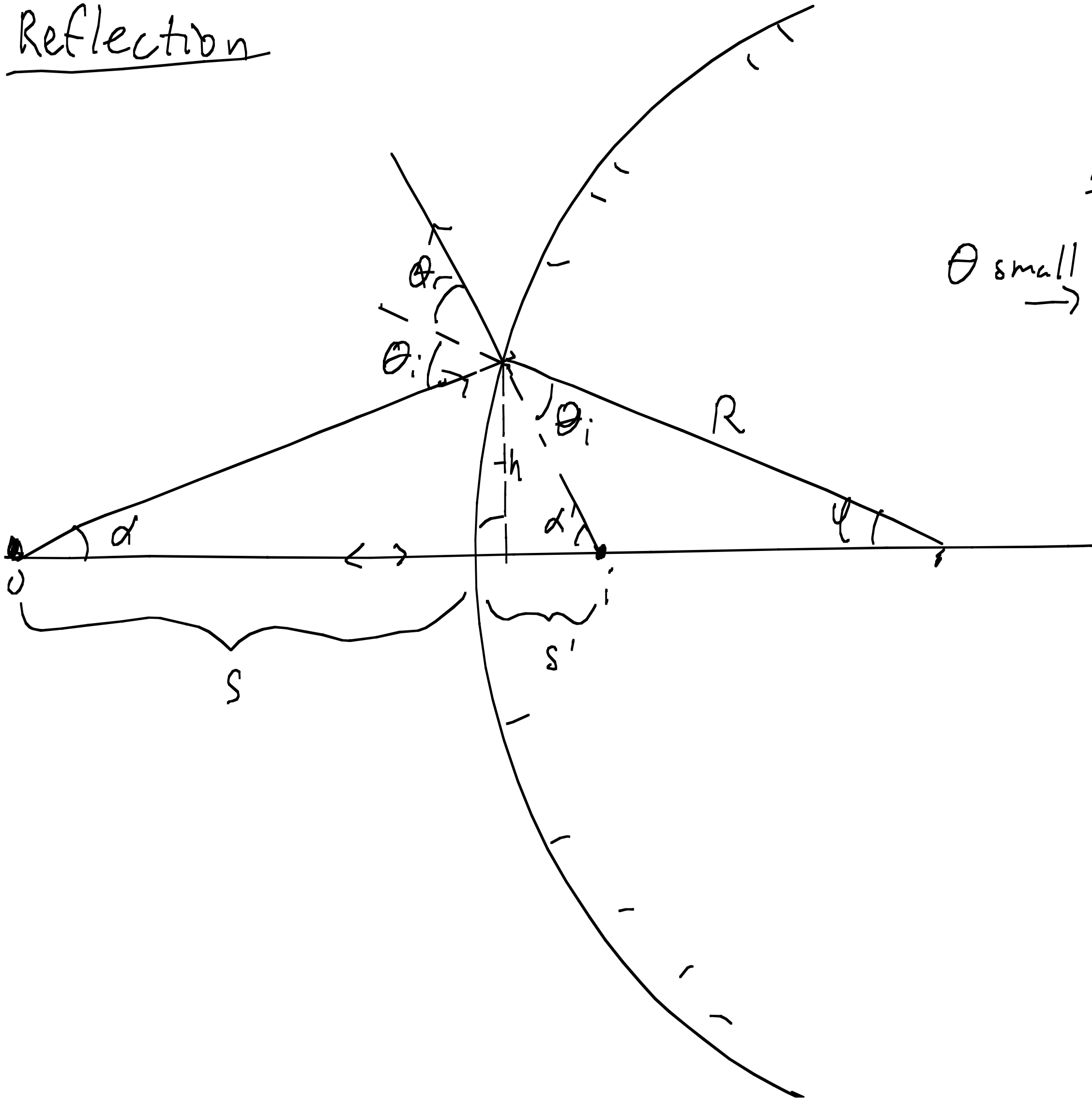
Reflection



$\tan\alpha \sim \frac{h}{s}$, $\tan\alpha' \sim \frac{h}{s'}$, $\tan\varphi \sim \frac{h}{R}$

θ small $\longrightarrow$ $\alpha \sim \frac{h}{s}$, $\alpha' \sim \frac{h}{s'}$, $\varphi \sim \frac{h}{R}$

