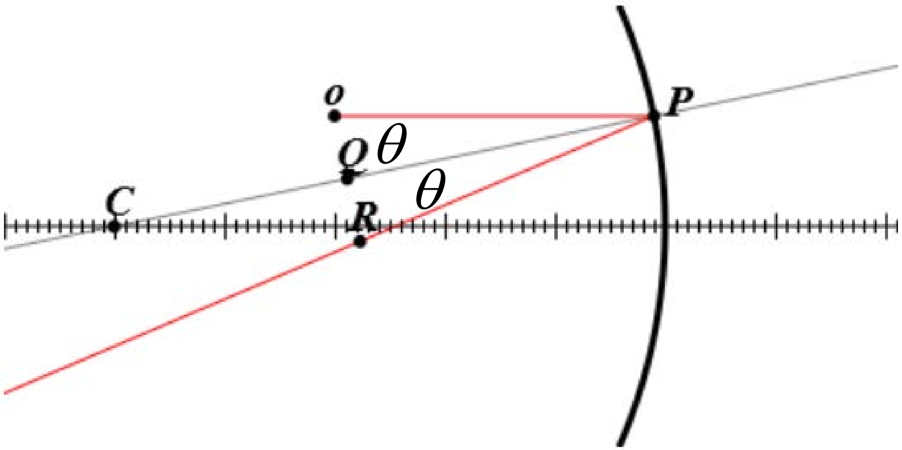
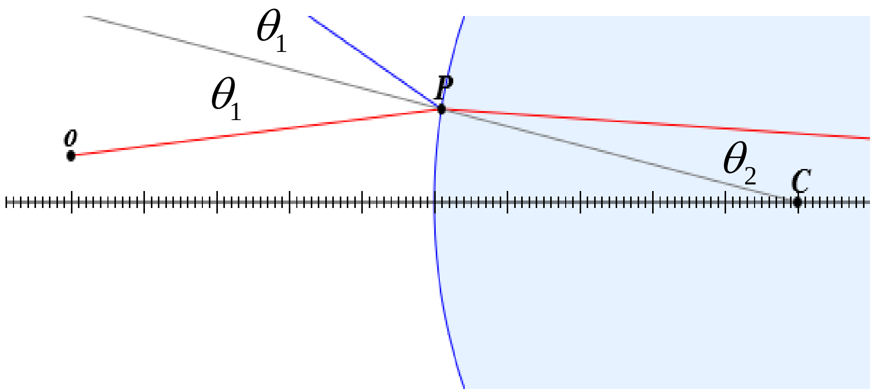
Geometrische Optik

