International Journal of Scientific Research in Science and Technology
Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)
doi : https://doi.org/10.32628/IJSRST229263

Study of Scattering of Non-Linear Wave in Dusty Plasma with Non-Thermal Ions

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Article Info
Volume 9, Issue 2
Page Number : 338-343

Publication Issue
March-April-2022

Article History
Accepted : 10 April 2022
Published : 21 April 2022

ABSTRACT

Research on Scattering of Non-Linear Wave has a wide applications and support - for Spectroscopic behavior of atomic modeling in terms of Plasma models. As the precision and scope of spectroscopic models has increased, the atomic modeling also has had to evolve. With a focus now on ITER and the dusty plasma with non-thermal ions. The characteristics of Dust- Acoustic Solitary Waves (DASWs) and Double Layers (DLs) are studied. Ions are treated as non-thermal and variable dust-charge is considered. The study in further extended to investigate the possibility of DLs. Only compressive DLs are permissible.

Keywords: Plasma Model, Acoustic Solitary Waves, Propagation Constant.

I. INTRODUCTION

In dusty plasma, a third charged species with diameter ranging from Nanometers to several hundred micrometers. The History, occurrence and characteristics of dusty plasmas in space and laboratory environments are well described and do cemented in recent publications. Collective processes such as low frequency mode in dusty plasma have received a great-deal of attention over plasms-20 years. The wave propagation along the azimuthal angle across an external axial steady magnetic field and is referred to as the azimuthal angle across an external axial steady magnetic field and is referred to as the azimuthal surface waves. In this work, we investigate the dispersion relations of azimuthal electromagnetic surface propagative perpendicularly in the same fashion.

II. METHODS AND MATERIAL

2.1. Configuration and General Equations

We consider an infinitely annular column of magnetized plasma with external and internal radii of R_i and R_a respectively surrounded by a cylindrical loss-free metal wave guide with-a cylindrical coaxial anisotropic dielectric wall with internal and external radii of R_d and R_e respectively.

Making use of Maxwell's equation to obtain the dispersive relation that we can obtain as follows-

$$\triangle \times B = \frac{1}{c}\frac{\partial}{\partial t} \ (\vec{\epsilon} E) \quad \text{---} \quad (1)$$

$$\triangle \times E = -\frac{1}{c}\frac{\partial}{\partial t} B \quad \text{---} \quad (2)$$

$$\triangle . \ B = 0 \quad \text{--} \quad (3)$$

$$\triangle . \ E = 0 \quad \text{--} \quad (4)$$

Where $\vec{\in}$ is the dielectric tensor and $\vec{E}$ and B are the perturbed values of electric and magnetic fields respectively. In general, in an electronic plasma with an axial external magnetic field, the relation between the dielectric tensorϵ_{jk} and the susceptibility tensor x_a of a plasma is given by,

$$\epsilon_{jk} = \epsilon_0 \ (\delta_{jk} + \chi_{jk})$$

Where

$$\chi_{jk} = \frac{-\omega_{jk}^2}{\omega^2(\omega^2 - \pi_e^2)} [\omega^2 s_{jk} - \pi_e^2 b_j b_k + i\omega\pi_r \varepsilon_{jk} b_i] \text{---------------------------}(5)$$

ω_{pe} is the electron plasma frequency Ω_2 is the electron cyclotron frequency, b_i is a component of $\vec{b}$ a unit vector $\hat{b}$ in the direction of B_0 and ε_{jki} is the leve - Civita tensor. In a magneto active cold plasma with $\vec{b}$ along the $\vec{z}$ director the dielectric tensor can have the following forms

$$\vec{\varepsilon} = \begin{pmatrix} \varepsilon_1 & ig & 0 \\ ig & \varepsilon_1 & 0 \\ 0 & 0 & \varepsilon_1 \end{pmatrix} \text{---}(6)$$

$$\text{Where, } \varepsilon_\perp = 1 - \frac{\omega^2 \mu c}{\omega^2 \Omega_c^{\ 2}}$$

$$\varepsilon_1 = 1 - \frac{\omega_{pe}^{\ 2}}{\omega^2}, g = \frac{-\omega_{pe}^{\ 2}\Omega_e}{\omega(\omega^2 - \Omega^2{}_e)}$$

