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VARIATION OF DAMPING LENGTH AND WAVELENGTH IN NORTH POLAR CORONAL HOLES OF SOLAR ATMOSPHERE

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ABSTRACT :

In the present paper, I would like to discuss about variation of damping length and wavelength in the region of 1.05R⊙ to 1.35R⊙ and in different cases like (i) Magnetic diffusivity only (ii) viscosity only and (iii) when both are present. It shows that Comparison of the fast and slow modes explicitly shows that the damping length as well as the wavelength for the fast-mode waves is much larger than those for the slow-mode waves.

INTRODUCTION:

The role of magnetohydrodynamics (MHD) waves has been discussed extensively in solar physics for understanding the outstanding problems of solar coronal heating and the solar wind accelerationMechanisms[1]. For derivation of dispersion relation we have to consider following MHD equation

$$\rho\frac{\partial v}{\partial t}+\rho(v\cdot\nabla)v=\frac{1}{\mu}(\nabla\times B)\times B+\rho\upsilon\nabla^2 V \qquad (1)$$

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

$$\nabla\cdot B=0 \qquad (3)$$

The equations (1), (2) and (3) are known as momentum equation, Induction equation and Magnetic flux conservation equation respectively. Where v is the velocity, B the magnetic field and ρ, μ,η, V are, respectively, the mass density, Magnetic permeability, magnetic diffusivity and the coefficient of viscosity.

Taking the perturbations from the equilibrium (Priest [2]) and linearize the equations (1) through (3) by neglecting squares and products of the small quantities. After solving above equations we get a dispersion relation as follows

$$\omega^2=k^2\left[v_A^2-i\omega(\upsilon+\eta)\right]+\upsilon\eta k^4 \qquad (4)$$

Where $V_A = B_0/(sqrt\{\mu\rho_0\})$ is the Alfven velocity. The dispersion relation was obtained by Pekunu et al. [3] &Kumthekar [4] . This dispersion relation is applied for the plasma in the North Polar Coronal Hole where assumed the angular frequency ω to be a real quantity and the wave number *k* as a complex quantity.

RESULT AND DISCUSSION:

For a given value of ω = 2π/τ and the physical parameters discussed in the Kumthekar [3] and solved with the help of a FORTRAN program. I assumed the angular frequency ω to be a real quantity and thewave number k as a complex quantity so that $k = kr + iki$. When both the $kr$and $ki$are positive numbers, they are related to the damping length D and the wavelengthλ of the wave as Chandra et al. [5]

$$D = \frac{2\pi}{k_i} \quad and \quad \lambda = \frac{2\pi}{k_r}$$

Equation (4) is a simple quadratic equation it can be solved for getting roots of equation. This equation can be studied for three cases (i) Magnetic diffusivity only (ii) viscosity only and (iii) when both are present.

Case I: Magnetic diffusivity:

Let us consider the case of magnetic diffusivity only. That is, there is no viscosity ($\upsilon = 0$). For this case, equation (4) gives $kr$and kivalues. Then we can apply a condition $\omega \ll v_A^2$, we get

$$k_r = \frac{\omega}{v_A} \quad and \quad k_i = \frac{\omega^2}{2v_A^3}$$

Thus, we have two roots; one with positive values of kr and ki, and the other with the negative values. For the positive values, the damping length D and wavelength λ are calculate as a function of R, for $\tau = 10^{-2}$ s, 10^{-3} s and 10^{-4} s and are given in Fig.1 (a). As from the expressions, here the damping length is much larger than the wavelength. While D shows a large variation, with a maximum around 1.2R$\odot$, the λ remains nearly constant. Fig.1 (a) shows that the wavelength is proportional to τ whereas the damping length is proportionalto τ^2.

Case II: Viscosity only:

Let us consider the case of viscosity only. That is, there is no magnetic diffusivity ($\eta = 0$). For this case, equation (4) gives $kr$and kivalues. Then we can apply a condition $\omega\upsilon \gg v_A^2$, we get

$$k_r = \frac{\sqrt{\omega}}{\sqrt{2\upsilon}} and k_i = \frac{\sqrt{\omega}}{\sqrt{2\upsilon}}$$

Again, we have two roots; one with positive values of kr and ki, and the other with the negative values. For the positive values, the damping length D and wavelength λ are calculate as a function of R, for $\tau = 10^{-2}$ s, 10^{-3} s and 10^{-4} s and are given in Fig.1 (b).

As from the expressions, as long as $\omega\upsilon \gg v_A^2$, the damping length and the wavelength are equal to each other. There is a maximum around 1.2$R\odot$. It is the case for $\tau = 10^{-3}$ s and 10^{-4} s. But, for $\tau = 10^{-2}$ s, the D and λ differ slightly from each other, showing that the condition $\omega\upsilon \gg v_A^2$ is not satisfied here. There is a maximum around 1.2$R\odot$.

Case III: Both are Present $\upsilon \neq 0$ and $\eta \neq 0$.

Equation (4) is a quadratic equation in k2 and therefore, its roots are of the form of two pairs: ±(kr1 +iki1) and ±(kr2 +iki2). These two pairs for the roots correspond to the fast-mode and slow-mode waves. The damping length D and wavelength λ for the two modes as a function of R for $\tau = 10^{-2}$ s, 10^{-3} s and 10^{-4} s are shown in Fig. 2. It is interesting to note that the variationof D and λ for the fast-mode wave is similar to that for the case of $\eta = 0$. Theslow-mode wave shows an opposite behaviour for the variation of D as well as λ. There is a minimum around *1.2R*$\odot$.Here, also, D is nearly equal to $\lambda$for $\tau = 10^{-3}$ s and 10^{-4} s. But, for $\tau = 10^{-2}$s , the D and λ differ slightly fromeach other. Comparison of the fast and slow modes explicitly shows that the damping length as well as the wavelength for the fast-mode waves is much larger than those for the slow-mode wave. Thus, the slow-mode waves cannot propagate through the corona.