Spiegel:
Einfallswinkel = Reflexionswinkel



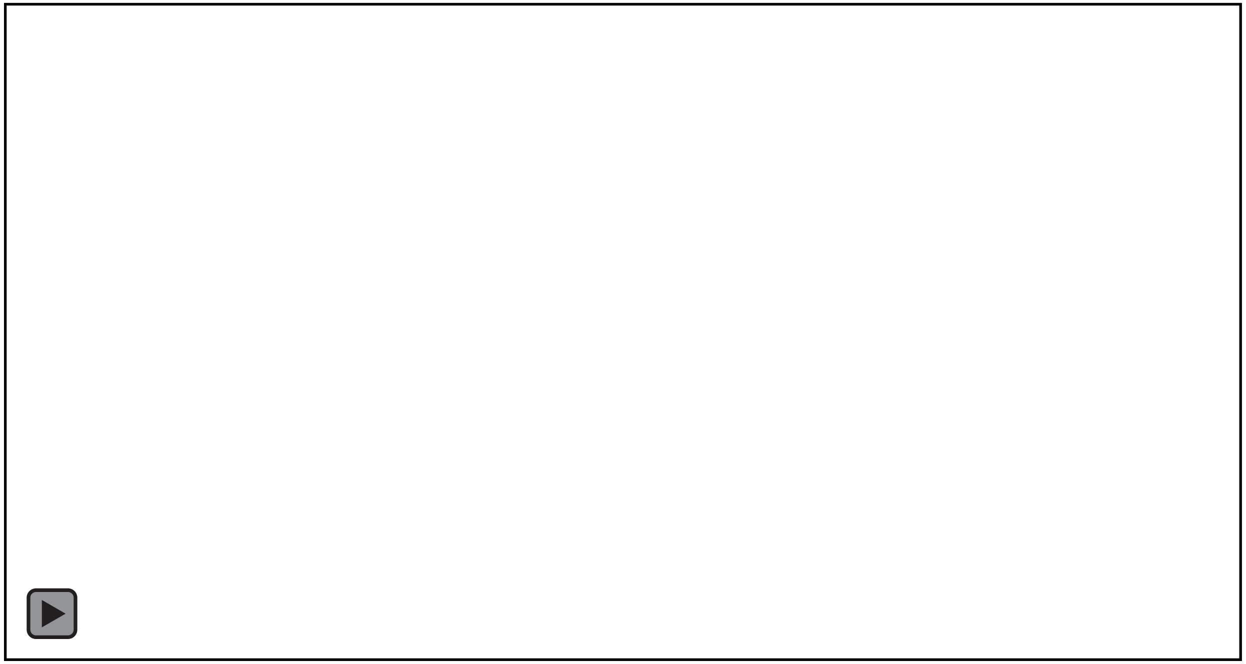
Linsen:
Snelliussches Brechungsgesetz



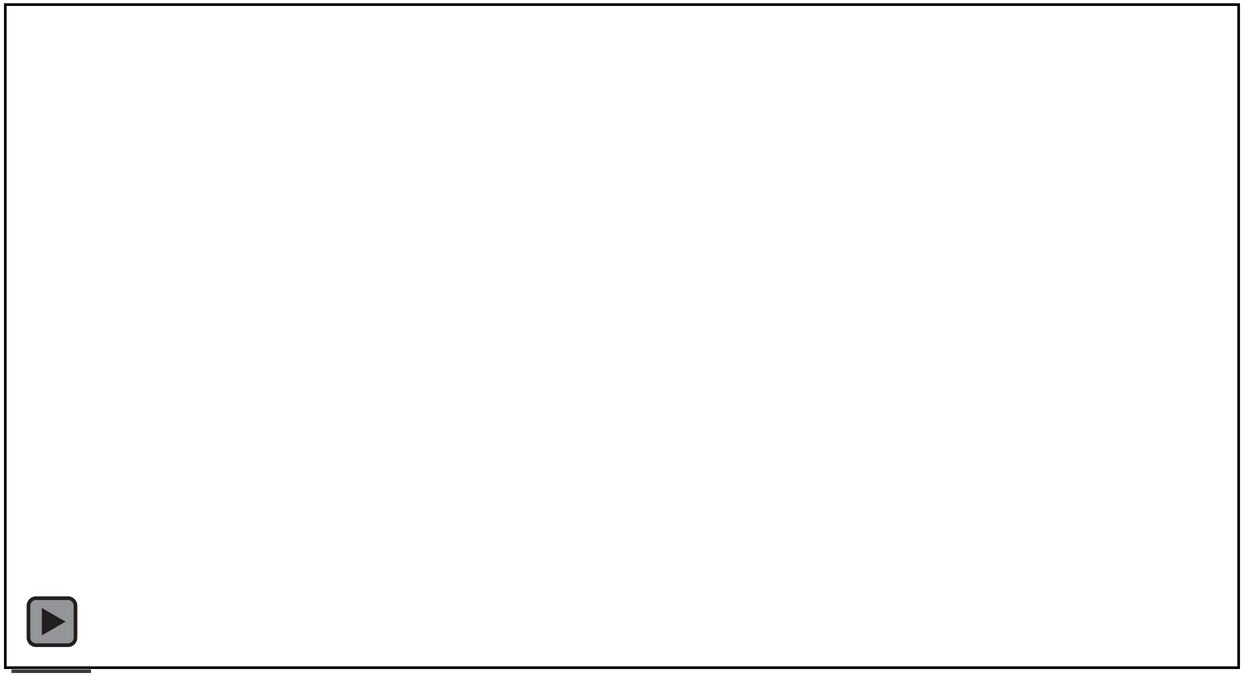
$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

