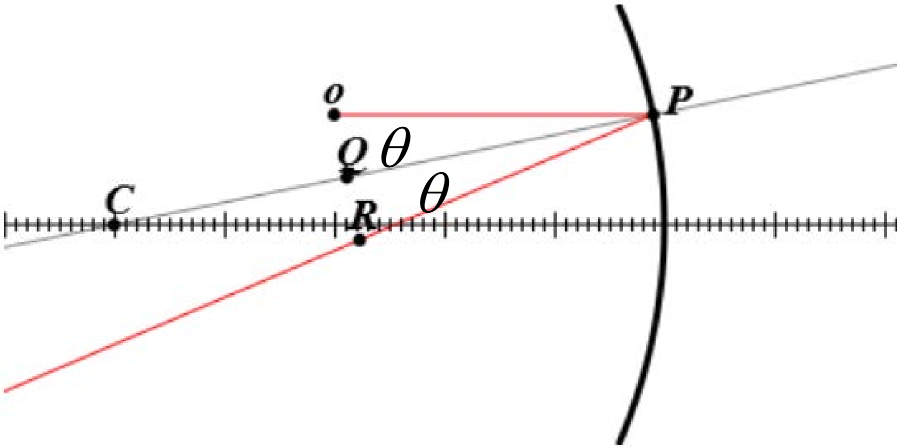
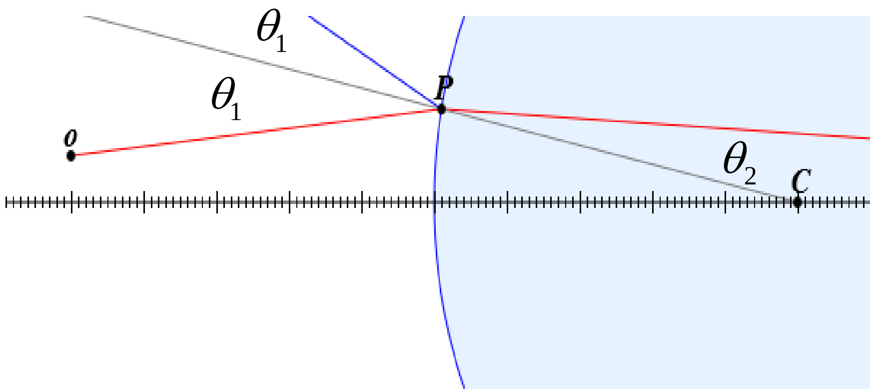
Geometrische Optik

Spiegel:
Einfallswinkel = Reflexionswinkel



Linsen:
Snelliussches Brechungsgesetz

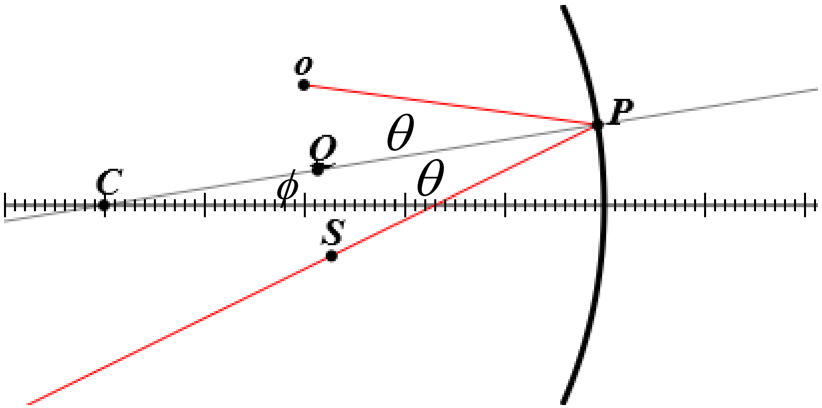


$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

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

Spiegel

Einfallswinkel = Reflexionswinkel



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

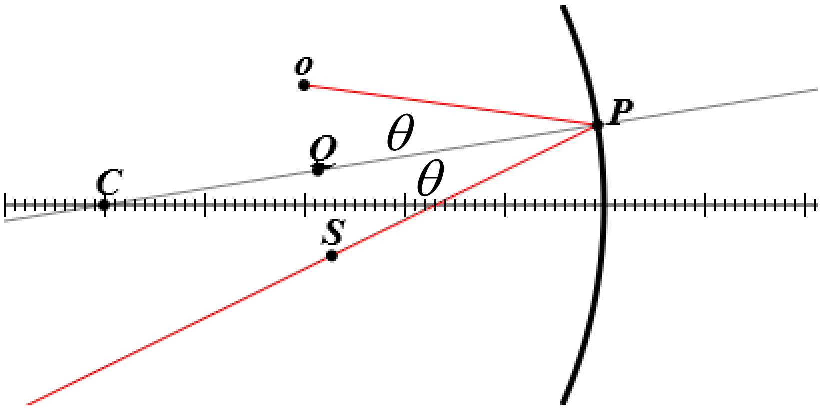
$$\overrightarrow{PC} = (x_C - x_P)\hat{x} + (y_C - y_P)\hat{y}$$

$$\overrightarrow{PC} \cdot \overrightarrow{Po} = \left|\overrightarrow{PC}\right|\left|\overrightarrow{Po}\right| \cos\theta$$

