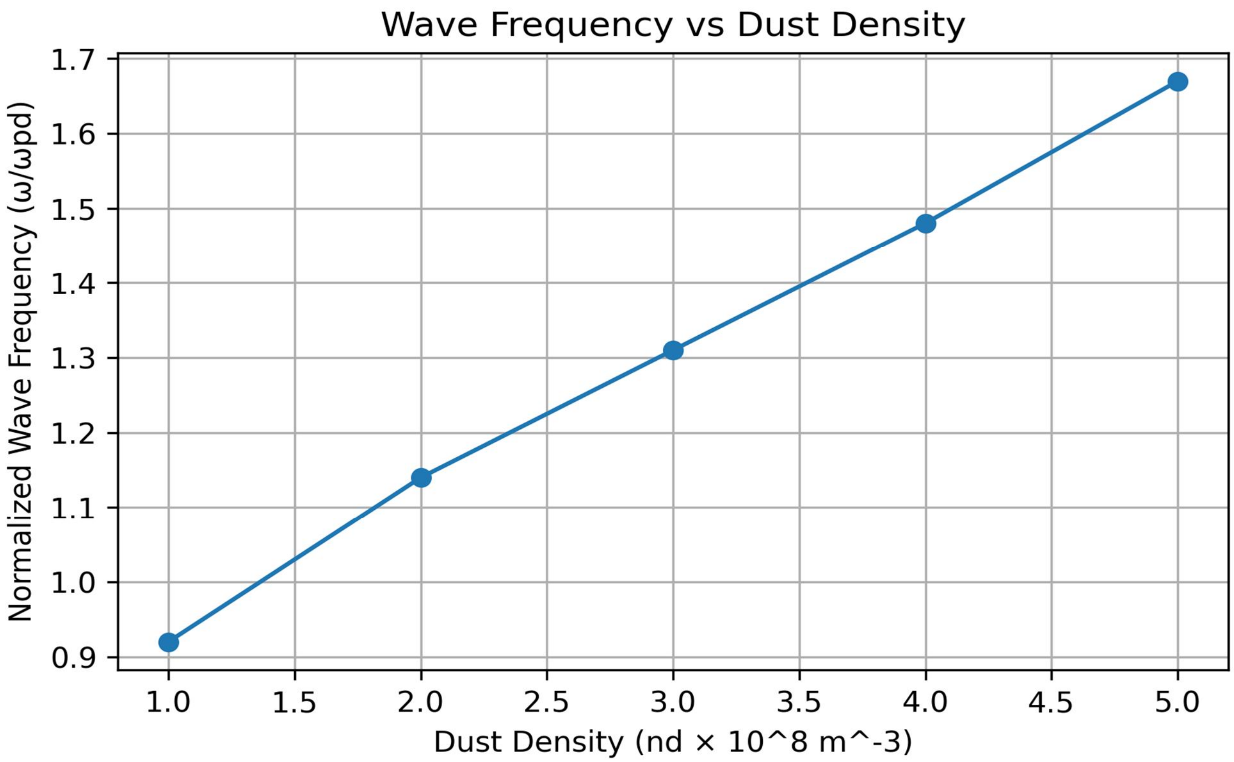


It is observed that the growth rate increases significantly with increasing streaming velocity. The relative motion between plasma species provides free energy for wave amplification, thereby promoting instability growth. Higher streaming velocities therefore enhance the destabilization of the plasma system (Rosenberg, 1993 [10]; Gary, 2015 [21]).

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue IX Sep 2026- Available at www.ijraset.com

C. Effect of Dust Density

Figure 3. Variation of normalized wave frequency (ω/ωpd) with dust density (nd). The wave frequency increases with increasing dust density due to enhanced collective interactions and modification of the dielectric properties of the plasma medium.



The effect of dust density on wave propagation characteristics was examined and is shown in Table 3.

Table 3. Variation of Wave Frequency with Dust Density

Dust Density (nd × 10^8 m^-3)	Wave Frequency (ω/ωpd)
1	0.92
2	1.14
3	1.31
4	1.48
5	1.67

The increase in dust density modifies the dielectric properties of the plasma and results in higher wave frequencies. The presence of additional charged dust grains enhances collective plasma interactions and alters the dispersion characteristics of the system (Rao et al., 1990 [8]; Verheest, 2000 [7]).