Wellenoptik: $L \sim \lambda$
Geometrische Optik: $L >> \lambda$

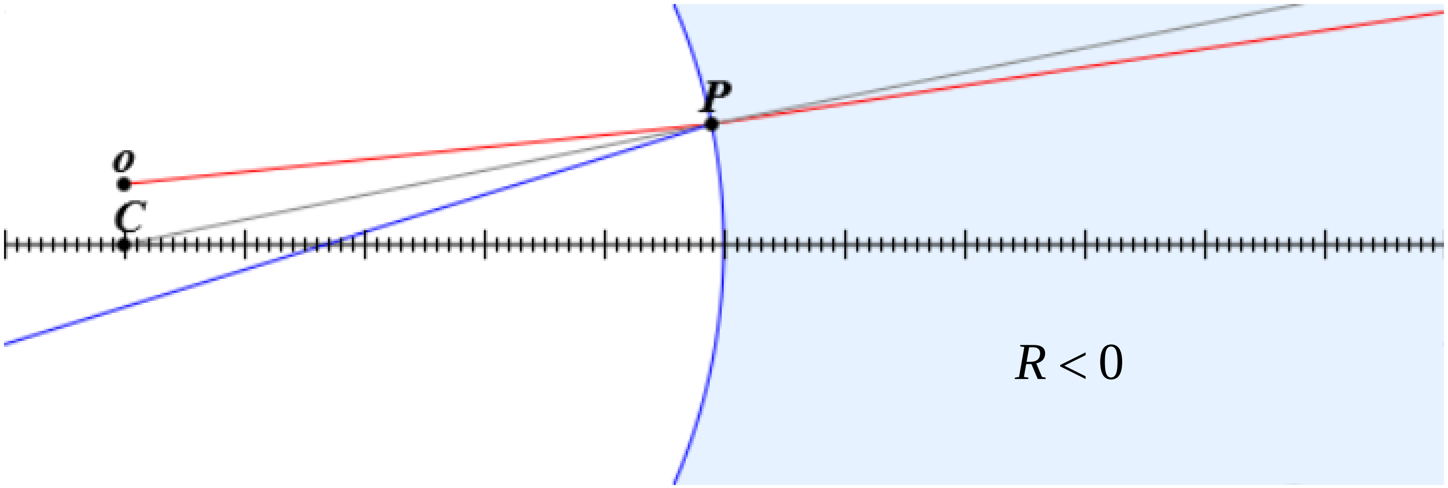
Brechung

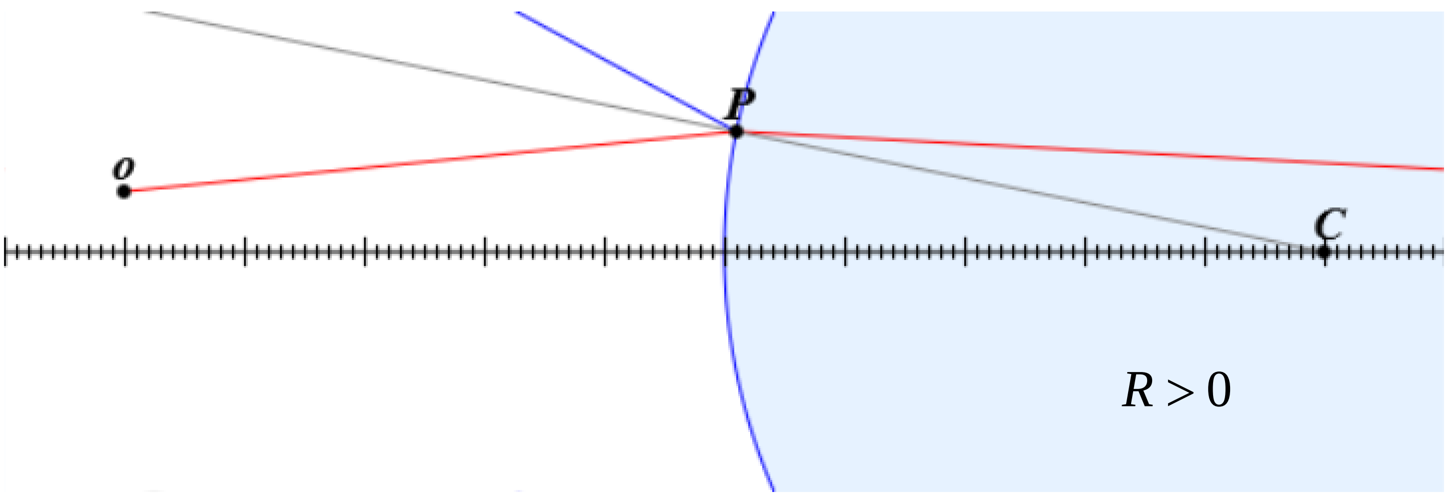


Totalreflexion

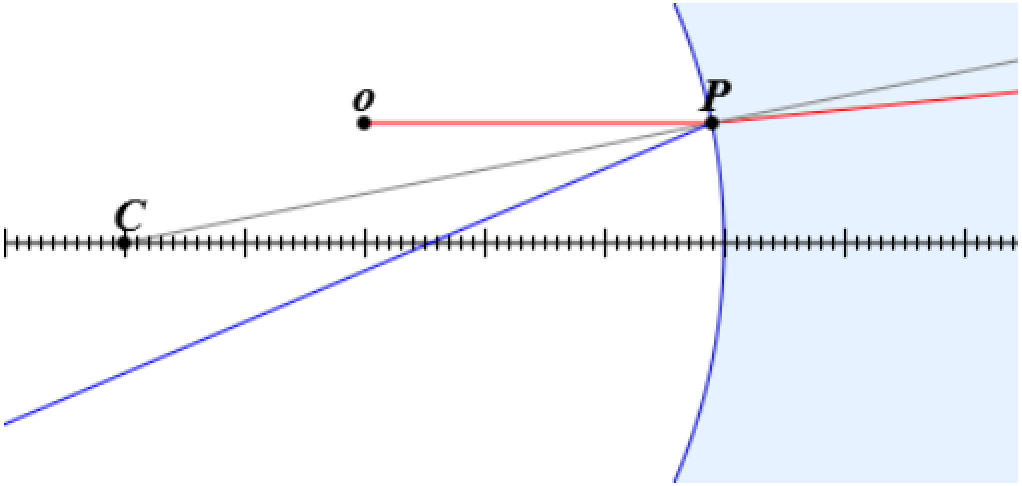


Brechung an einer gekrümmten Grenzfläche





Brechung

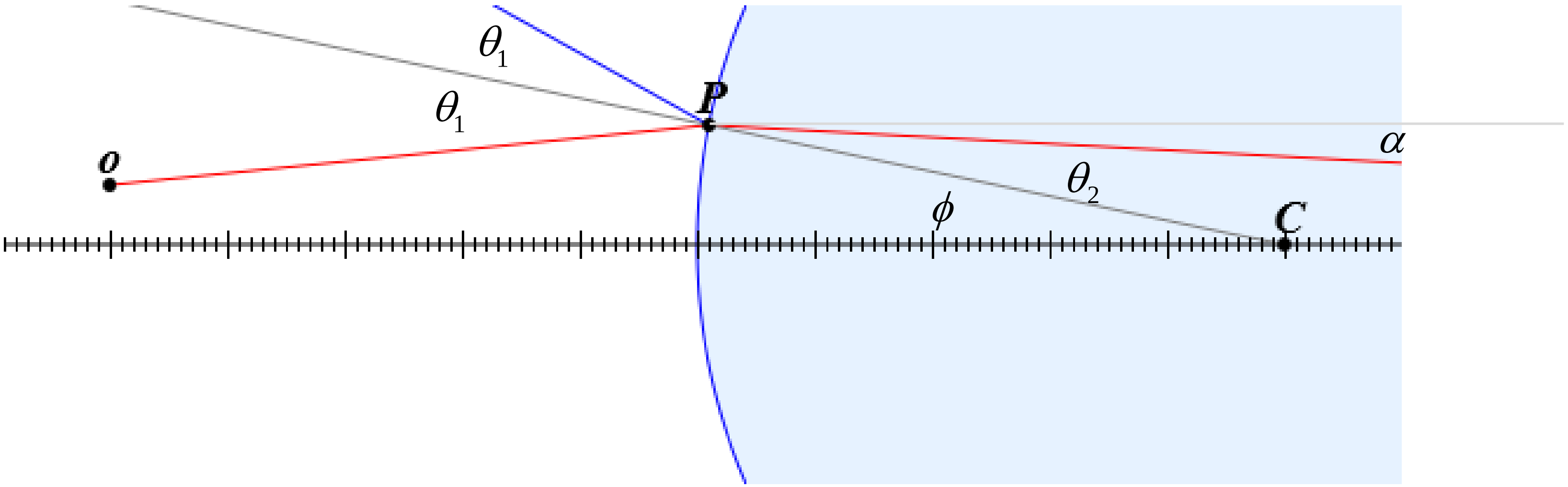


Methode 1: mit Vektoren $n_1 \sin\theta_1 = n_2 \sin\theta_2$

Methode 2: kleinen Winkeln zur optischen Achse $\phi_{i+1} = \frac{n_1 - n_2}{n_2 R} y_i + \frac{n_1}{n_2}\phi_i$

Methode 3: dünne Linsen $x_i = \frac{f x_o}{f + x_o}$ $y_i = \frac{f y_o}{f + x_o}$

Methode 1: Vektoren



$$\overrightarrow{Po} = (x_o - x_P)\hat{x} + (y_o - y_P)\hat{y}$$

$$\tan\phi = \frac{y_p}{\sqrt{R^2 - y_p^2}}$$

$$\overrightarrow{CP} = (x_P - x_C)\hat{x} + (y_P - y_C)\hat{y}$$

$$\overrightarrow{CP} \cdot \overrightarrow{Po} = \left|\overrightarrow{CP}\right|\left|\overrightarrow{Po}\right| \cos\theta_1$$

$$\alpha = \phi - \theta_2$$

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

Methode 1: Vektoren

Dicke Linsen

$R_1 =$ 10 [cm]