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

Spiegel

Einfallswinkel = Reflexionswinkel



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

$$\widehat{PC} = \frac{x_C - x_P}{\sqrt{(x_C - x_P)^2 + (y_C - y_P)^2}}\hat{x} + \frac{y_C - y_P}{\sqrt{(x_C - x_P)^2 + (y_C - y_P)^2}}\hat{y}$$

$$\overrightarrow{PQ} = \overrightarrow{Po} \cdot \widehat{PC}$$

$$\overrightarrow{Qo} = \overrightarrow{Po} - \overrightarrow{PQ}$$

$$\overrightarrow{oS} = -2\overrightarrow{Qo}$$

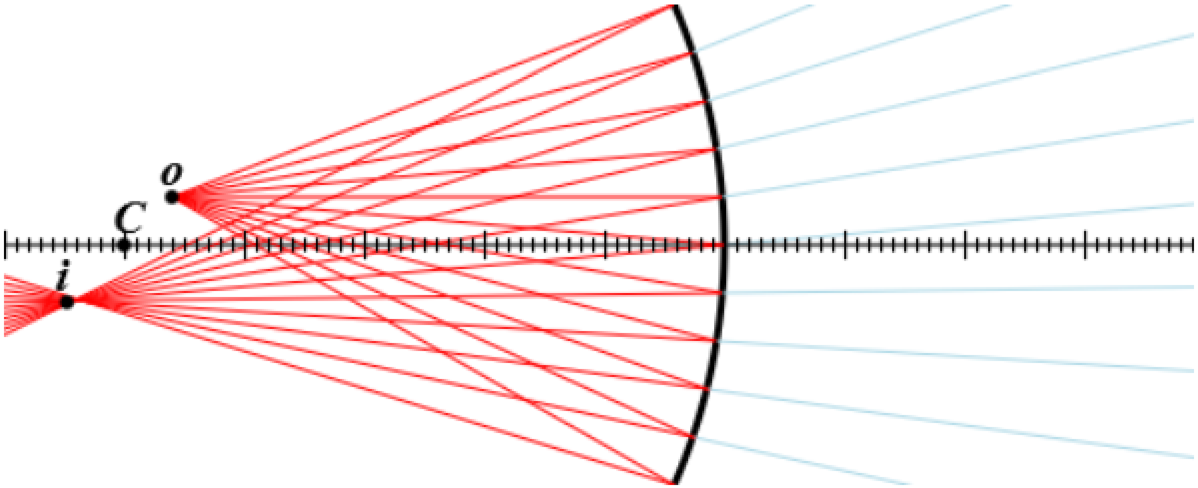
Spiegel

$R =$ -5 [cm]

$x_o =$ -4.6 [cm]

$y_o =$ 0.4 [cm]

