Snell's law: $n_1\ sin\theta_1 = n_2\ sin\theta_2$. This holds in general: sound waves, water waves, E&M waves. Snell's law is not the result of Maxwell's equations.

The following equations (the Fresnel eqs.) are the result of Maxwell's eqs.; θ_1 and θ_2 are connected through Snell's law.

$$r_\parallel = E_{0r\parallel}/E_{0i\parallel} = \frac{n_1\ cos\theta_2 - n_2\ cos\theta_1}{n_1\ cos\theta_2 + n_2\ cos\theta_1} = -\frac{tan(\theta_1-\theta_2)}{tan(\theta_1+\theta_2)} \quad (1)$$

$$r_\perp = E_{0r\perp}/E_{0i\perp} = \frac{n_1\ cos\theta_1 - n_2\ cos\theta_2}{n_1\ cos\theta_1 + n_2\ cos\theta_2} = -\frac{sin(\theta_1-\theta_2)}{sin(\theta_1+\theta_2)} \quad (2)$$

$$t_\parallel = E_{0t\parallel}/E_{0i\parallel} = \frac{2n_1\ cos\theta_1}{n_1\ cos\theta_2 + n_2\ cos\theta_1} = \frac{2\ sin\theta_2\ cos\theta_1}{sin(\theta_1+\theta_2)\ cos(\theta_1-\theta_2)} \quad (3)$$

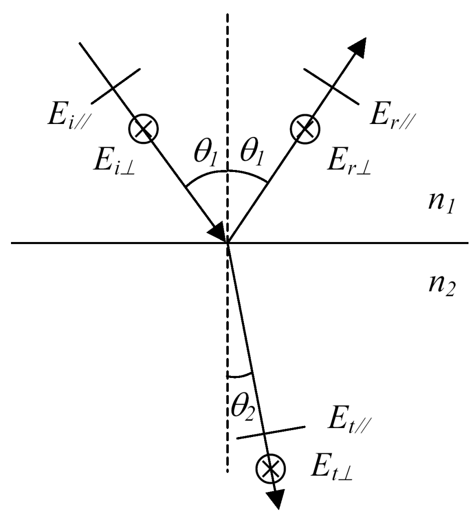
$$t_\perp = E_{0t\perp}/E_{0i\perp} = \frac{2n_1\ cos\theta_1}{n_1\ cos\theta_1 + n_2\ cos\theta_2} = \frac{2\ sin\theta_2\ cos\theta_1}{sin(\theta_1+\theta_2)} \quad (4)$$

- Special case of normal incidence: θ_1=0, θ_2=0

$$(1)\ \&\ (2) \Rightarrow \frac{n_1-n_2}{n_1+n_2} \qquad\qquad (3)\ \&\ (4) \Rightarrow \frac{2n_1}{n_1+n_2}$$

Notice Bekefi & Barrett flipped $\vec{E}_r$ relative to $\vec{E}_i$ at $z=0$; Fig. 7.10. I prefer not to do this (see figure below). Thus, according to Bekefi & Barrett, at normal incidence, $E_{0r}/E_{0i} = (n_2-n_1)/(n_1+n_2)$.

- Very special case: θ_1+$\theta_2 = 90°$, then $r_\parallel = 0$. This is the case when $tan\theta_1 = n_2/n_1$. Then θ_1 is the *Brewster Angle*.



B. Rossi follows my convention. The curves plotted below result from eqs (1) thru (4). 2

B. Rossi "Optics"

Brewster 56.3°

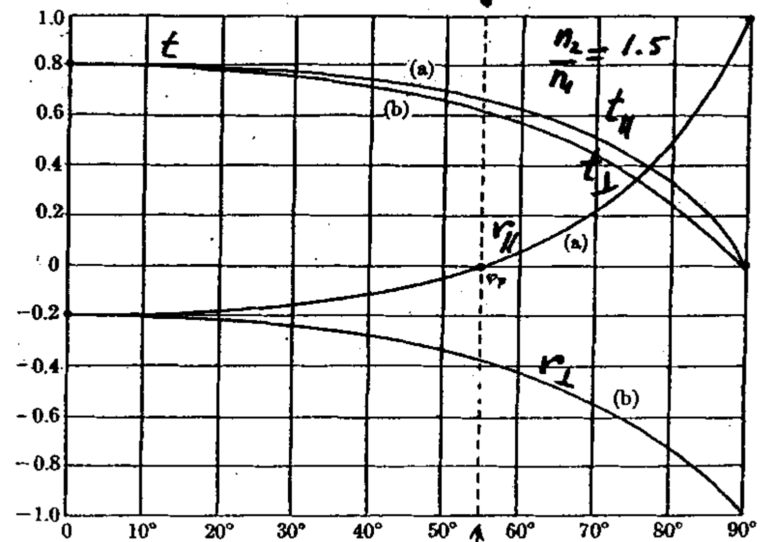
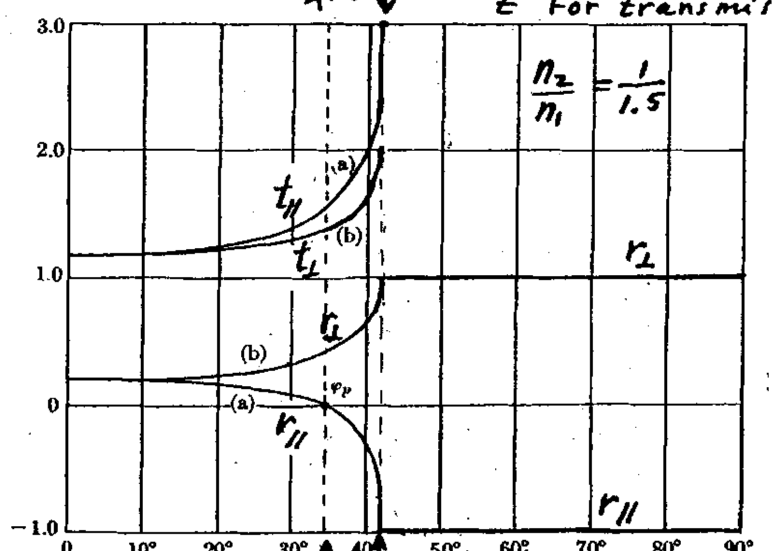


FIG. 8–11. Ratios of the refracted and reflected amplitudes to the incident amplitude, computed for $n_2/n_1 = 1.5$. (a) **E** in plane of incidence, (b) **E** perpendicular to plane of incidence.

critical angle 41.8°

r stands for reflection
t for transmission (= refraction)



critical angle

FIG. 8–12. Ratios of the refracted and reflected amplitudes to the incident amplitude, computed for $n_2/n_1 = 1/1.5$. (a) **E** in the plane of incidence, (b) **E** perpendicular to the plane of incidence.

Brewster 33.7°