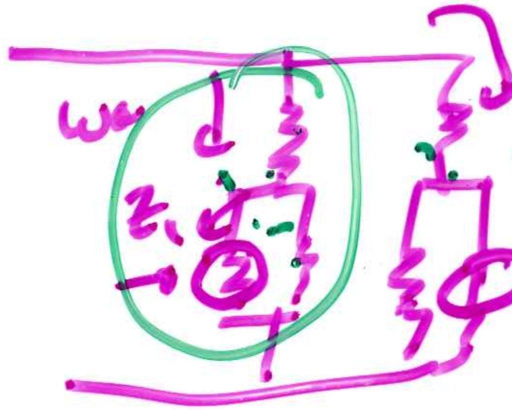
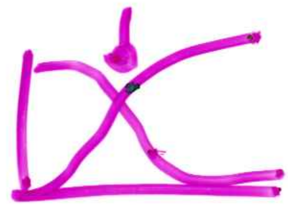
BP → E





Thu → Mond

Help
4:15
Friday

L

$$\frac{1}{Z} = \boxed{\frac{1}{Z_1}} + \frac{1}{Z_2}$$

Real (in phase) R

doesn't dep on ω

$L, C, R, \omega > 0$

$X = i\omega L = \frac{1}{i\omega C}$

$$\boxed{Z_1 + \text{Evaluate}[Z_1, \omega \to -\omega]}$$

$\omega \to -\omega^*$

$$Z_1 + Z_1^* = \underbrace{2\,\mathrm{Re}\,Z}_{2a}$$

$a+ib \quad a-ib$

$$IV = \mathrm{Re}[I]\,V \qquad \frac{V}{Z}$$

$$= \mathrm{Re}\left[\frac{1}{Z_1}\right] V^2$$

$$\mathrm{Re}\left[\frac{1}{Z_1}\right] = \mathrm{Re}\left[\frac{1}{Z_2}\right]$$

$$\begin{matrix} E \\ H \end{matrix} = \begin{matrix} E_0 \\ H_0 \end{matrix} e^{i(\vec{K}\cdot\vec{r}-\omega t)} \qquad \begin{matrix} \vec{K}\cdot\vec{E}_0 = 0 \\ \vec{K}\cdot\vec{H}_0 = 0 \end{matrix} \qquad \begin{matrix} \vec{K}\times\vec{E}_0 = \omega\mu\vec{H}_0 \\ \vec{K}\times\vec{H}_0 = -\omega\varepsilon\vec{E}_0 \end{matrix}$$

"transverse"

compare magnitudes

$$E_0 = \frac{\omega}{K}\mu H_0 = V_p \mu H_0$$

$$H_0 = \frac{\omega}{K}\varepsilon E_0 = V_p \varepsilon E_0$$

$$\Rightarrow V_p^2 = \frac{1}{\mu\varepsilon}$$

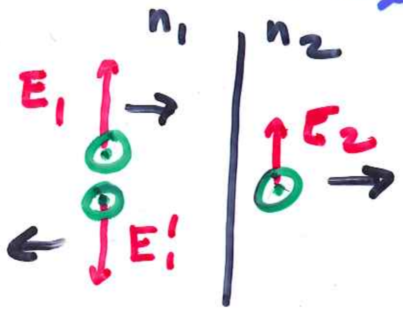
$$c = \frac{1}{\sqrt{\varepsilon_0\mu_0}}$$

$$n = \frac{c}{V_p} = \sqrt{K_\varepsilon K_\mu}$$

K_μ → 1 as $\mu = \mu_0$

$$\vec{S} = \overrightarrow{E\times H} = V_p\varepsilon E^2 = \frac{1}{V_p\mu}E^2 = \frac{n}{c\mu}E^2$$