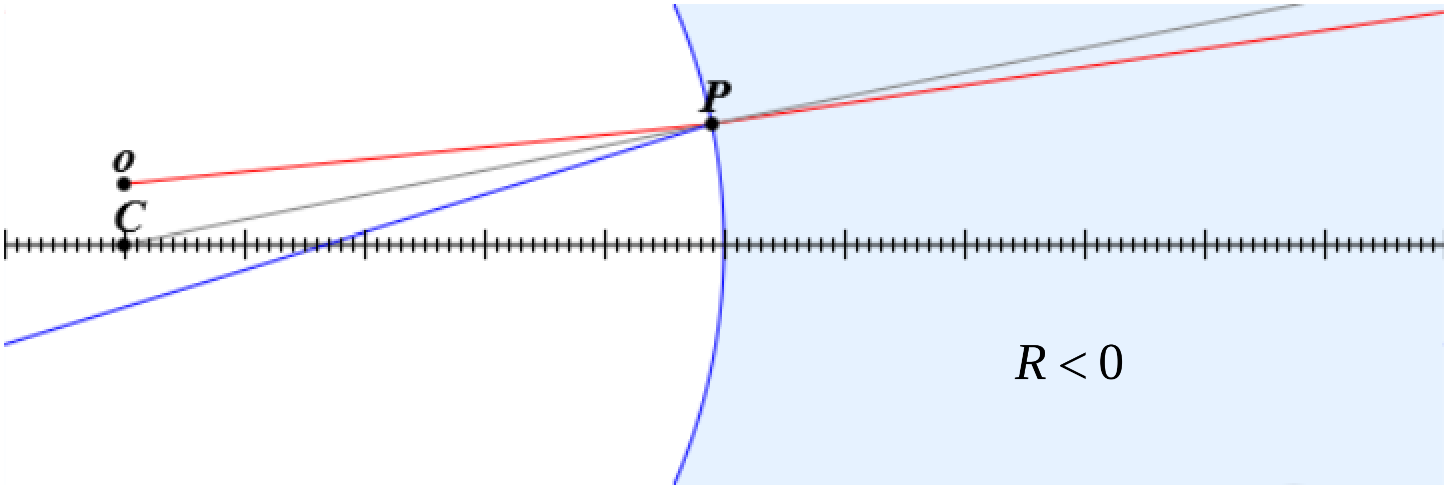
plot

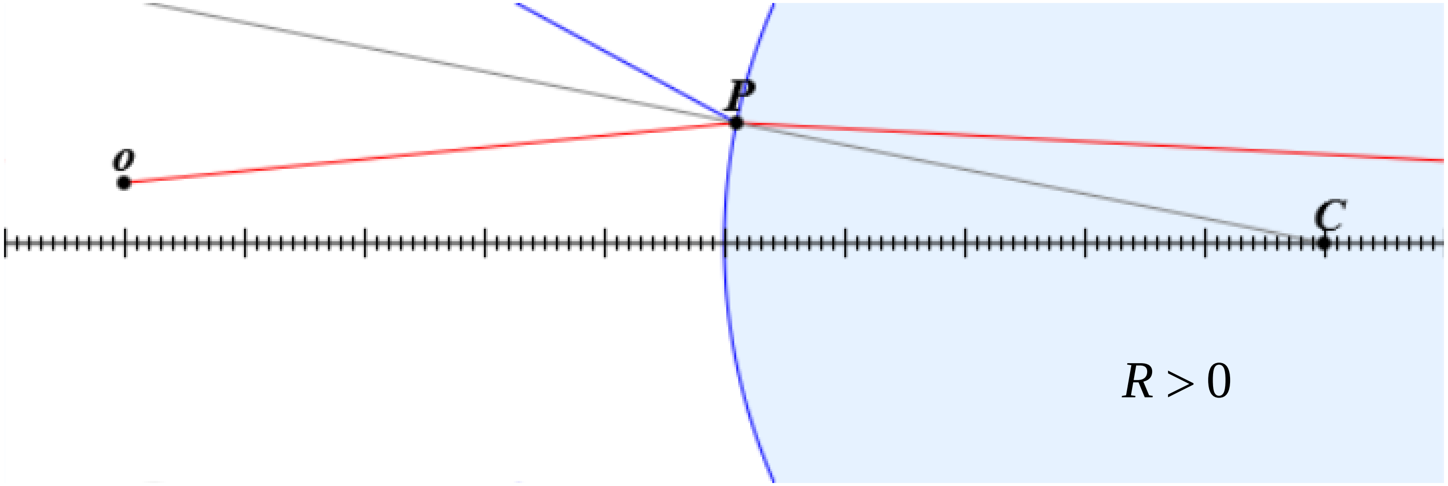


$$\frac{1}{x_o} + \frac{1}{x_i} = \frac{2}{R},$$

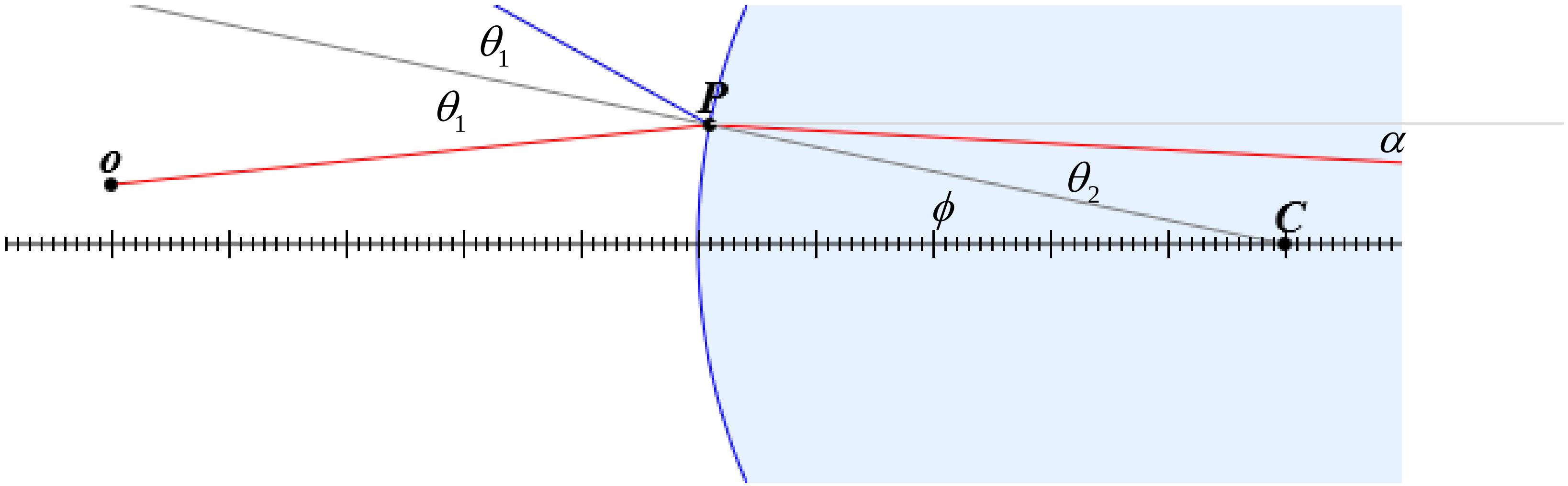
$$y_i = \frac{-y_o R}{2(x_o - R/2)}.$$

Brechung an einer gekrümmten Grenzfläche





Snelliussches Brechungsgesetz



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

