$$\vec{\nabla}\times\vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t} \qquad \vec{\nabla}\cdot\vec{D} = \rho$$

$$\vec{\nabla}\times\vec{E} = -\frac{\partial \vec{B}}{\partial t} \qquad \vec{\nabla}\cdot\vec{B} = 0$$

$$\vec{D} = \varepsilon_0\vec{E} + \vec{P} = \varepsilon\varepsilon_0\vec{E}$$

$$\vec{B} = \mu_0\vec{H} + \vec{M} = \mu\mu_0\vec{H}$$

In vacuum

$$\nabla^2\vec{E} = \varepsilon_0\mu_0\frac{\partial^2\vec{E}}{\partial t^2} \quad \Rightarrow \quad \vec{E}(\vec{r},t) = \vec{E}_0 e^{i(\vec{q}\cdot\vec{r} - \omega t)}$$

$$\frac{\omega}{q} = c = \frac{1}{\sqrt{\varepsilon_0\mu_0}}$$

In a solid?

$\vec{P} \neq 0 \qquad \vec{P} = \varepsilon_0\chi\vec{E}$ in 1st order

$$\vec{D} = \varepsilon_0\vec{E} + \vec{P} = \varepsilon_0(1+\chi)\vec{E} = \varepsilon\,\varepsilon_b(\omega)\vec{E}$$

bound

$\vec{J} = \sigma(\omega)\vec{E}$ σ is the conductivity

$$\vec{\nabla}\times\vec{\nabla}\times\vec{E} = \nabla^2\vec{E} - \vec{\nabla}(\vec{\nabla}\cdot\vec{E}) = \varepsilon_b\varepsilon_0\mu_0\frac{\partial^2\vec{E}}{\partial t} + \sigma\mu_0\frac{\partial\vec{E}}{\partial t}$$

$$q^2\vec{E} - \vec{q}(\vec{q}\cdot\vec{E}) = \varepsilon_b\varepsilon_0\mu_0\omega^2\vec{E} + i\sigma\mu_0\omega\vec{E}$$

$$= \omega^2\varepsilon(\omega)\varepsilon_0\mu_0\vec{E} \qquad \varepsilon(\omega) = \varepsilon_b(\omega) + i\frac{\sigma(\omega)}{\varepsilon_0\omega}$$

$$\vec{E} = E_t\hat{t} + E_q\hat{q}$$

$$\left(q^2 - \frac{\omega^2}{c^2}\varepsilon(\omega)\right)E_t\hat{t} - \frac{\omega^2}{c^2}\varepsilon(\omega)E_q\hat{q} = 0$$

$$q^2 = \frac{\omega^2}{c^2}\varepsilon(\omega) \qquad \varepsilon(\omega) = 0$$

generalized dispersion relation

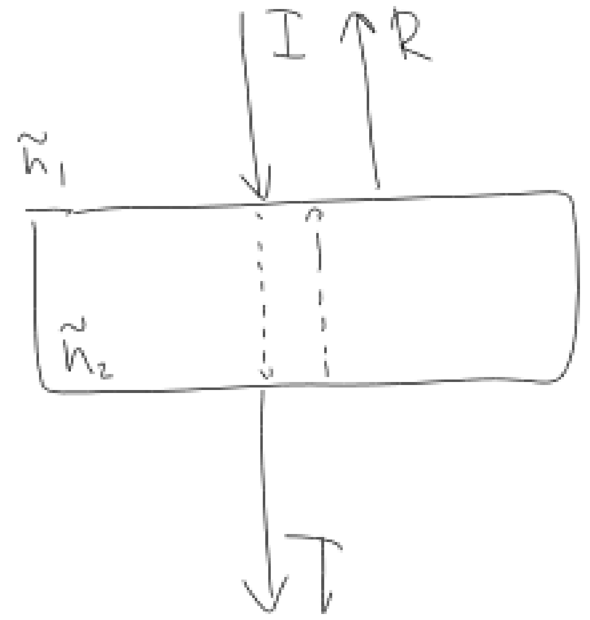
condition for longitudinal waves to exist

$\tilde{n} = n + ik = \sqrt{\varepsilon(\omega)}$

k : extintion coeff.

$n = c/v$

$\hookrightarrow \vec{E} = \vec{E}_0 e^{-k q_0 z} e^{i(n q_0 z - \omega t)}$ $q_0 = \frac{\omega}{c}$



at normal incidence

$$r = \frac{E_r}{E_i} = \frac{\tilde{n}_1 - \tilde{n}_2}{\tilde{n}_1 + \tilde{n}_2}$$

$$t = \frac{E_t}{E_i} = \frac{2\tilde{n}_1}{\tilde{n}_1 + \tilde{n}_2}$$

$R = r r^*$ $T = t t^*$

In air $\tilde{n}_1 = 1 + i \cdot 0$

$\downarrow$

$$R = \frac{(n-1)^2 + k^2}{(n+1)^2 + k^2}$$