For an ideal waveguide oriented along the z axis the dielectric tensor is only a function of the transfer coordinates i.e. $\overrightarrow{\varepsilon_d} = \overrightarrow{\varepsilon_d}(r.\psi)$,

$$\text{Where} \qquad \overrightarrow{\varepsilon_d} = \begin{pmatrix} \varepsilon_{id} & 0 & 0 \\ 0 & \varepsilon_{id} & 0 \\ 0 & 0 & \varepsilon_{id} \end{pmatrix} \quad \text{----------------------------} \quad (7)$$

Here, we assume that $\varepsilon_{\perp d}$ and ε_{id} are constant. In the linear approximation, the perturbed fields B and E are assumed to be monochromatic plane waves.

$$B\ (r.\Psi\ z,\ t) = \sum_{i=1}^{3} \hat{e}_i B_i(r)\exp[-i(\omega t - k_j z - m\psi)]..$$

$$E\ (r.\Psi\ z,\ t) = \sum_{i=1}^{3} \hat{e}_i E_j(r)\exp[-i(\omega t - k_j z - m\psi)].$$

$$E\ (r.\Psi\ z,\ t) = \sum_{i=1}^{3} \hat{e}_i E_i(r)\exp[-i(\omega t - k_j z - m\psi)].. \text{--------------------------}(8\text{-}10)$$

Here $\overrightarrow{\varepsilon_i}$ is a unit vector in cylindrical coordinates (4) and m is an integer. But substituting (9) and (10) into equation (6) and (7). The system of equation describing the general behavior of electric and magnitude fields in this geometry

$$\left(x^2 + \frac{g^2\omega^2}{\varepsilon_1^2 c^2}\right)\nabla_1^2 E_z - E\frac{E_1}{E1}E_z = ik_z \frac{w}{c}\frac{g}{\varepsilon_1}\nabla_1^2 E_z \quad \text{-------------------------}(11)$$

$$x^2\nabla_1^2 B_z - B_z = ikz\frac{w}{c}g\,\nabla_1^2 E_z$$

Where, $x^2 = k^2z - \quad E_1\frac{w^2}{c^2}, E = x^4 - q^2\frac{w^2}{c^4}$

and the transverse Laplacian operator is given by,

$$\nabla_1^2 = \left(1\!\!\diagup\!2\right)\left(d\!\!\diagup\!dr\right)r\left(d\!\!\diagup\!dr\right) - \frac{m^2}{r^2} \qquad \text{--(12)}$$

2.2. Elementary processes in dusty plasmas

Changing of dust particles in plasmas different processes leading to the charging of dust particles immersed in plasmas are considered. Expressions for the ion and electron fluxes to the particle surface caused by different processes (collection of plasmas electrons and ions secondary, Thermionic and photo electric emission of electrons from the particle surface are given problems such as stationary surface). Potential kinetics of charging of plasma charge composition in response of fluctuations due to the stochastic nature of charging process are considered more detailed examination of charging processes can be found. We mostly focus on the processes which are important for the problems addressed in the present review.

2.3. Charging in gas discharge plasma

In a non-equilibrium plasma of law reassume gas discharge the ions, atoms and microscopic charged particle typically remain cold, whilst of electron energies are relatively high, Due to high immobility of the electron their flux begins to charge on the particle leads to the repulsion of electron and ion fluxes are balanced negatively. The emerging negative charge on the particle leads to the repulsion of the electron and ion fluxes are balanced on longer experiences only small inflections around its equilibrium value.

The stationary surface potential of the dust particle is defined as$\Psi_3 = -T_e/e$ where T_e is the electron temperature in energy units. Physically this can be explained by the requirement that in the stationary state most of the electron should have kinetic energies to overcome the potential barrier between the particle surface and surrounding plasmas.