$R_2 =$ -10 [cm]

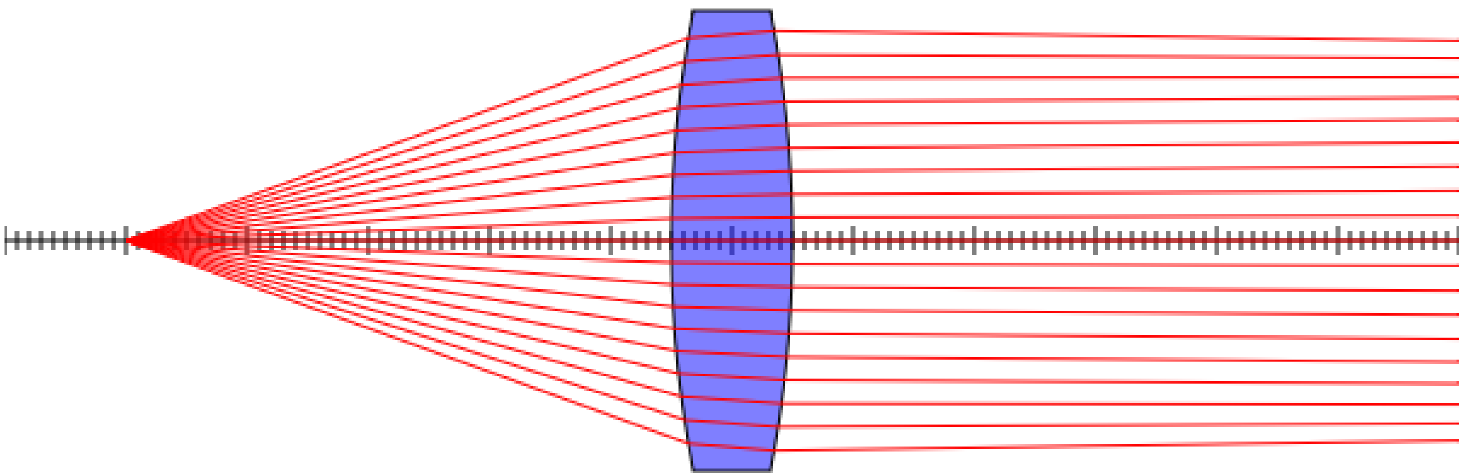
$d =$ 1 [cm]

$x_o =$ -5 [cm]

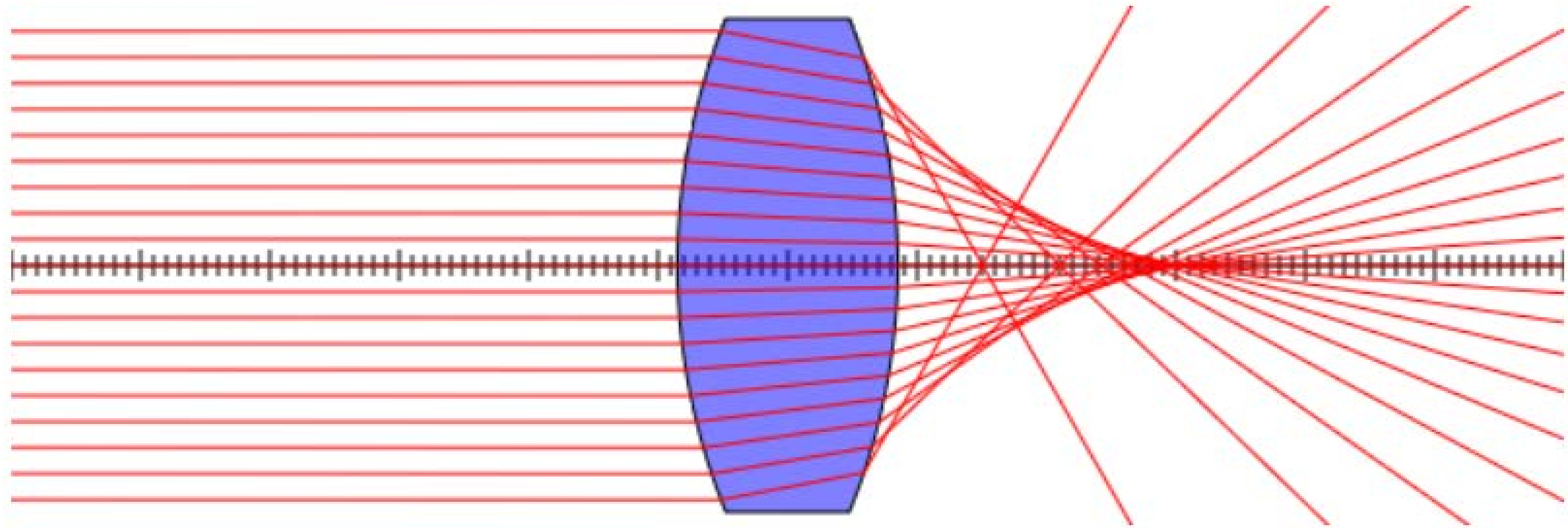
$y_o =$ 0 [cm]

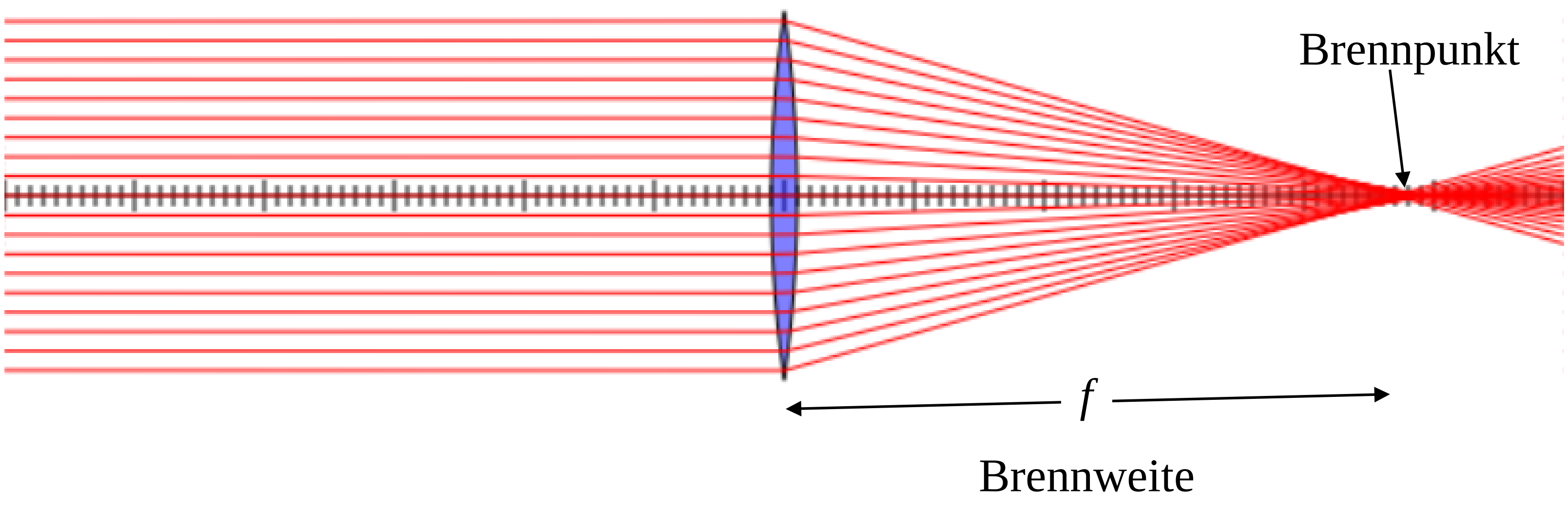
	Rot	Grün	Blau
$n_{\text{Umg}} =$	1	1	1
$n_{\text{Linse}} =$	2	2.5	3