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

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

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

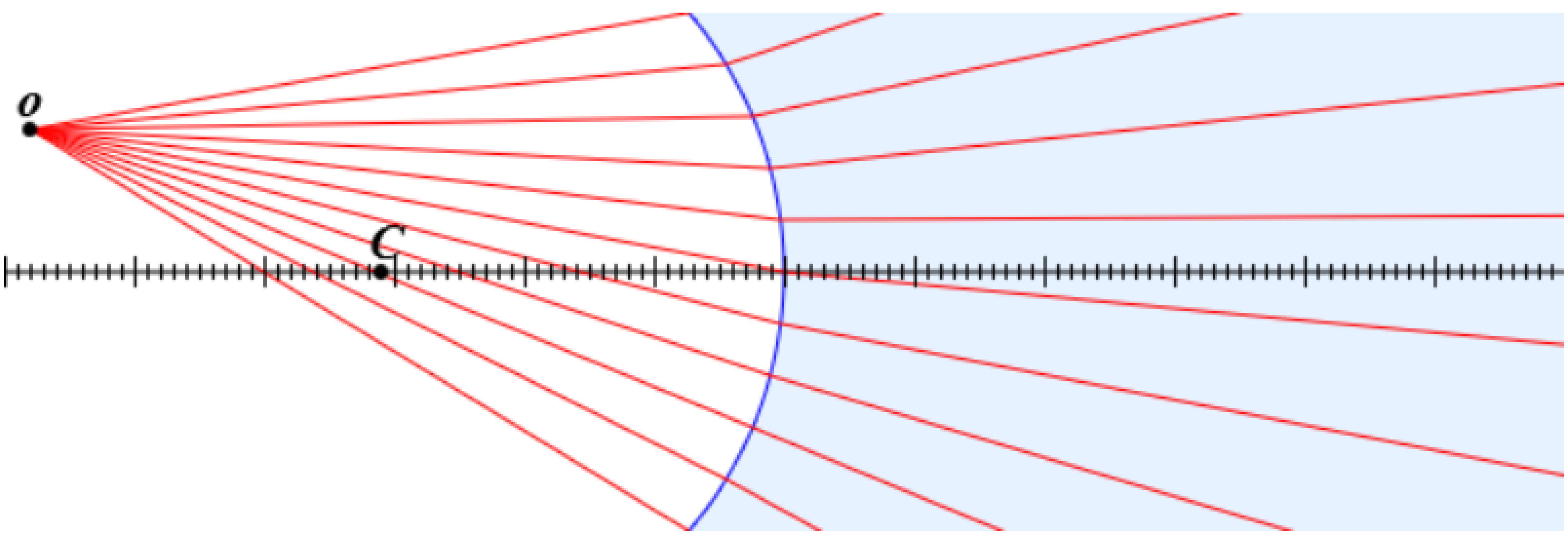
$$\alpha = \phi - \theta_2$$

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

Brechung an einer gekrümmten Grenzfläche (2)