D. Influence of Quantum Effects

The role of quantum effects was investigated through the inclusion of Bohm potential and Fermi pressure. The variation of instability growth rate with quantum parameter H is shown in Table 4.

Figure 4. Variation of normalized instability growth rate (γ/ωpd) with quantum parameter (H). The growth rate decreases with increasing quantum parameter, indicating the stabilizing influence of Bohm potential and Fermi pressure in dense quantum dusty plasma.

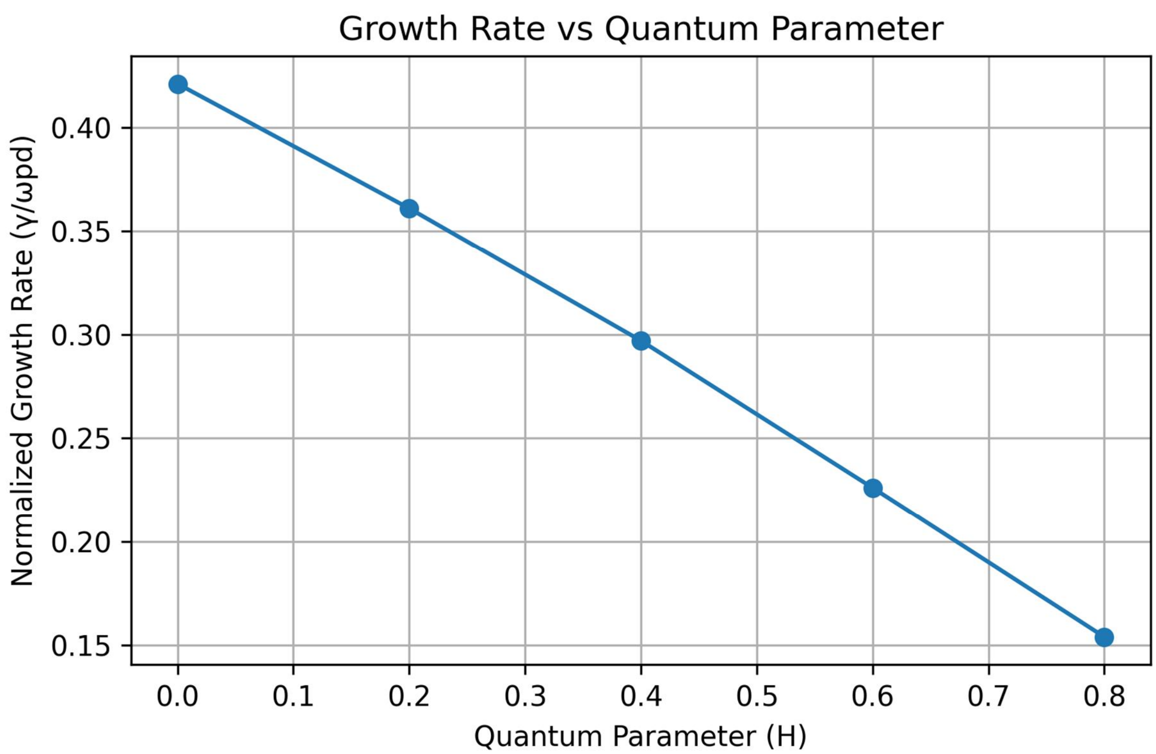


Table 4. Variation of Growth Rate with Quantum Parameter

Quantum Parameter (H)	Growth Rate (γ/ωpd)
0.0	0.421
0.2	0.361
0.4	0.297
0.6	0.226
0.8	0.154

The results indicate that quantum effects suppress instability growth. Bohm potential introduces additional dispersion while Fermi pressure enhances plasma stabilization. The combined effect reduces the growth rate of unstable modes (Haas, 2011 [23]; Shukla and Eliasson, 2011 [24])..