show: ☑ Rot ☐ Grün ☐ Blau plot

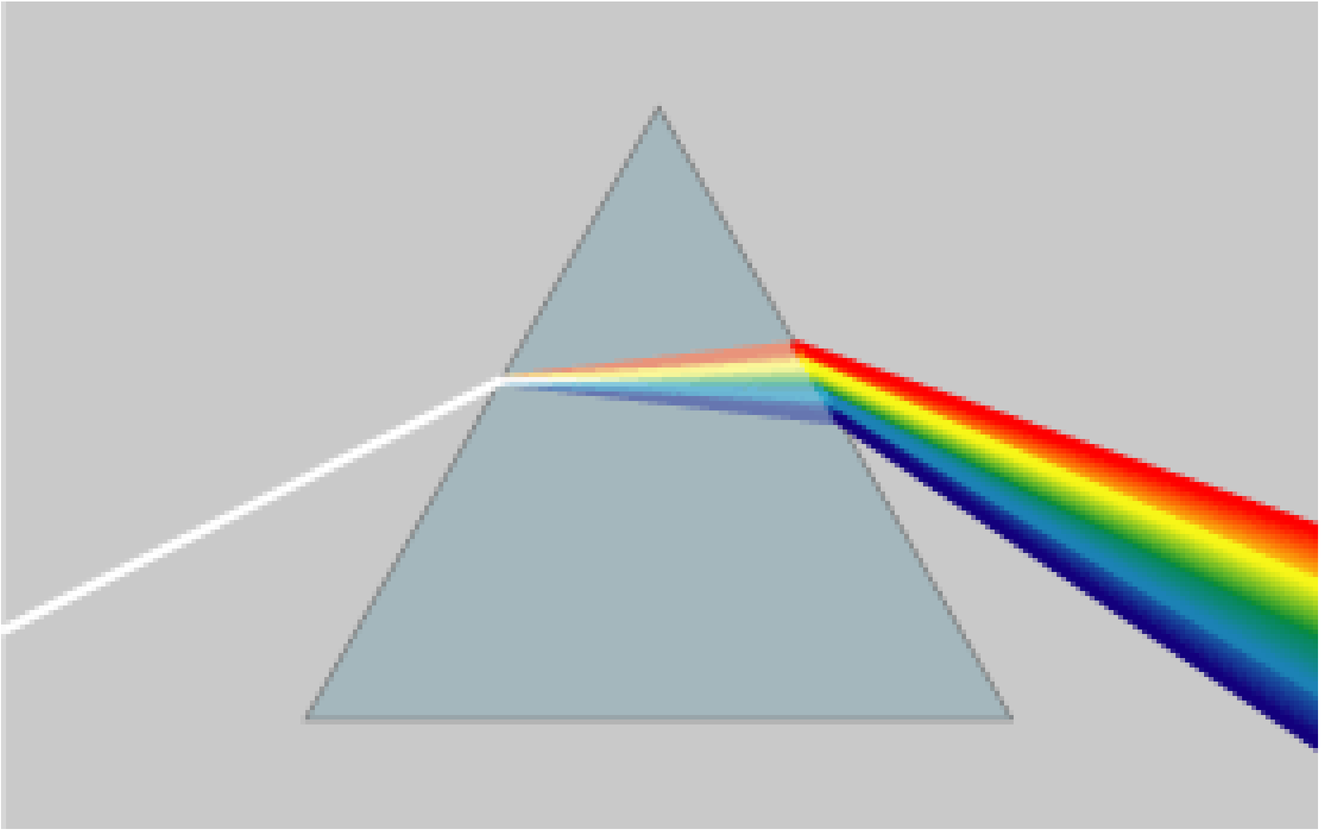


Sphärische Aberration





Dispersion



$n(\lambda)$

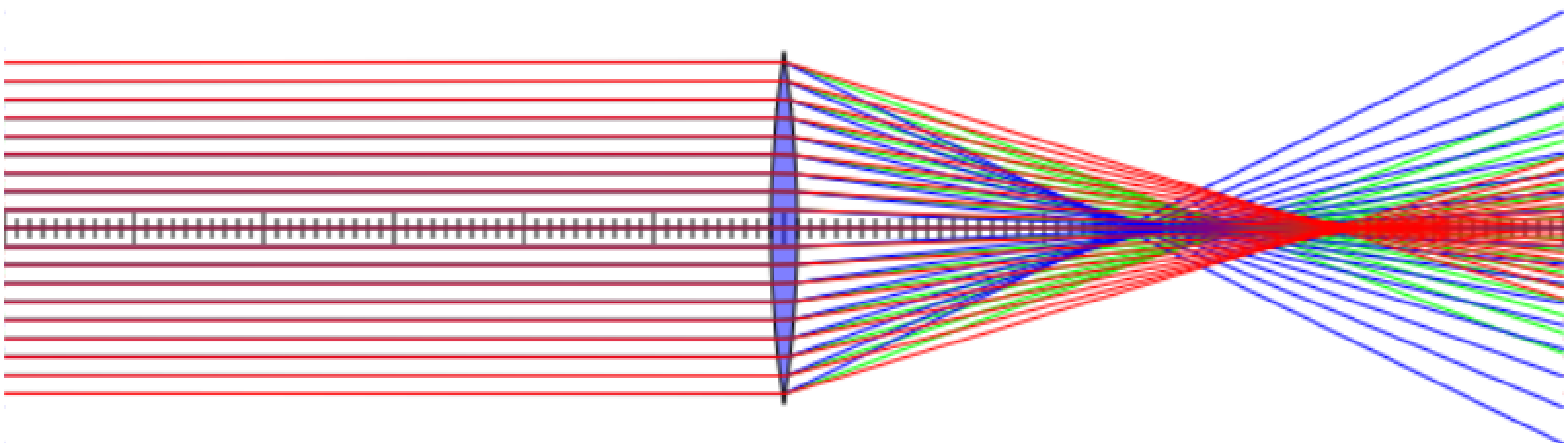
Brechungsindex

http://en.wikipedia.org/wiki/Dispersion_%28optics%29#mediaviewer/File:Prism_rainbow_schema.png

Chromatische Aberration

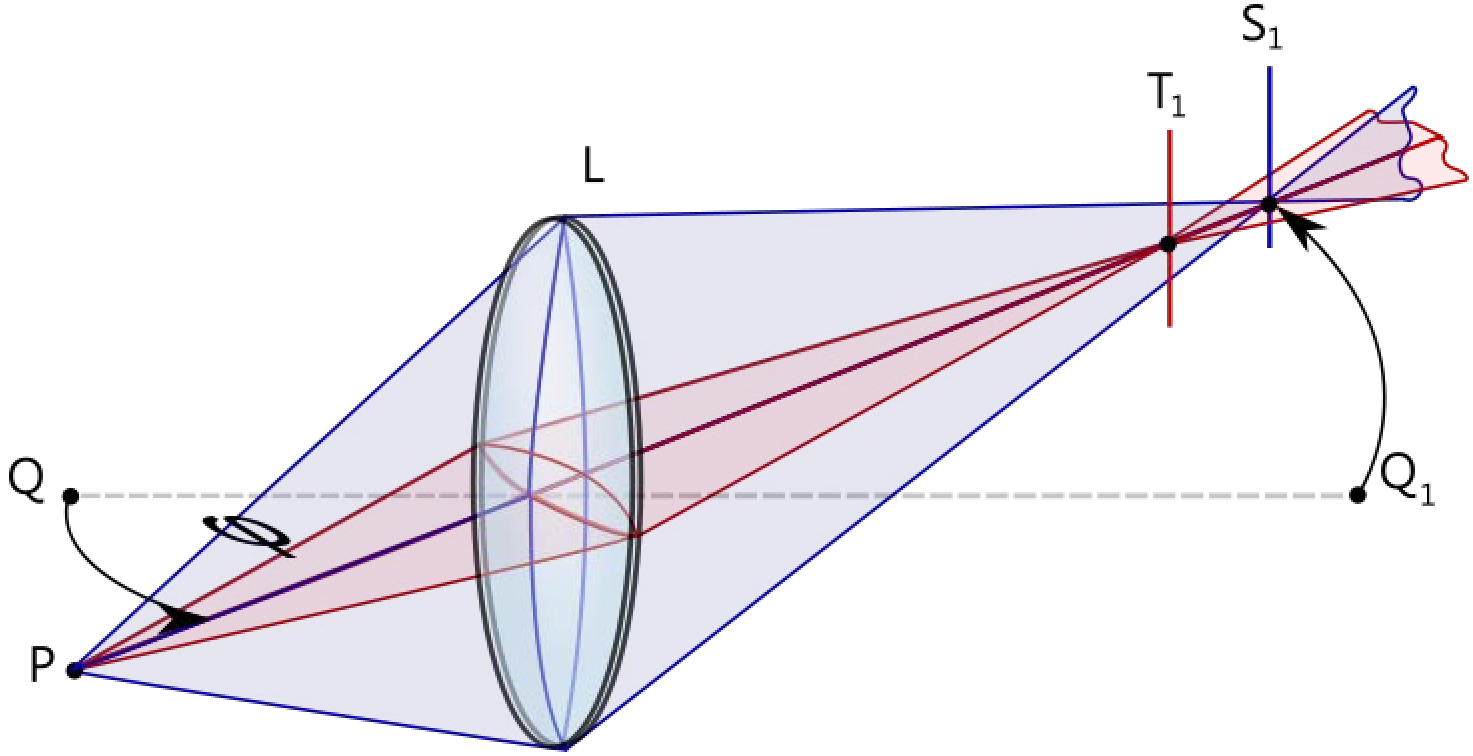
	Rot	Grün	Blau
$n_{\mathrm{Umg}} =$	1	1	1
$n_{\mathrm{Linse}} =$	2	2.2	2.5