$R =$	-3.1	[cm]
$x_o =$	-5.8	[cm]
$y_o =$	1.1	[cm]
$n_1 =$	1	
$n_2 =$	2	

plot

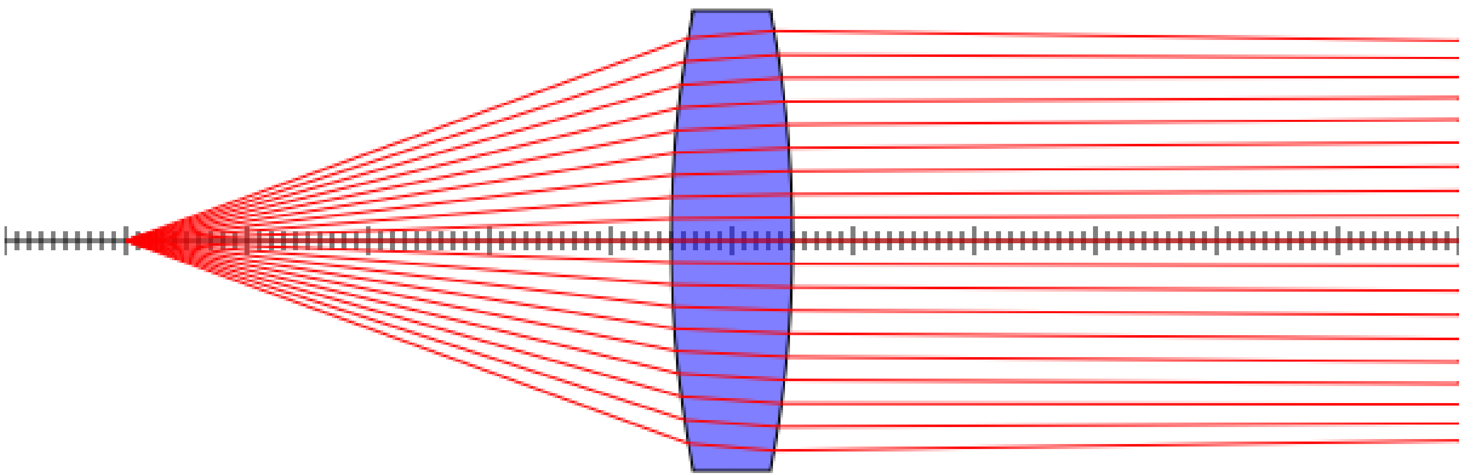


Dicke Linsen

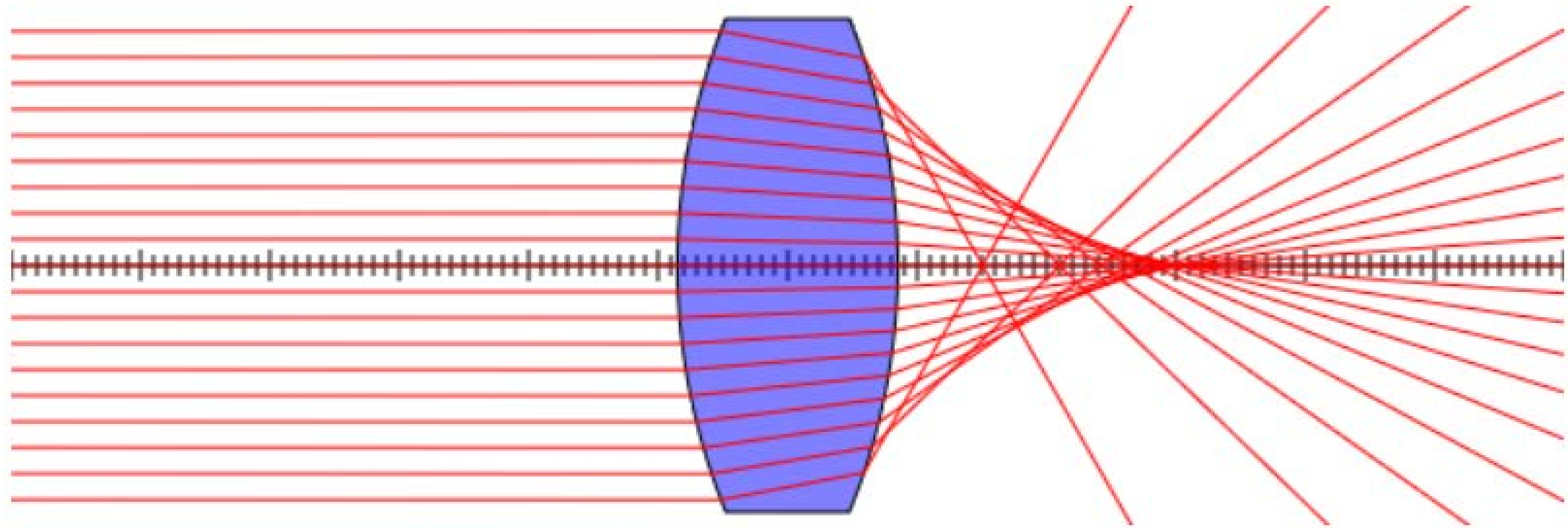
$R_1 =$	10	[cm]	
$R_2 =$	-10	[cm]	
$d =$	1	[cm]	
$x_o =$	-5	[cm]	
$y_o =$	0	[cm]	