E. Comparison Between Classical and Quantum Models

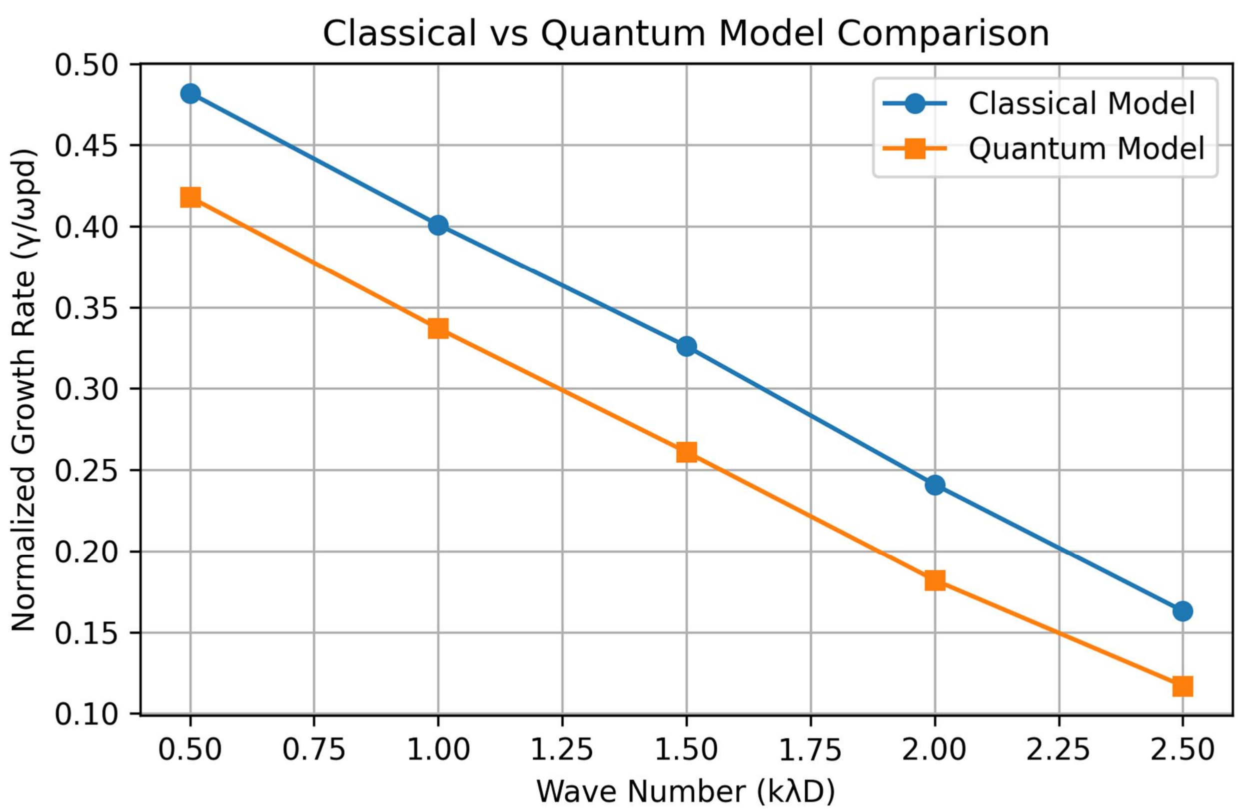
A comparison between classical magnetohydrodynamic and quantum magnetohydrodynamic models is presented in Table 5.

Table 5. Comparison of Instability Growth Rate

Wave Number (kλD)	Classical Model	Quantum Model
0.5	0.482	0.418
1.0	0.401	0.337
1.5	0.326	0.261
2.0	0.241	0.182
2.5	0.163	0.117

The quantum model consistently predicts lower instability growth rates compared to the classical model. This behaviour confirms the stabilizing influence of quantum corrections in dense dusty plasma systems (Manfredi, 2005 [22]; Akbari-Moghanjoughi, 2021 [25])..

Figure 5. Comparison of normalized instability growth rate predicted by classical and quantum models. The quantum model consistently predicts lower growth rates than the classical model, demonstrating the stabilizing influence of quantum corrections such as Bohm potential and Fermi degeneracy pressure



Overall, the results demonstrate that magnetic confinement and quantum effects contribute significantly to plasma stabilization, whereas increasing streaming velocity enhances instability growth. These findings provide useful insight into the control of streaming instabilities in fusion dusty plasma environments.

VI. CONCLUSION

This study investigated streaming instabilities in homogeneous fusion dusty plasma using a Quantum Magnetohydrodynamic (QMHD) framework. The analysis demonstrated that magnetic field strength and quantum effects play a significant role in controlling plasma stability, whereas increasing streaming velocity promotes instability growth. Variations in dust density were found to modify wave propagation characteristics and influence the overall instability behaviour.