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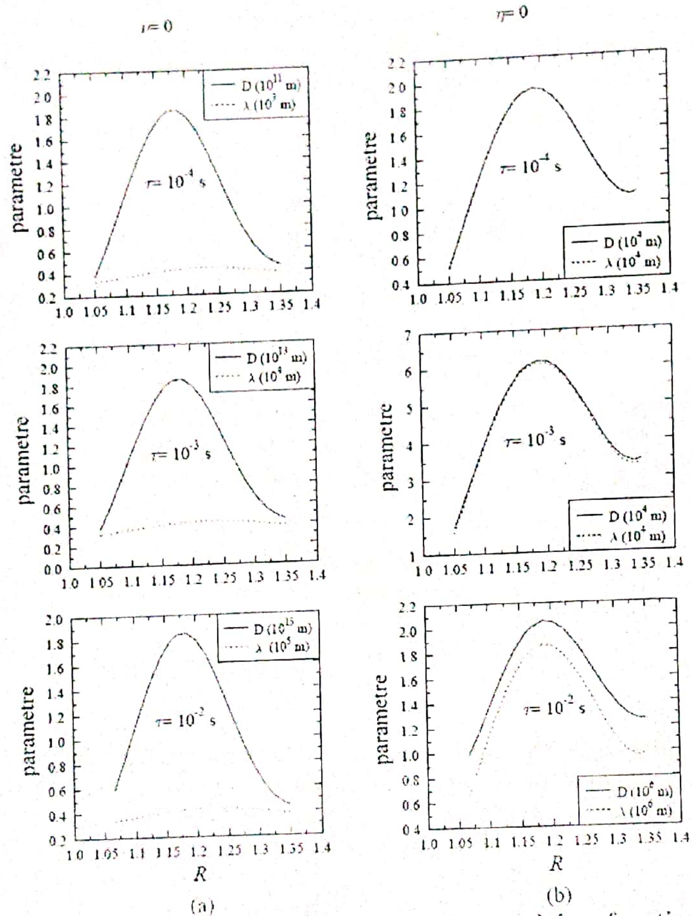

Fig. 1:Variation of damping length D and the wavelength λ as function of R for $\tau = 10^{-2}$ s, 10^{-3} s and 10^{-4} s for two cases υ=0 and η =0.

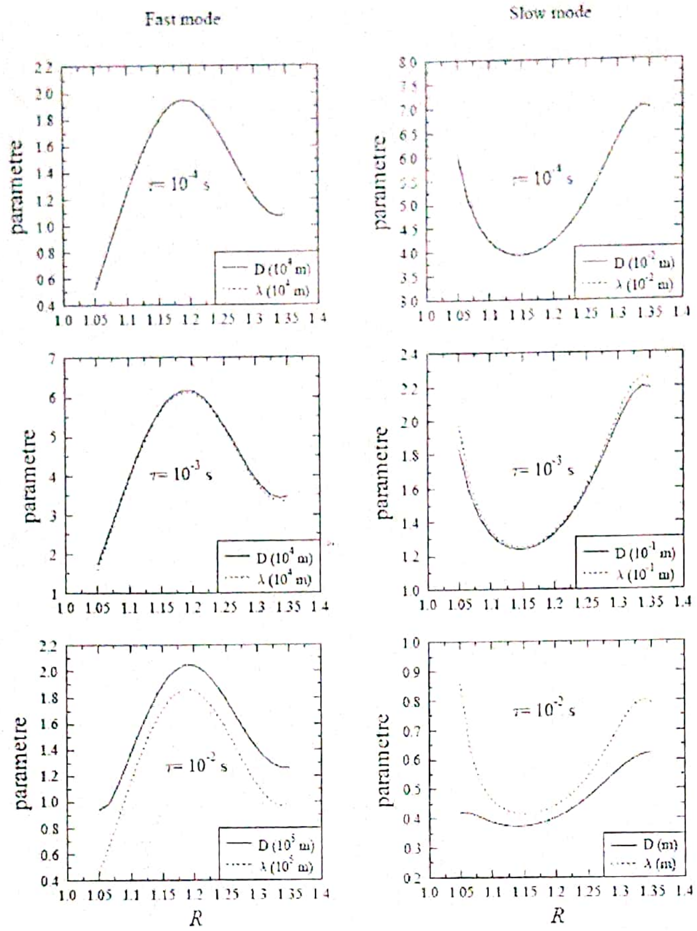

Fig. 2:Variation of damping length D and the wavelength λ for fast mode and slow mode waves as function of R for $\tau = 10^{-2}$ s, 10^{-3} s and 10^{-4} s for two cases $\nu \neq 0$ and $\eta \neq 0$.

REFERENCES:

[1] E N Parker *Space Sci Rev*, 4, 666 (1965)

[2] E R Priest Solar Magnetohydrodynamics. (Dordrecht, Holland: D. ReidelPublishing Company) (1982)

[3] E R Pekunlu, Z Bozkurt, M Afsar, E Soydugan and F Soydugan Mon Notices Roy AstronSoc, 336, 1195 (2002)

[4] B. K.Kumthekar, International Journal of Innovative Science, Engineering & Technology, (IJISET) Vol. 4 Issue 6, (2017)

[5] Chandra S, B. K. Kumthekar& G. M. Dak, Indian Journal of Radio & Space Physics (IJRSP) 39, (2010)

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