electromagnetism  $\rightarrow$  wave propagation

## **Plasma Ionization Waves**

Electrons (of charge  $-q_e$ ) are approximately excited in a plasma according to the PDE

$$\frac{\partial n}{\partial t} = \gamma N |\mathbf{E}| + D \nabla^2 n$$

where  $n(\mathbf{x}, t)$  describes the number density of electrons, **E** is the electric field, *D* is a diffusion constant, *N* is the number density of neutral atoms and  $\gamma$  is a coefficient describing how ionizable the neutral atoms are.

- (a) Use Gauss' Law to relate E and  $\rho$ , and find the dispersion relation for ionization waves.
- (b) In what limit is the diffusion term negligible?
- (c) Assuming that diffusion is negligible, show that  $v_{\rm p} = -v_{\rm g}$ .