The comparison between classical and quantum models showed that quantum corrections reduce the instability growth rate, highlighting the stabilizing effects of Bohm potential and Fermi degeneracy pressure. Overall, the findings improve the theoretical understanding of streaming instabilities in magnetized fusion dusty plasmas and provide a useful basis for future analytical, numerical and experimental investigations aimed at enhancing plasma confinement in fusion devices.

A. Acknowledgement

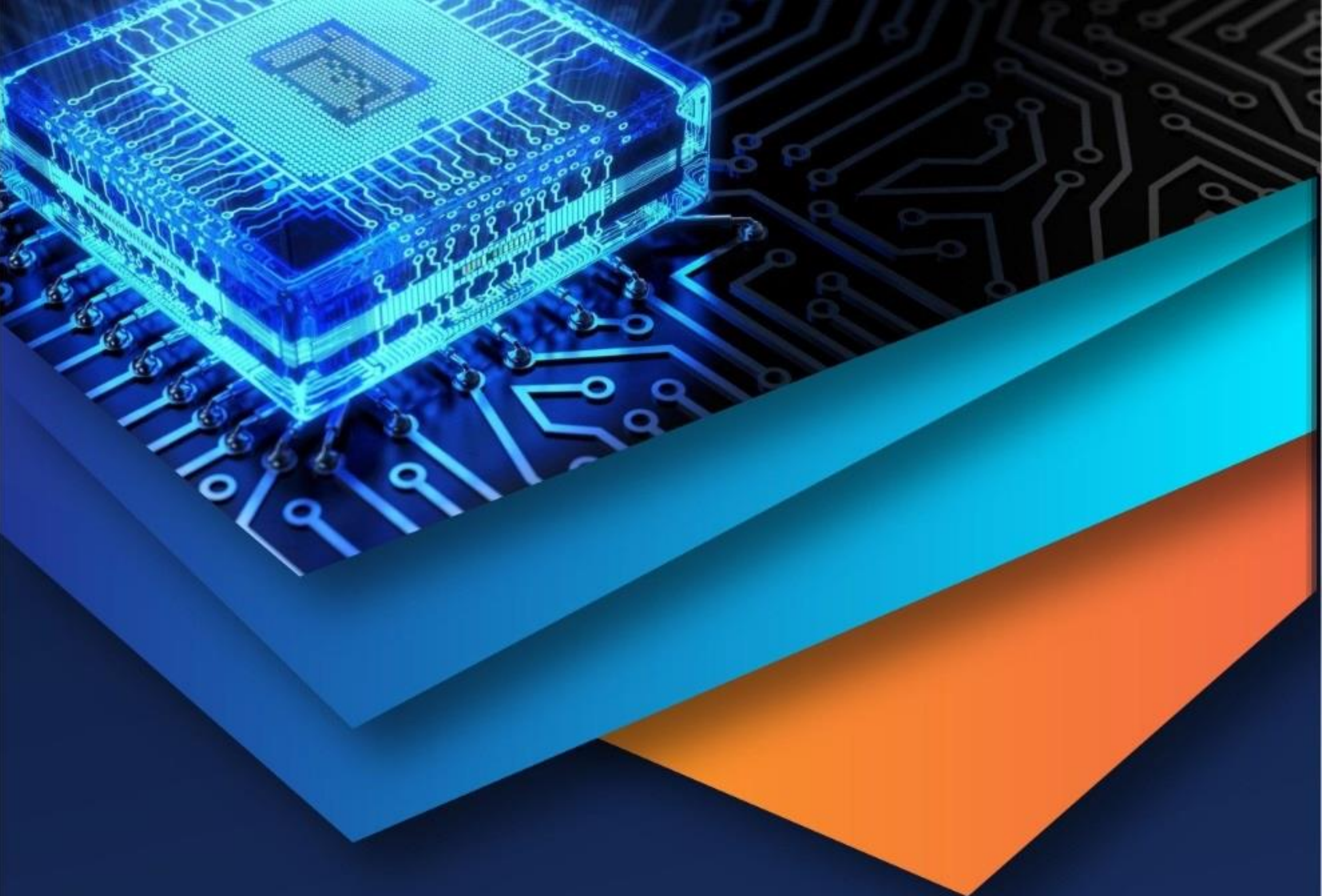
The authors are grateful to the Department of Physics, Jayoti Vidyapeeth Women's University, Jaipur, Rajasthan, India, for providing academic support and research facilities required for the completion of this work.

B. Conflict Of Interest

The authors declare that there is no conflict of interest regarding the publication of this research work.