$$\langle S\rangle = \frac{1}{2}\frac{n}{c\mu}E_0^2$$



$$E_1 - E_1' = E_2$$

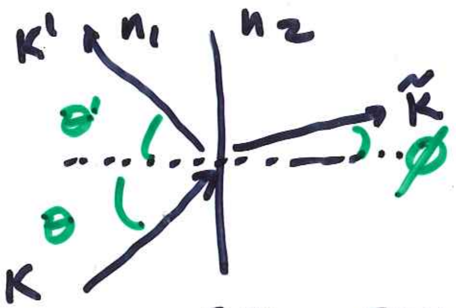
$$B_1 + B_1' = B_2$$

$$n_1(E_1 + E_1') = n_2 E_2$$

as $B = \frac{1}{V_p}E = \frac{n}{c}E$

$$\frac{E_1'}{E_1} = \frac{(n_2 - n_1)}{(n_2 + n_1)}$$

Note: $n_2 > n_1$
⇒ inversion
4% for glass



$$K = \frac{2\pi}{\lambda} = \frac{2\pi n f}{c}$$

Any consistent BC $\omega_1 = \omega_2$

→ $n\lambda$ = constant

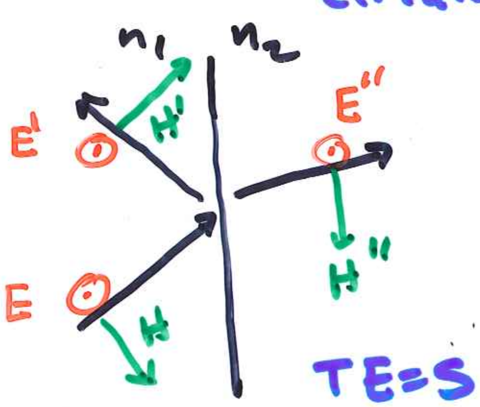
∥ Component of K's equal

$$K\sin\theta = K'\sin\theta' = \tilde{K}\sin\phi$$

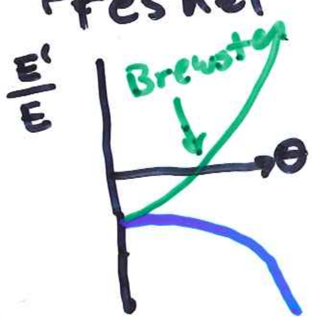
$\theta = \theta'$ $\qquad n_1 \sin\theta = n_2 \sin\phi$

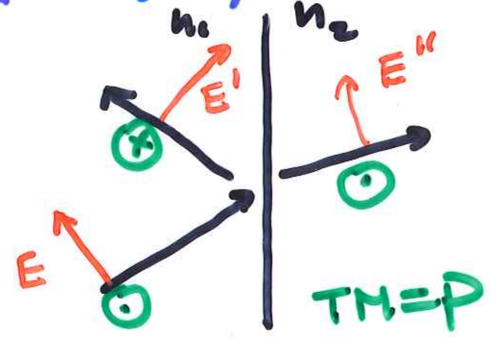
polarization: linear : E fixed direction ⊥ K

circular: E fixed length, rotates



Fresnel





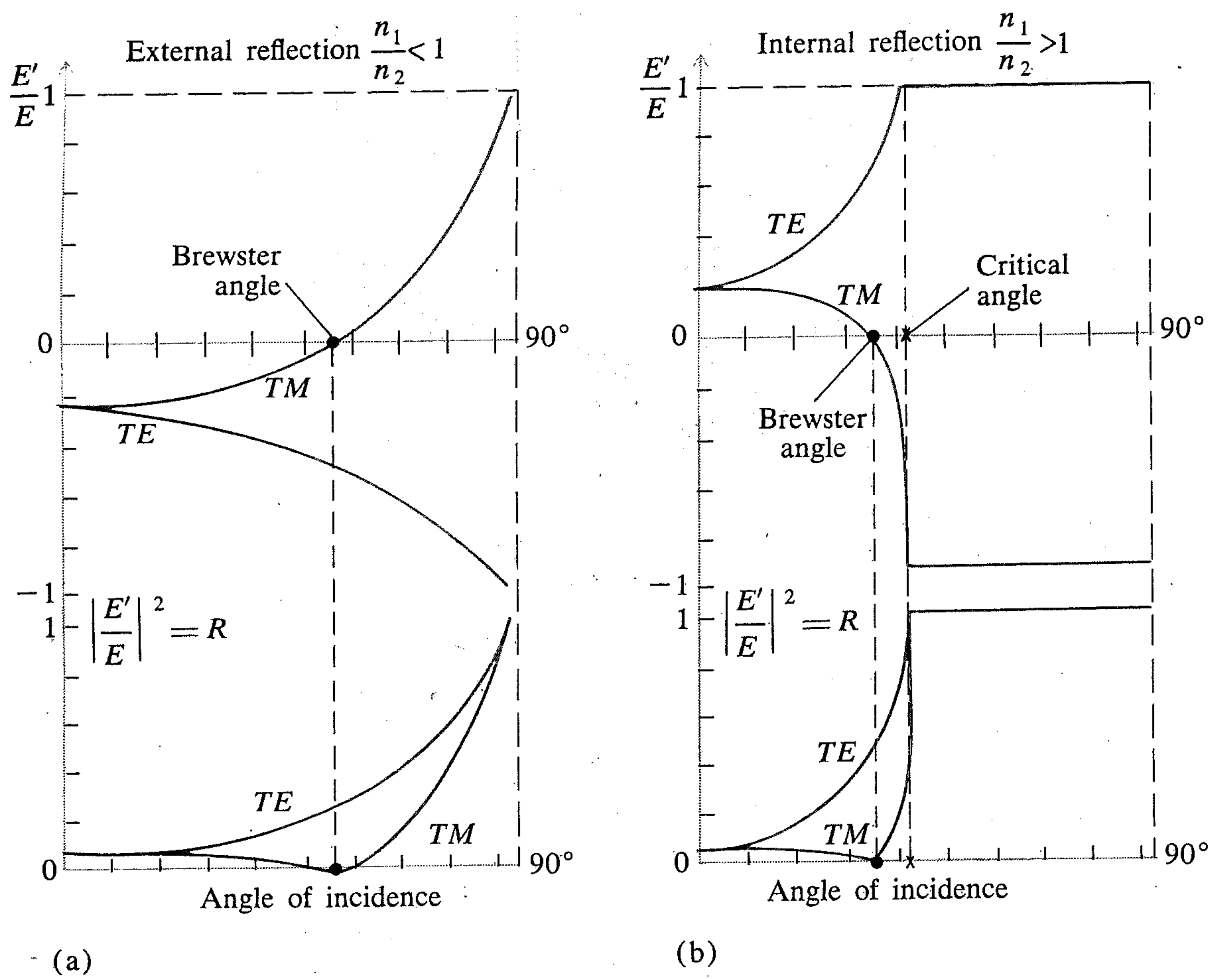
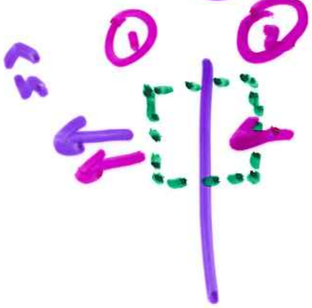