show: ☑ Rot ☑ Grün ☑ Blau plot



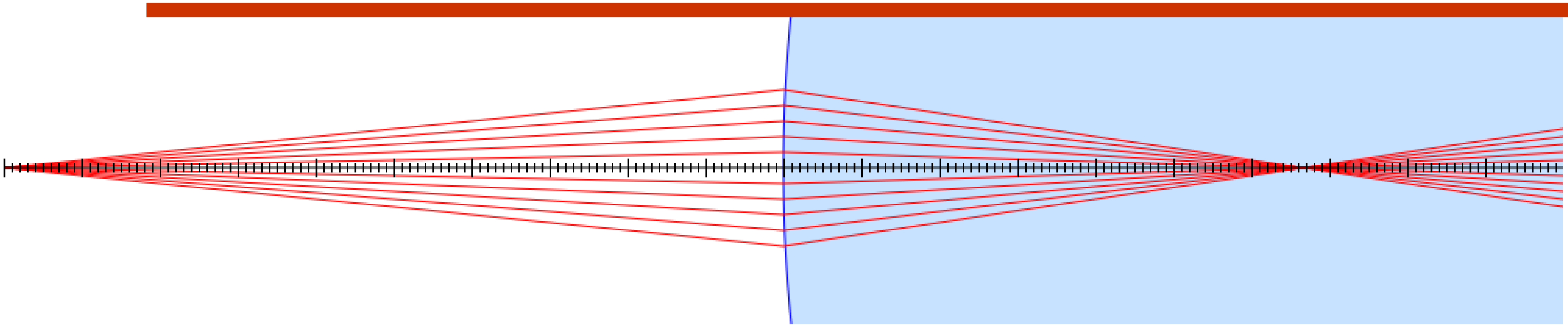
Astigmatismus

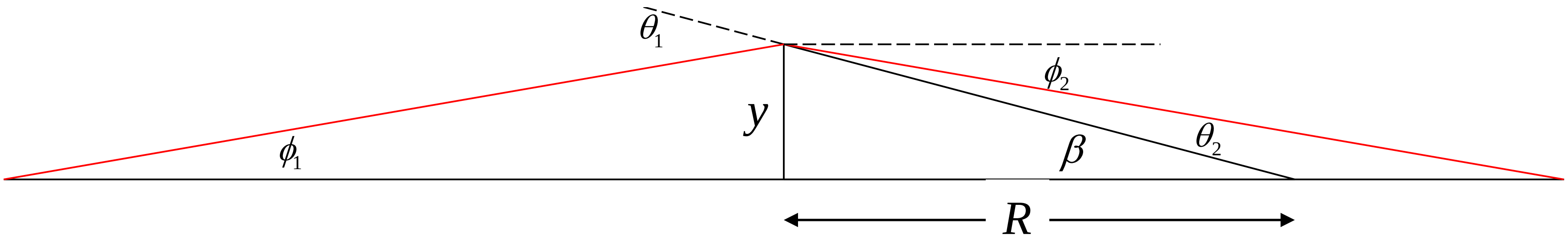
Die Brechung hängt von der Einfallsebene ab.



