

2010 Day 2 Question 1 (Waves)

1.  ~~$N \times (N \times \vec{E})$~~   $N_i N_j - N^2 \delta_{ij} + \epsilon_{ij} = 0$  in general  
 (i) resonance is necessary (but not sufficient) condition for electrostatic wave.  
 no resonance (see para 2.)  $\rightarrow$  not electrostatic

2. Rewrite  $N_L^2 = \frac{zc^2}{v_e^2} \frac{\omega p_e^2}{\omega p_i^2} \left( 1 - \frac{\Omega_i^2}{\omega^2} \right)$

No choice of  $\omega$  will lead  $N_L^2 \rightarrow \infty$ .

Thus there is no resonance.

3. Easily see cutoff at  $\omega^2 = \Omega_i^2$ .

$\omega^2 < \Omega_i^2$  normal propagation ( $N_L^2 > 0$ )

$\omega^2 < \Omega_i^2$  must have  $N_L^2 < 0$ ,

Crossover between propagation and attenuation gives cutoff.