2.4. Orbit motion limited approximation

For a quantitative description of the particle charging in gas discharge plasmas probe theory is generally adopted. One of most frequently used approaches is the orbit motion limited (OML) Theory. This approach only from the laws of conservation of energy and angular momentum. Usually, the conditions of applicability of the OML Theory are formulated

$$a \ll \lambda_D \ll lge$$

Where λ_D is the plasma screening length (The corresponding Debye radius) and li(e)is the mean free path of the ions (electrons). It is also assumed that the dust-particle is isolated in the sense that other dust particles do not affect the motion of electrons and ions in its vicinity. Electron and ion fluxes to the particle surface are determined by the integration of the corresponding cross sections with velocity distribution function fe (j) (u)

$$Ie(i) = Ha(i)\int VCT\,e(i)\ fe(i)\,d^3v$$

Where he (i) is the electron (ion) number density for the Maxwell an velocity distribution of plasma particles vi_3

$$\int e(ij)(v) = \left[2\pi v^2 Te(i)\right]^{-3/2} \exp.\left(-\frac{v^2}{2v^2 Telj}\right)$$

Where, $v_{je}(i) = \sqrt{\frac{Te(j)}{me(i)}}$

is the electron (ion) thermal velocity, the integral in equation (9) performed with the use of formula as. The equilibrium surface potential is then determined by.

$$\exp(-Z) = \frac{\mu}{\tau}(1 + z\tau)(1 + p)$$

Whereas dimensions less parameters

P = $|Z_d|\frac{nd}{ne}$ determines the ratio of the charge residing on the doubt components to that on the electron component. The particle charge tends to the charge of an isolated particle where p ≤ 1, which for P > 1 it is reduced considerable is stead of expression. The quantity $\alpha T^{-2}{}_{e(\frac{x_d}{n_e})}$ is used, which differs from P by the numerical factor 1/z.

$$t^1 - \frac{Wpi}{\sqrt{2\pi}}\left(\frac{\alpha}{\lambda pi}\right)t$$

3.1. Applicability of the orbit motion limited approach

The point is that the motion of the ions approaching the dust particle is determined by the flectional interaction potential U_{eff} which in addition to the attractive electro state potential v(r) between positive ion and negatively charged particle contains a component associated with the certain fungal repulsion due to ion angular moment conservation. The effective potential normalized on the ion kinetic energy = $m_1 \frac{v^2{}_1}{2}$ is given by U_{eff} (r,ρ)Where ρ is the impact parameter and v(r) < 0 for a given row ρ, the distance r_0 at which U_{eff} (r_o. ρ) = 1 corresponds to the distance of the closest approach between the ion and the dust particle.

3.2. Kinetics of dust particle charging

The kinetic equation for dust particle charging is plasma in written as follows,

$$\frac{dZ_d}{dt}\sum_j I_{j=I}$$

Where the summation is made over all the fluxes Ij of charged particle collected or emitted by the dust particle in determined from the condition dZ_d/dt = o let us consider particle charging in the absence of emission processes. In so during we use the standard equations

Where $\lambda_{Di} = \sqrt{Ti/\left(4\pi e^2 ni\right)}$ in the ionic Debye radius and Wpi =$VT_i/\lambda D_i$ is the ion plasma frequency we qet instead of the following equation.

$$\frac{dz}{dt} = \frac{1}{\sqrt{\mu T}}\left[\exp(-z) - \left(\frac{\mu}{z}\right)^{\frac{1}{2}}(1 + \tau z)\right]$$

Combined with the initial condition Z(t* = 0) This equation allows m to determine the stationary value of the particle charge z = z($(\tau\mu)$ for$t \to \infty$ and the characteristic time of charge t from the uncharged state.