1. $2\theta_i + (\pi - \alpha - \alpha') = \pi$

$$2\theta_i = \alpha + \alpha'$$

2. $\theta_i + (\pi - \alpha - \varphi) = \pi$

$$\theta_i = \alpha + \varphi$$

$$2\alpha + 2\varphi = \alpha + \alpha'$$

$$2\varphi = \alpha' - \alpha$$

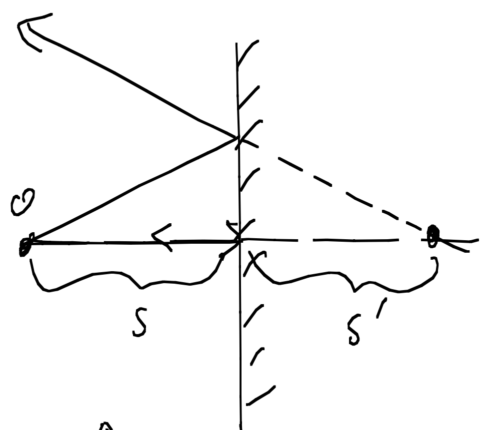
$$\frac{2\cancel{h}}{R} = \frac{\cancel{h}}{s'} - \frac{\cancel{h}}{s} \longrightarrow \frac{1}{s'} - \frac{1}{s} = \frac{2}{R}$$

Convention

$$\frac{1}{s} + \frac{1}{s'} = \frac{-2}{R}$$ + definitions on p. 29 of Pedrotti

Example: $R \to \infty$ (plane)

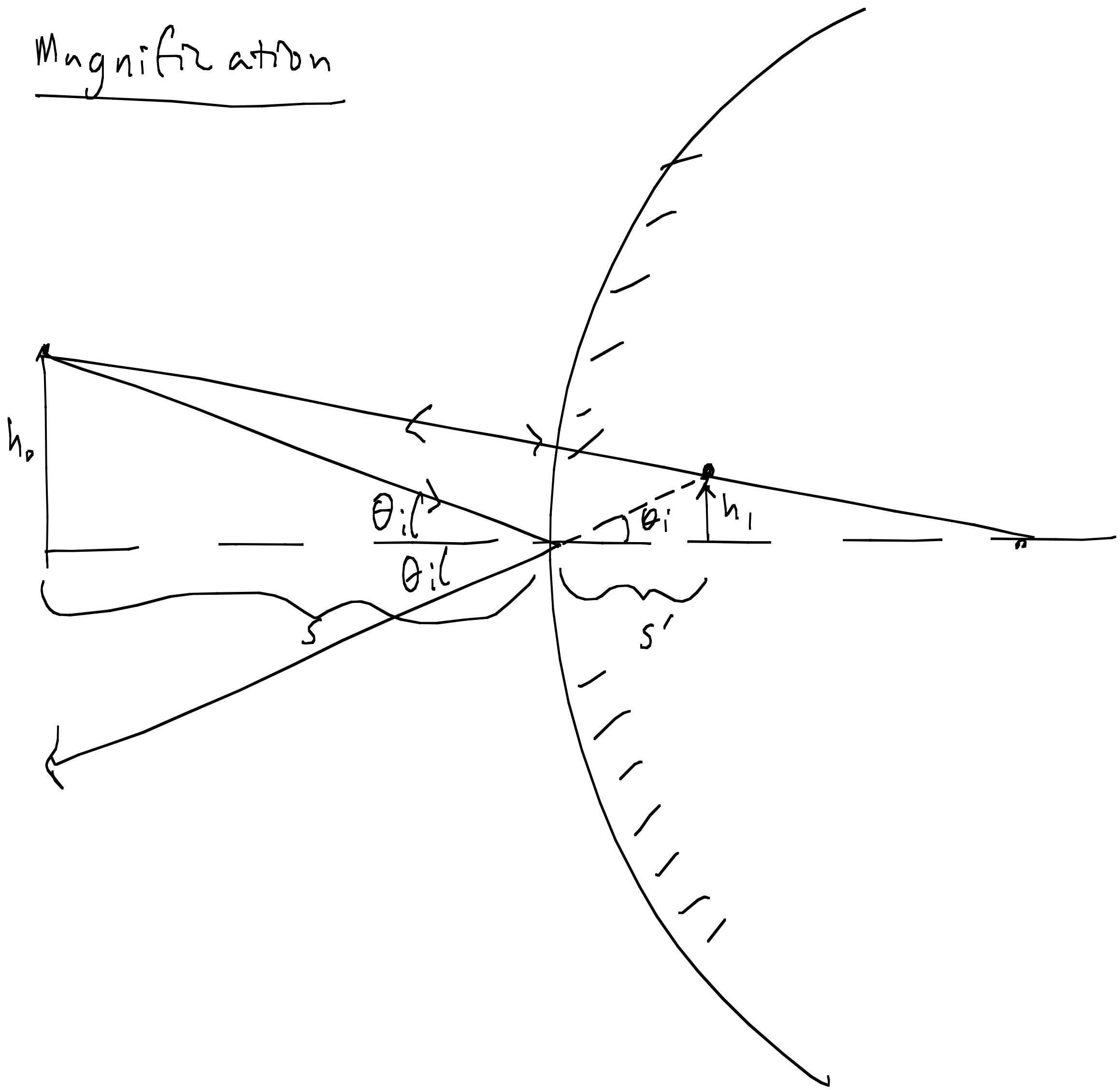
$$\frac{1}{s} + \frac{1}{s'} = 0 \qquad s' = -s$$



special case: $s \to \infty$ $\quad s' \equiv f$ ("focal length")

$$\frac{1}{f} = -\frac{2}{R} \longrightarrow \frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$$