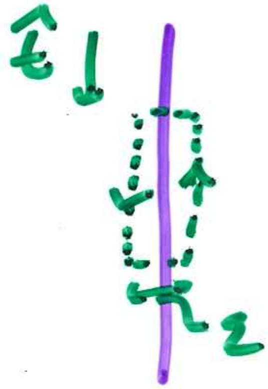
Figure 2.11. Graphs of E'/E and $|E'/E|^2$ versus angle of incidence for (a) ex-

$$\nabla \cdot B = 0$$



$$B_{1n} - B_{2n} = 0$$

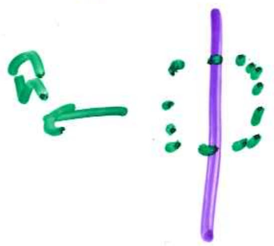
$$E_{1t} - E_{2t} = 0$$



$$E_{1t}\,l - E_{2t}\,l = 0$$

$$\nabla \times E = -\partial_t B$$

$$\nabla \cdot D = \rho$$



$$\varepsilon E$$

$$D_{1n} A - D_{2n} A = \sigma A$$

$$\varepsilon_1 E_{1n} - \varepsilon_2 E_{2n} = \sigma$$

$$\nabla \cdot J + \partial_t \rho = 0$$

$$\nabla \cdot J = -\partial_t \rho$$

$$-i\omega$$

$$J_{1n} A - J_{2n} A = i\omega \sigma A$$

$$= +i\omega \sigma$$

$$g_1 E_{1n} - g_2 E_{2n}$$

$$\frac{g_1}{i\omega} E_{1n} - \frac{g_2}{i\omega} E_{2n} = \sigma$$

$$\left(\varepsilon_1 - \frac{g_1}{i\omega}\right) E_{1n} = \left(\varepsilon_2 - \frac{g_2}{i\omega}\right) E_{2n}$$

$$g_2 \to \infty$$

$$E_{2n} \to 0$$

$$\nabla \times H = J + \partial_t D$$

$$H_{1t} - H_{2t} = 0$$

unless $g_2 \to \infty$

$g_2 \to \infty$ $\quad \nabla \times H = J + \partial_t D$

$E \to 0$ $\quad = (g - i\omega\varepsilon) E$

$H \to 0$

$\frac{1}{g - i\omega\varepsilon} \nabla \times H = E \to 0$

$\nabla \times E = -\partial_t B = -\partial_t \mu \underset{=0}{\underset{\uparrow}{H}}$

$\frac{d\vec{v}}{dt} + \frac{1}{\tau} v = \frac{q}{m} E$

$-i\omega$

$\tau \sim 10^{-13}, 10^{-14}\, s$

$F = \frac{q^2}{\varepsilon_0 r^2}$ $\quad v = \frac{\frac{q}{m} E}{\frac{1}{\tau} - i\omega}$