REFERENCES

[1] Chen FF. Introduction to Plasma Physics and Controlled Fusion. 3rd ed. Cham: Springer; 2016.
[2] Bittencourt JA. Fundamentals of Plasma Physics. 3rd ed. New York: Springer; 2010.
[3] Krall NA, Trivelpiece AW. Principles of Plasma Physics. New York: McGraw-Hill; 1973.
[4] Nicholson DR. Introduction to Plasma Theory. New York: John Wiley & Sons; 1983.
[5] Goldston RJ, Rutherford PH. Introduction to Plasma Physics. Bristol: Institute of Physics Publishing; 1995.
[6] Shukla PK, Mamun AA. Introduction to Dusty Plasma Physics. Bristol: Institute of Physics Publishing; 2002.
[7] Verheest F. Waves in Dusty Space Plasmas. Dordrecht: Kluwer Academic Publishers; 2000.
[8] Rao NN, Shukla PK, Yu MY. Dust-acoustic waves in dusty plasmas. Planet Space Sci. 1990;38(4):543-546.
[9] Shukla PK, Silin VP. Dust ion-acoustic wave. Phys Scr. 1992;45(5):508-511.
[10] Rosenberg M. Ion and dust-acoustic instabilities in dusty plasmas. Planet Space Sci. 1993;41(3):229-233.
[11] Barkan A, Merlino RL, D'Angelo N. Laboratory observation of the dust-acoustic wave mode. Phys Plasmas. 1995;2(10):3563-3565.
[12] Fortov VE, Ivlev AV, Khrapak SA, Khrapak AG, Morfill GE. Complex (dusty) plasmas: current status, open issues, perspectives. Phys Rep. 2005;421(1-2):1-103.
[13] Morfill GE, Ivlev AV. Complex plasmas: an interdisciplinary research field. Rev Mod Phys. 2009;81(4):1353-1404.
[14] Federici G, Skinner CH, Brooks JN, Coad JP, Grisolia C, Haasz AA, et al. Plasma-material interactions in current tokamaks and their implications for next-step fusion reactors. Nucl Fusion. 2001;41(12):1967-2137.
[15] Winter J. Dust in fusion devices: a multifaceted problem connecting high- and low-temperature plasma physics. Plasma Phys Control Fusion. 2004;46:B583-B592.
[16] Krasheninnikov SI, Smirnov RD, Rudakov DL. Dust in magnetic fusion devices. Plasma Phys Control Fusion. 2011;53(8):083001.
[17] Krasheninnikov SI, Smirnov RD, Rudakov DL. Dust transport and dynamics in magnetic fusion devices. Nucl Fusion. 2020;60(7):076039.
[18] Wesson J. Tokamaks. 4th ed. Oxford: Oxford University Press; 2011.
[19] Goedbloed JP, Poedts S. Principles of Magnetohydrodynamics. Cambridge: Cambridge University Press; 2004.
[20] Swanson DG. Plasma Waves. 2nd ed. Boca Raton (FL): CRC Press; 2012.
[21] Gary SP. Theory of Space Plasma Microinstabilities. Cambridge: Cambridge University Press; 2015.
[22] Manfredi G. How to model quantum plasmas. Fields Inst Commun. 2005;46:263-287.
[23] Haas F. Quantum Plasmas: An Hydrodynamic Approach. New York: Springer; 2011.
[24] Shukla PK, Eliasson B. Colloquium: fundamentals of quantum plasmas. Rev Mod Phys. 2011;83(3):885-906.
[25] Akbari-Moghanjoughi M. Quantum plasma dynamics and applications. Contrib Plasma Phys. 2021;61(8):e202100018.
[26] Pandey BP, Vladimirov SV. Magnetized dusty plasma waves and instabilities. Phys Plasmas. 2007;14(8):083703.
[27] Bonitz M, Horing NJM, Ludwig P, editors. Introduction to Complex Plasmas. Berlin: Springer; 2010.
[28] Piel A. Plasma Physics: An Introduction to Laboratory, Space and Fusion Plasmas. Berlin: Springer; 2010.
[29] Landau LD, Lifshitz EM. Electrodynamics of Continuous Media. 2nd ed. Oxford: Pergamon Press; 1984.
[30] Ichimaru S. Statistical Plasma Physics. Boulder (CO): Westview Press; 2004.



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

TOGETHER WE REACH THE GOAL

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY