Module 4: Power of a Single Curved Surface

Course 1 of *Optical Engineering*: First Order Optical System Design

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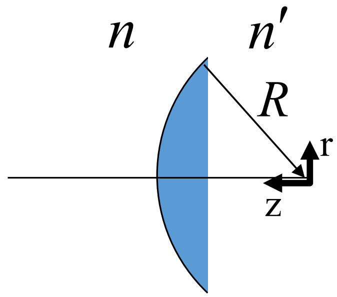
What is a lens? Paraxial power via Fermat

Consider a curved surface between to refractive indices



z coordinate of surface is

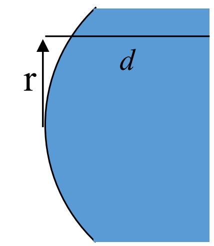
$$r^2 + z^2 = R^2$$

Sphere

$$z = \sqrt{R^2 - r^2} \approx R\left(1 - \frac{1}{2}\frac{r^2}{R^2}\right) = R - \frac{1}{2}\frac{r^2}{R}$$

Paraxial = parabola

Calculate optical path length along z at some height r



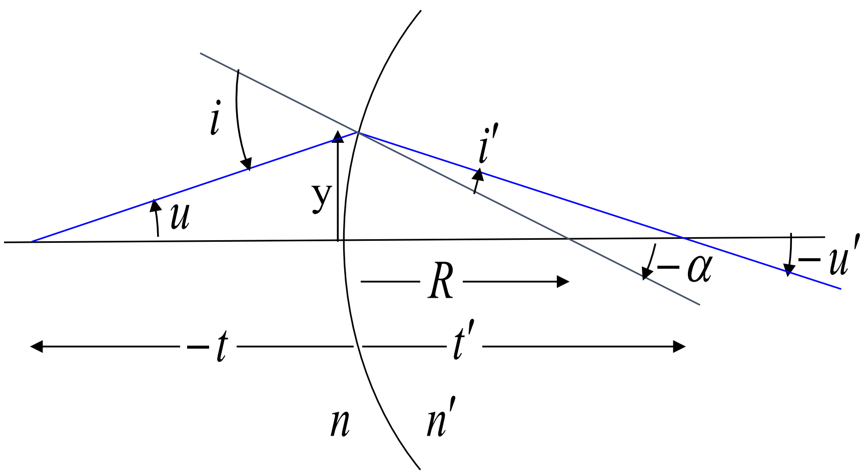
$$\begin{aligned} S &= nL + n'L' \\ &= n\left(\frac{1}{2}\frac{r^2}{R}\right) + n'\left(d - \frac{1}{2}\frac{r^2}{R}\right) \\ &= -(n'-n)\left(\frac{1}{2}\frac{r^2}{R}\right) + n'd \\ &\equiv -\frac{r^2}{2f} \end{aligned}$$

Set equal to our definition of OPL for thin lens

$$\boxed{\phi = \frac{1}{R}(n'-n) = c(n'-n)}$$

Paraxial power of curved surface

What is a lens? Paraxial power via Snell



$$ni = n'i'$$

Paraxial Snell's Law

$$n(u-\alpha) = n'(u'-\alpha)$$

Replace refraction with ray angles

$$n\left(\frac{y}{-t} - \frac{-y}{R}\right) = n'\left(\frac{-y}{t'} - \frac{-y}{R}\right)$$

Paraxial approximations to angle, obeying sign conv.

$$\frac{n}{-t} + \frac{n'}{t'} = \frac{1}{R}(n'-n) = \phi$$

Cancel *y*, rearrange.

which agrees with the previous derivation