Magnification

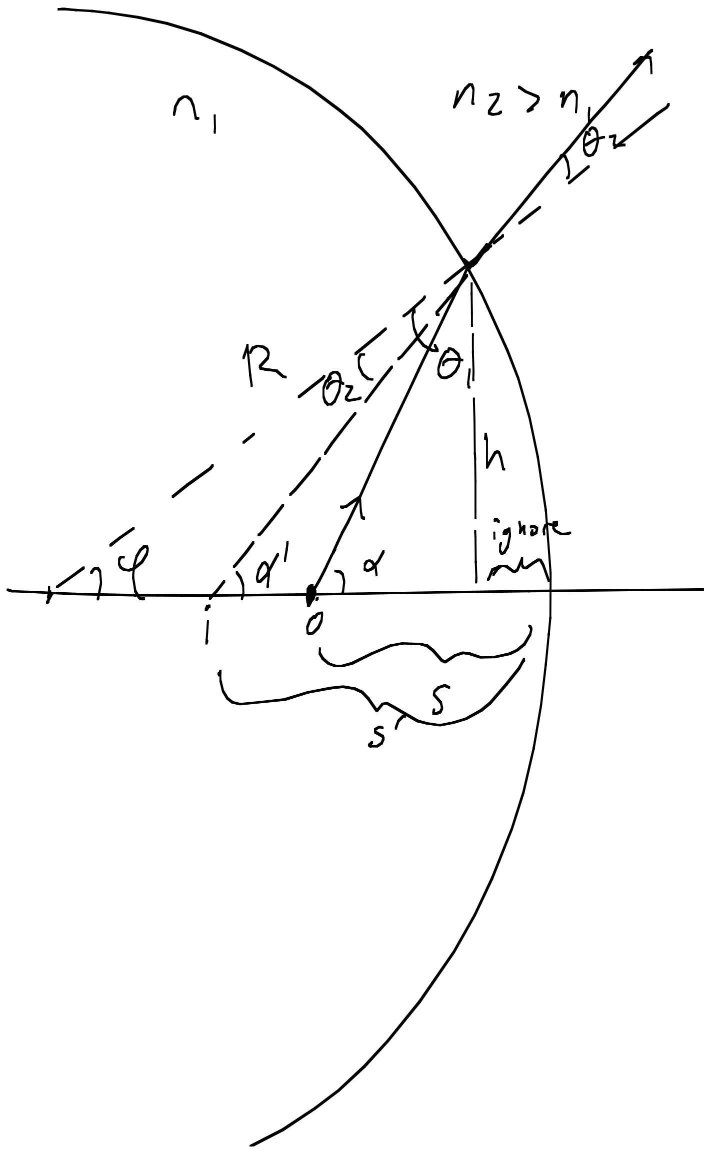


$$\frac{h_o}{s} = \frac{h_1}{s'}$$

$$\frac{h_1}{h_o} = \underset{m}{\text{magnification}} = \frac{s'}{s}$$

by convention, $m = -\frac{s'}{s}$

Refraction



$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$\rightarrow n_1\theta_1 = n_2\theta_2 \quad (\theta_1 \text{ small})$

again, $\varphi \sim \frac{h}{R}$, $\alpha \sim \frac{h}{s}$, $\alpha' \sim \frac{h}{s'}$

(1) $\frac{\pi}{2} - \varphi = \theta_1 + \left(\frac{\pi}{2} - \alpha\right)$ $\quad$ (2) $\frac{\pi}{2} - \varphi = \theta_2 + \left(\frac{\pi}{2} - \alpha'\right)$

$\theta_1 = \alpha - \varphi$ $\quad\quad$ $\theta_2 = \alpha' - \varphi$

$$n_1(\alpha - \varphi) = n_2(\alpha' - \varphi)$$

$$n_1\left(\frac{h}{s} - \frac{h}{R}\right) = n_2\left(\frac{h}{s'} - \frac{h}{R}\right)$$

$$\frac{n_1}{s} - \frac{n_2}{s'} = \frac{n_1 - n_2}{R}$$

by convention, $\frac{n_1}{s} + \frac{n_2}{s'} = \frac{n_2 - n_1}{R}$

Example : $R \to \infty$

$$\frac{n_1}{s} + \frac{n_2}{s'} = 0$$

$$s' = -\frac{n_2}{n_1} s$$

$$m = -\frac{s'}{s} = \frac{n_2}{n_1}$$