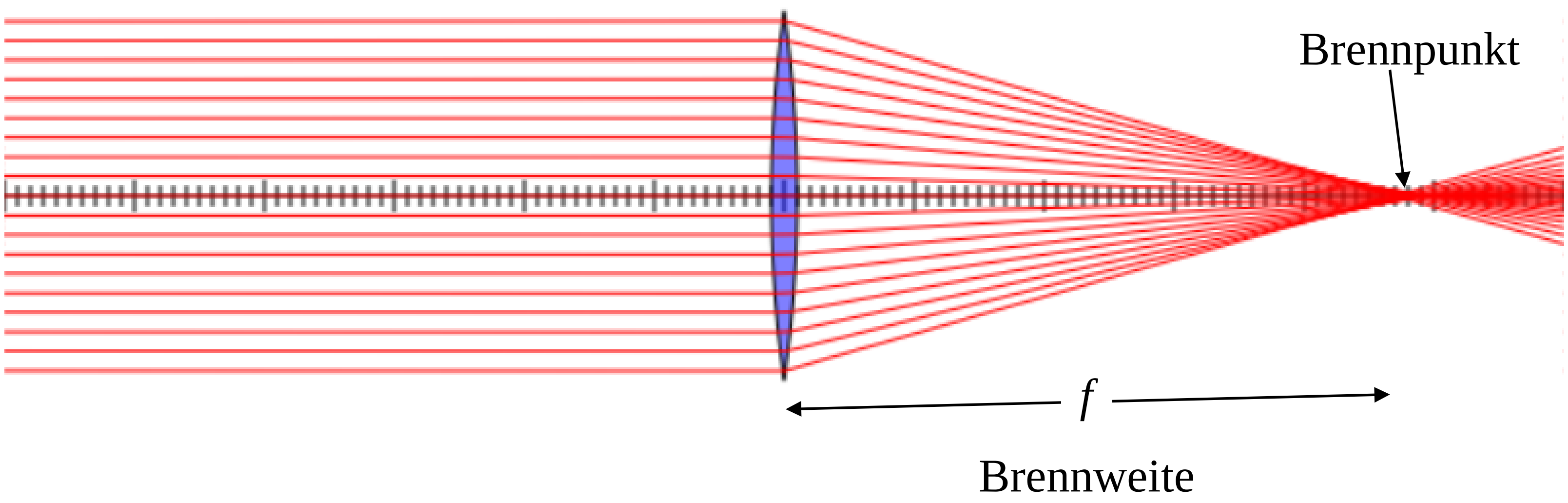
	Rot	Grün	Blau
$n_{\text{Umg}} =$	1	1	1
$n_{\text{Linse}} =$	2	2.5	3