https://en.wikipedia.org/wiki/Astigmatism#/media/File:Astigmatism.svg

Methode 2: kleinen Winkeln zur optischen Achse





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

$$\downarrow$$

$$n_1\theta_1 \approx n_2\theta_2$$

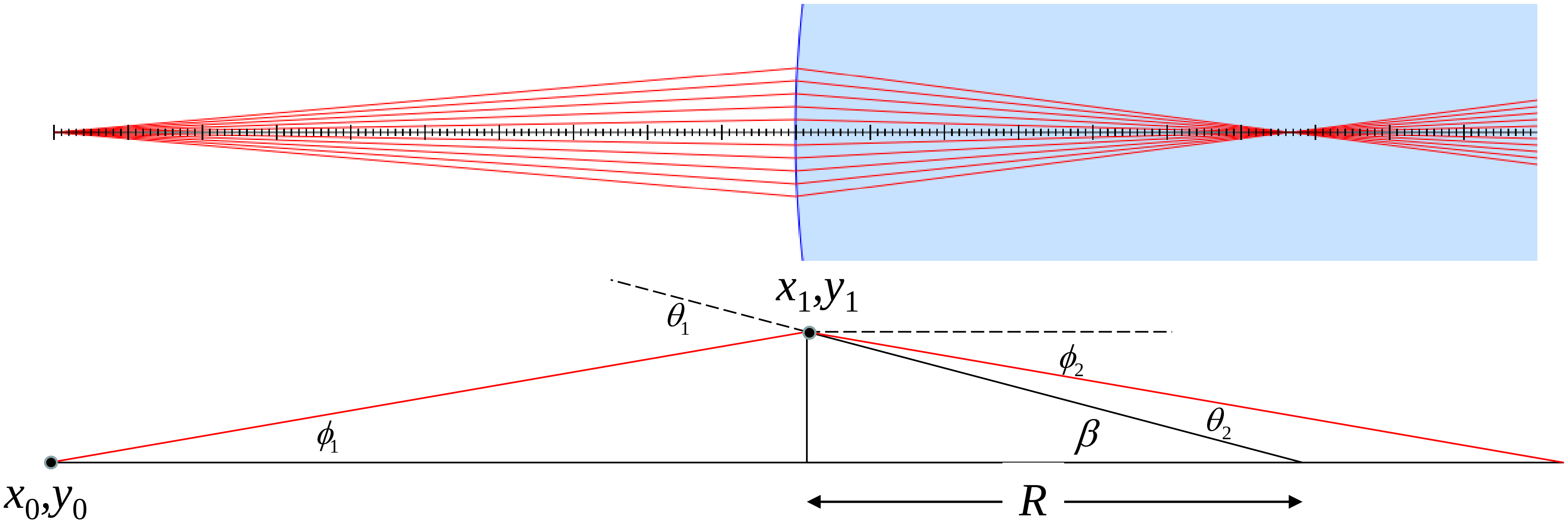
$$\theta_1 = \phi_1 + \beta$$

$$-\phi_2 + \theta_2 = \beta$$

$$\beta \approx \frac{y}{R}$$

$$\boxed{\phi_2 = \frac{n_1 - n_2}{n_2 R} y + \frac{n_1}{n_2}\phi_1}$$

Methode 2: kleinen Winkeln zur optischen Achse



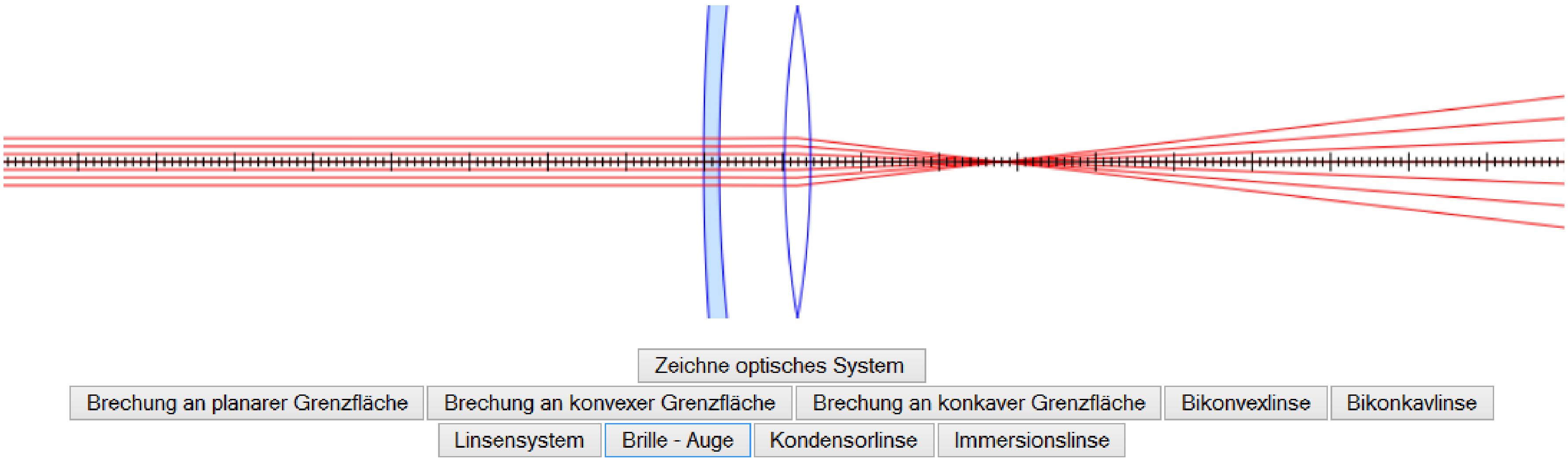
zwischen Grenzflächen

$$y_{i+1} = y_i + \phi_i (x_{i+1} - x_i)$$

bei Grenzfläche

$$\phi_{i+1} = \frac{n_1 - n_2}{n_2 R} y_i + \frac{n_1}{n_2} \phi_i$$

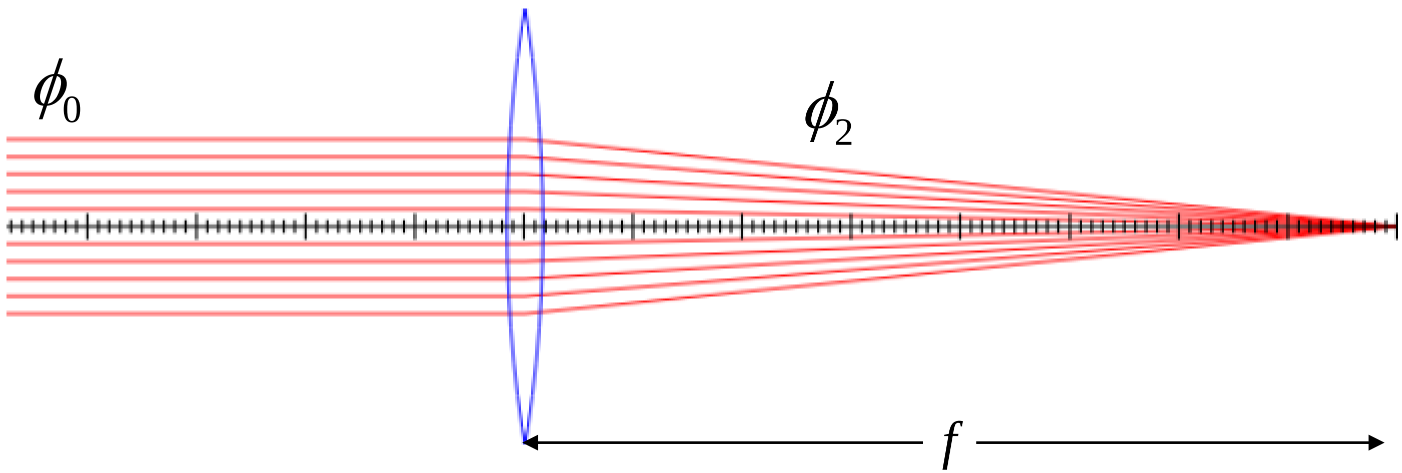
Ray tracing mittels Transfermatrixmethode



zwischen Grenzflächen $$y_{i+1} = y_i + \phi_i (x_{i+1} - x_i)$$

bei Grenzfläche $$\phi_{i+1} = \frac{n_1 - n_2}{n_2 R} y_i + \frac{n_1}{n_2} \phi_i$$

Methode 3: dünne Linsen



$$\phi_1 = \frac{n_0 - n_1}{n_1 R_1} y + \frac{n_0 \phi_0}{n_1}$$

Brennweite

$$\phi_2 = \frac{n_1 - n_0}{n_0 R_2} y + \frac{n_1}{n_0}\left(\frac{n_0 - n_1}{n_1 R_1} y + \frac{n_0 \phi_0}{n_1} \right)$$

$$\boxed{\phi_2 = -\frac{y}{f} + \phi_0}$$

$$\frac{1}{f} = \left(\frac{n_1 - n_0}{n_0} \right)\left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

Linsenmacherformel