$\omega \sim 0$
DC

$J = qNv = \underbrace{\frac{q^2/m\, N}{\frac{1}{\tau} - i\omega}}_{g} E$

$\frac{q^2 N \tau}{m(1 - i\omega\tau)}$ $\quad \omega \gg \frac{1}{\tau}$ not DC $\quad Fr^2$

$\frac{1}{L^3} \frac{L}{T^2} L^2 = \frac{1}{T^2}$

Plasma freq $= \omega_p^2 = \frac{N q^2}{m \varepsilon_0}$

$$0 = \left(\nabla^2 - \varepsilon\mu\partial_t^2 - g\mu\partial_t\right)\vec{E}$$

$$e^{i(\vec{k}\cdot\vec{r}-\omega t)}$$

complex $(k_R + i k_i)$

$-k_i \cdot r \leftarrow$ damping

$$\left(\varepsilon\mu\omega^2 + i\omega g\mu\right) = \hat{k}^2$$

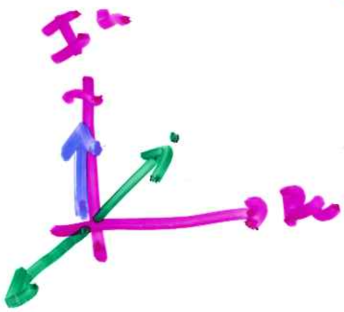
$$\left(\varepsilon\mu + \frac{i g\mu}{\omega}\right) = \frac{\hat{k}^2}{\omega^2} = \frac{\hat{n}^2}{c^2} = \frac{1}{v_p^2}$$

Low freq: $\omega \ll \frac{1}{\tau}$ $\quad g = \frac{e^2 N\tau}{m}$

$$\frac{i g\mu}{\omega} = \frac{\hat{k}^2}{\omega^2}$$

$$\sqrt{i}\sqrt{g\mu\omega} = k$$

$$k_i = \frac{1}{\sqrt{2}}\sqrt{g\omega\mu} = \sqrt{\frac{g\omega\mu}{2}}$$



$$i = e^{i\pi/2} = \cos 90^\circ + i\sin 90^\circ$$

$$i^{1/2} = e^{i\pi/4}$$

$$\sqrt{i} = \frac{1}{\sqrt{2}}(1+i)$$

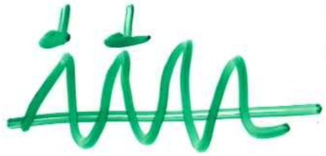
$$\sqrt{i}^2 = \frac{1}{2}(1+i)^2 = \frac{1}{2}(1+2i-1) = i \checkmark$$

$e^{-k_i z}$

e^{-1}

$$z = \delta = \frac{1}{k_i} = \sqrt{\frac{2}{g\mu\omega}}$$

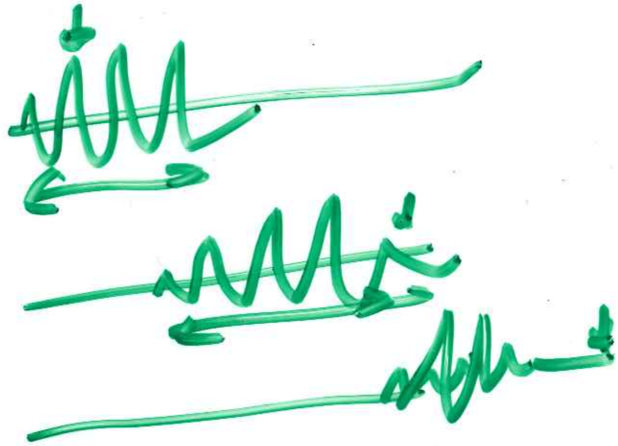
Skin depth



<u>High</u>

$\omega\tau \gg 1$

$10^{-14}\,s$



$$g = \frac{Nq^2/m}{-i\omega}$$

$$\frac{k^2}{c^2} = \underbrace{\epsilon\mu}_{\frac{1}{c^2}} - \frac{\omega_p^2}{\omega^2}\frac{1}{c^2}$$

$$v_{gp} = \frac{d\omega}{dk}$$

$$= \frac{1}{c^2}\left(1 - \frac{\omega_p^2}{\omega^2}\right) \qquad \omega > \omega_p$$

$$n = \sqrt{1 - \frac{\omega_p^2}{\omega^2}}$$

10 MHz

10^{14}

<u>1 MHz</u>

$n < 1$

$v_p > c$

$v_p = \frac{c}{n}$

<u>AM</u> ✓