show: ☑ Rot ☐ Grün ☐ Blau plot

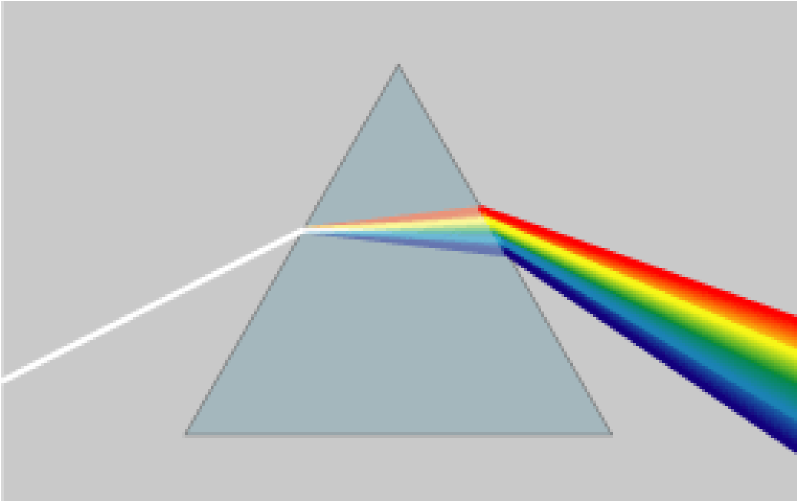


Sphärische Aberration





Dispersion



$$n(\lambda)$$

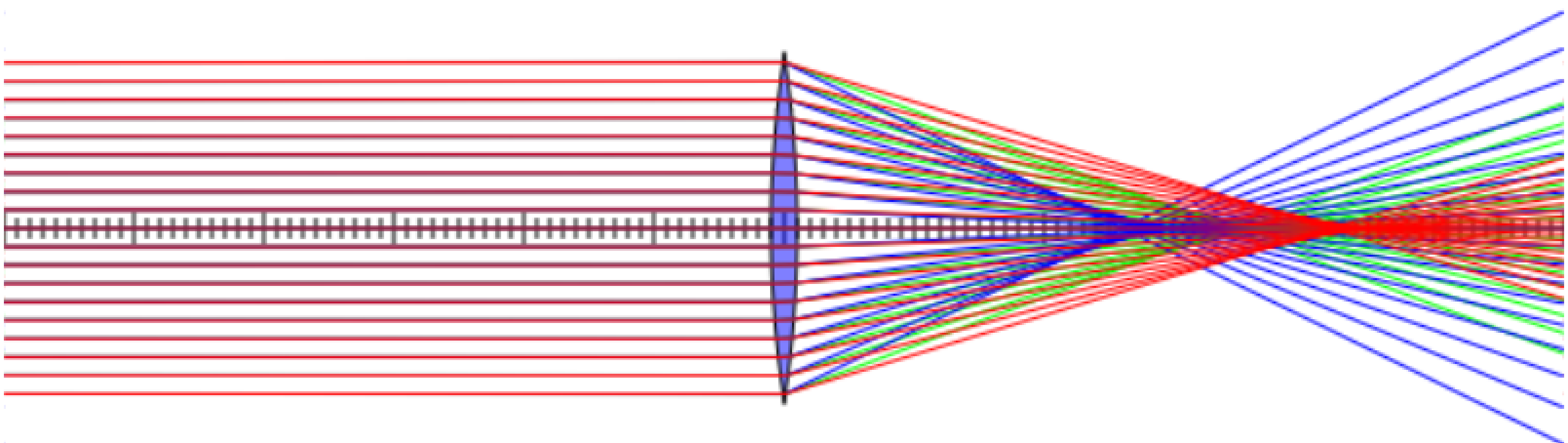
Brechungsindex

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

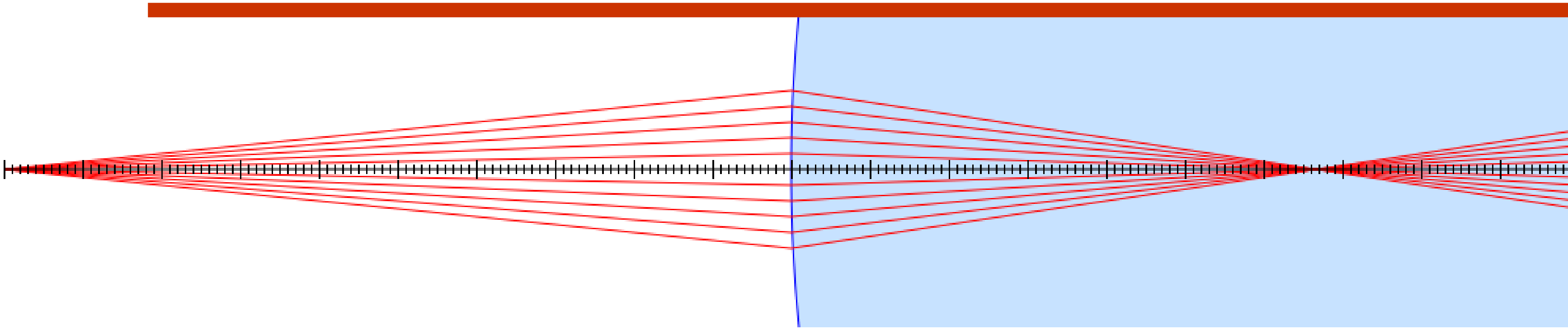
Chromatische Aberration

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

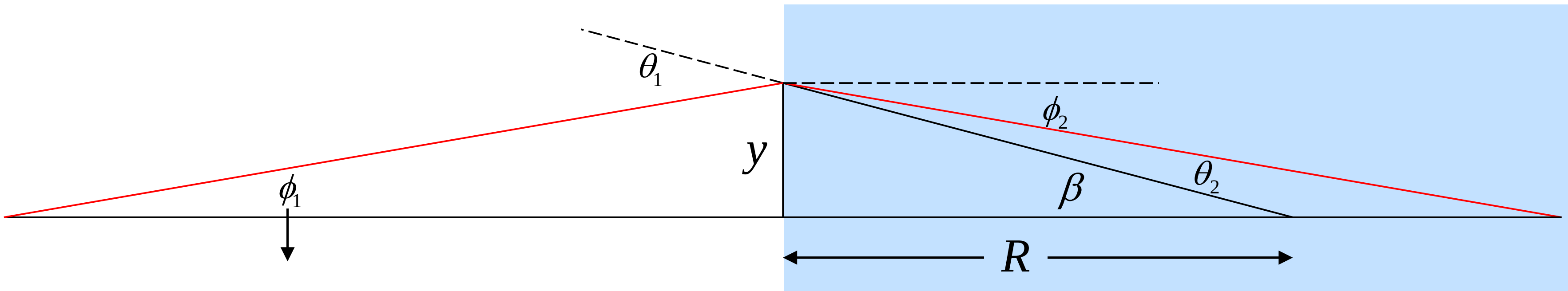
show: ☑ Rot ☑ Grün ☑ Blau plot



kleinen Winkeln zur optischen Achse



$n_1 \sin\theta_1 = n_2 \sin\theta_2$ kleinen Winkeln $\longrightarrow$ $n_1\theta_1 \approx n_2\theta_2$



