Fresnel equations

Come from matching the *boundary conditions* for E-M waves at a dielectric interface (eqs. 4.34,35,40,41).

Note that $r_\perp$, $t_\perp$ and $r_\parallel$, $t_\parallel$ are **amplitude** reflection and transmission coefficients—relative strengths of electric and magnetic fields on reflection/transmission.

Relative brightnesses correspond to energies, and are given by **reflectance**, $R \sim r^2$, and **transmittance** $T \sim t^2$.

We will usually call

$$n_i > n_t$$

the case of internal reflection, and

$$n_t > n_i$$

external reflection.

Look carefully at the graphs 4.41 and 4.42 on pgs.116–117. Note that $\|$ and $\perp$ refer to the plane-of-incidence. So the $\perp$ case is fields $\|$ to the surface (!).

Phase shifts on reflection

The $E_\perp$ undergoes a phase shift of π radians on external reflection.

Other phase shifts are more complex. See fig. 4.44

Reflectance and Transmittance

These are coefficients of reflected and transmitted power (fig. 4.48).

For $\theta_i = 0$,

$$R = \left(\frac{n_t - n_i}{n_t + n_i} \right)^2$$

and

$$T = \frac{4 n_t n_i}{(n_t + n_i)^2}.$$

for glass-air interface $R \approx 0.04$ this is **very** important in optical systems, because this is at *every* interface.

Total Internal Reflection

By Snell's law, on refection from $n_i > n_t$, the angle of the transmitted wave can reach 90 degrees. Then there is no transmitted wave, and reflection is total (see fig.4.51).

The incident angle for this to occurr is the critical angle θ_c. For angles greater than θ_c we have total internal reflection.