Notice coincides with equation for $n_e = n_{i.}$ let us define the charging frequency Ω the inverse charging time as the retardation frequency for a small deviation from the stationary

$$\Omega_{th} = \frac{dl}{dz_d}/zdo$$

3.3. Interaction between dust particles in plasma

The potential of interaction between dust particles differs from the coulomb interaction potential between charged particles in a vacuum. When the electrostatic potential distribution ψ(r) in a plasma surrounding a test particle is known. The absolute value of the electrostatic force acting on a particle with a fixed charge Z_d and located at a distance r from the test-particle can be presented in the forum F_{de} = -d U_{el}®/dr, where

$$U\ el(r) = Z_d\ e\psi(r)$$

Thus, it is necessary to know the distribution ψ(r) of the potential in plasma, As was previously, the potential of an isolated spherical particle in an isotropic plasma in purely columbic at small distances for r << λ_D for r≈ λ D, The screening is important and the Debye – Hockel form can be after used, the potential has an inverse power law asymptotic to λ_D it is reasonable to use a screened columbic type of the potential

Uel (r) = $\frac{z^{2e}6^s}{r} exp.(-\frac{r}{\lambda_D})$

Different additional mechanism governing attraction and repulsion between the dust particles can exist as a consequence of the openers of dusty plasma systems. The continuous flow of plasma electrons and ions on the surface of a dust particle leads to a drag experience by neighboring particles.

3.4. Strongly coupled dusty plasmas and phase transitions

The conditions which can be realized industry plasma are quite diverse and depend on relations among. Their characteristics of a many, particle in terracing. System is the coupling parameter F defined as the ratio of the potential energy of interaction between neighboring particles to their kinetic energy

$\tau = \frac{Z^2e^2}{T\Delta}$, where $\Delta = n^{-1/3}$ characterizes the average inter particle spacing and T characterizes their kinetic energy. The conditions typical of dusty plasma experiments, the number of electrons (ions) $N^D_{e(j)}$ in the electron (ion) Debye sphere in large $N^D_{e(j)}$ = $ne(j)\lambda^3_{De}(j)^1$ >>1and hence electron and ion species are ideal

III. RESULTS AND DISCUSSION

Measurements were carried out for the spatial distribution of the degree of linear and circular polarization at the defector for a set of scattering samples having the same scatter size but varying. me show the value for degree of polarization at the pixel corresponding to the center of the ballistic beam as a function of $\sum$ for two samples, prepared using guerdons suspension of o.+I μ_m diameter.

This is consistent with the observed similar FWHM of spatial spread of degree of polarization for these isotropic scattering samples. The measured spatial distribution of degree of circular polarization for samples with agendum suspension variations of the measured degree of polarization, for larger scattering angles degrees of circular polarization is lower for the scatter having a lower value of refractive index scatters as compared to the scattered having a higher refractive index. These results would indicate that for these anisotropic scattering samples, polarization state can be used to filler out the multiply scattered photons. The reason for this difference in scattering behaviors originates from the difference in the value of the scattering matrix elements of two scattering samples having the same refractive index of the surrounding medium, but indices of scatters. The scattering matrix element S_Q as a function of scattering angle for these two scattered and for a Rayleigh scattered.

IV. CONCLUSION

Despite a history spanning nearly a century. The investigation of dusty plasma has acquired particular attention only during the last decade. The understanding of the observed effects is in possible without a detailed investigation such as particle charging, interaction between the particles, the main forces acting on the particle one of the most important application problem is the removal of dust particle when manufacturing computer chips by plasma, aided technologies our study short that for different samples prepared using larger sized scatters (a ≥ λ, g ≥ 0.7), scattering of both linearly and circularly polarized light significantly affected by the refractive index of scatters. While for larger scatters with higher value of refractive index, linearly polarized high depolarized much faster than circularly polarized light was observed for scatters. It appears that the difference in the relative refractive index ratio would be an important factor contributing to the differences observed in the relative behavior of scattering of linearly and circularly polarized light.

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Cite this article as :

Mukesh Kumar, K. B. Singh, "Study of Scattering of Non-Linear Wave in Dusty Plasma with Non-Thermal Ions", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 9 Issue 2, pp. 338-343, March-April 2022. Available at doi : https://doi.org/10.32628/IJSRST229263
Journal URL : https://ijsrst.com/IJSRST229263