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

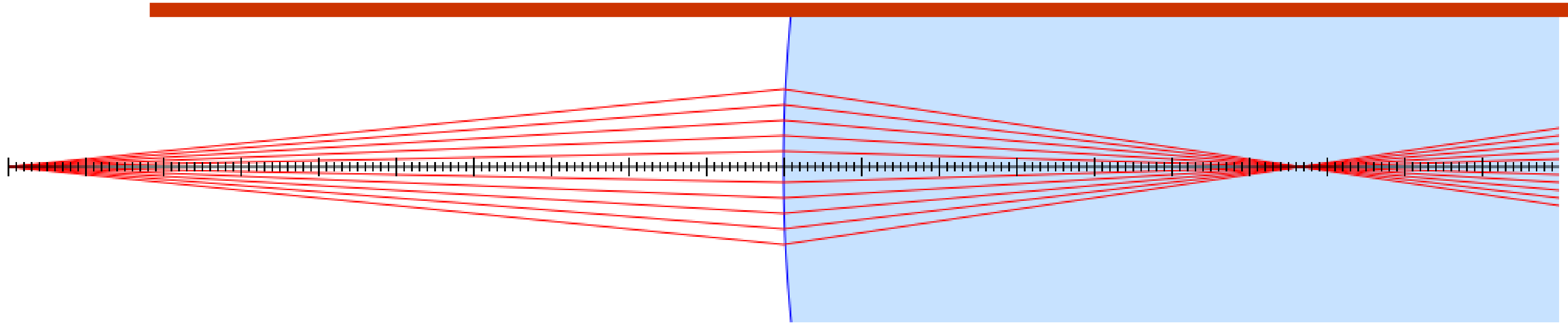
$$-\phi_2 + \theta_2 = \beta$$

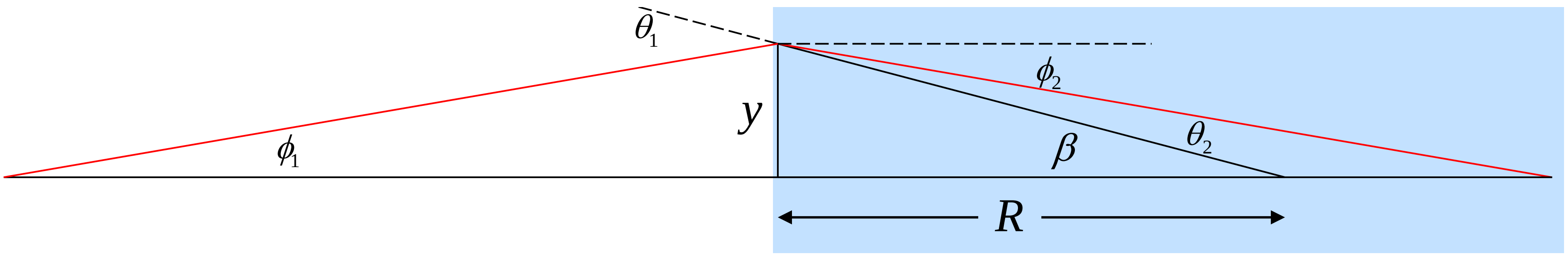
$$\phi_2 = \theta_2 - \beta$$

$$= \frac{n_1}{n_2}\theta_1 - \beta$$

$$= \frac{n_1}{n_2}(\phi_1 + \beta) - \beta$$

kleinen Winkeln zur optischen Achse





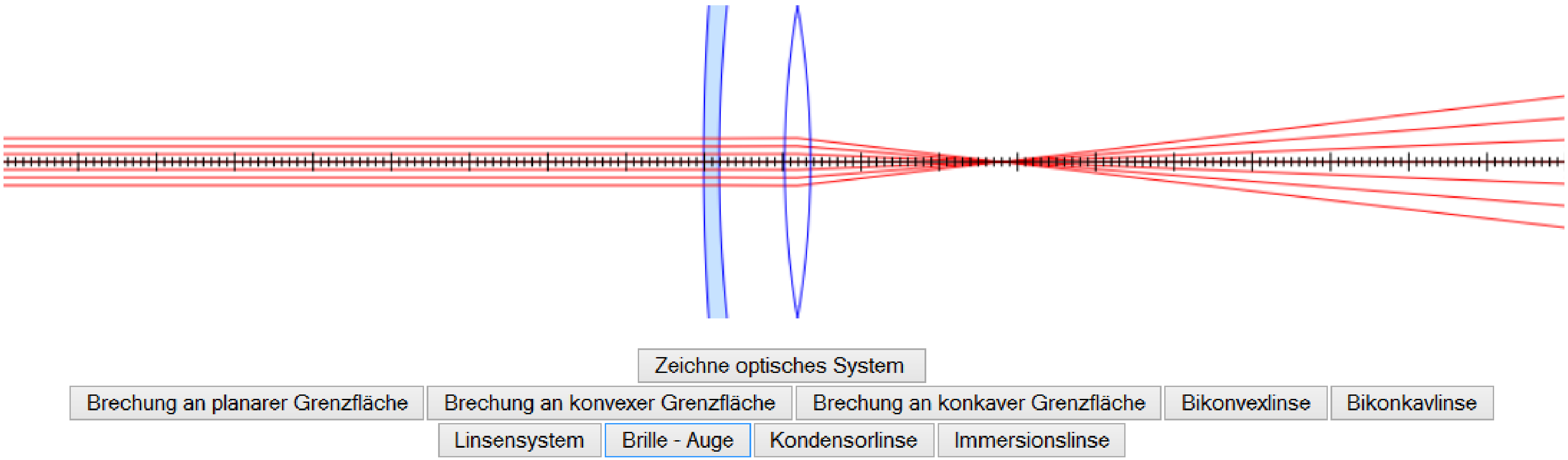
$$\phi_2 = \frac{n_1}{n_2}\left(\phi_1 + \beta\right) - \beta$$

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

$$\phi_2 = \frac{n_1}{n_2}\left(\phi_1 + \frac{y}{R}\right) - \frac{y}{R}$$

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

Ray tracing mittels Transfermatrixmethode



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

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