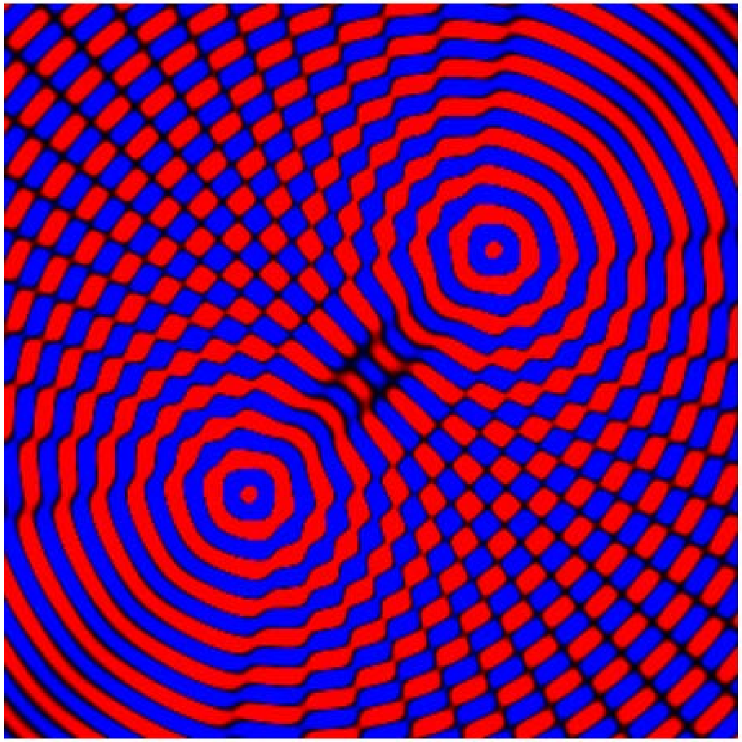
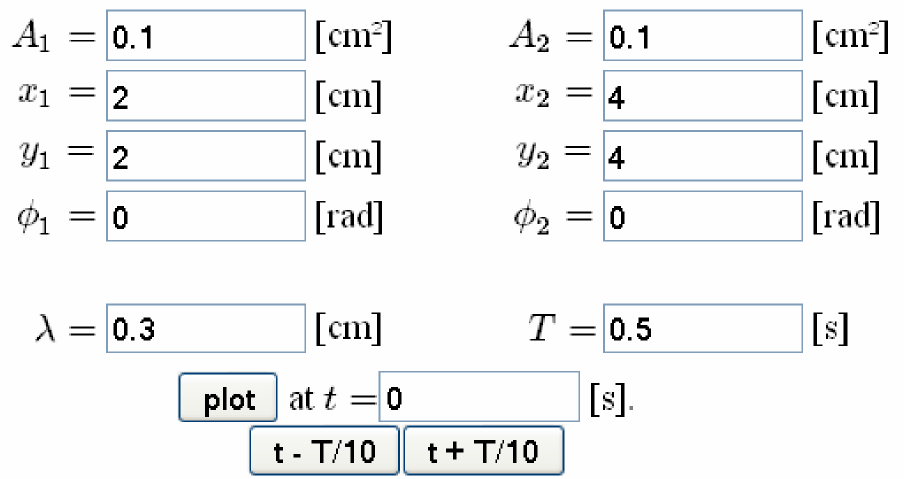
Wellen

Interferenz zweier Oberflächenwellen





$A_1 =$ 0.1 [cm²]

$x_1 =$ 2 [cm]

$y_1 =$ 2 [cm]

$\phi_1 =$ 0 [rad]

$A_2 =$ 0.1 [cm²]

$x_2 =$ 4 [cm]

$y_2 =$ 4 [cm]

$\phi_2 =$ 0 [rad]

$\lambda =$ 0.3 [cm]

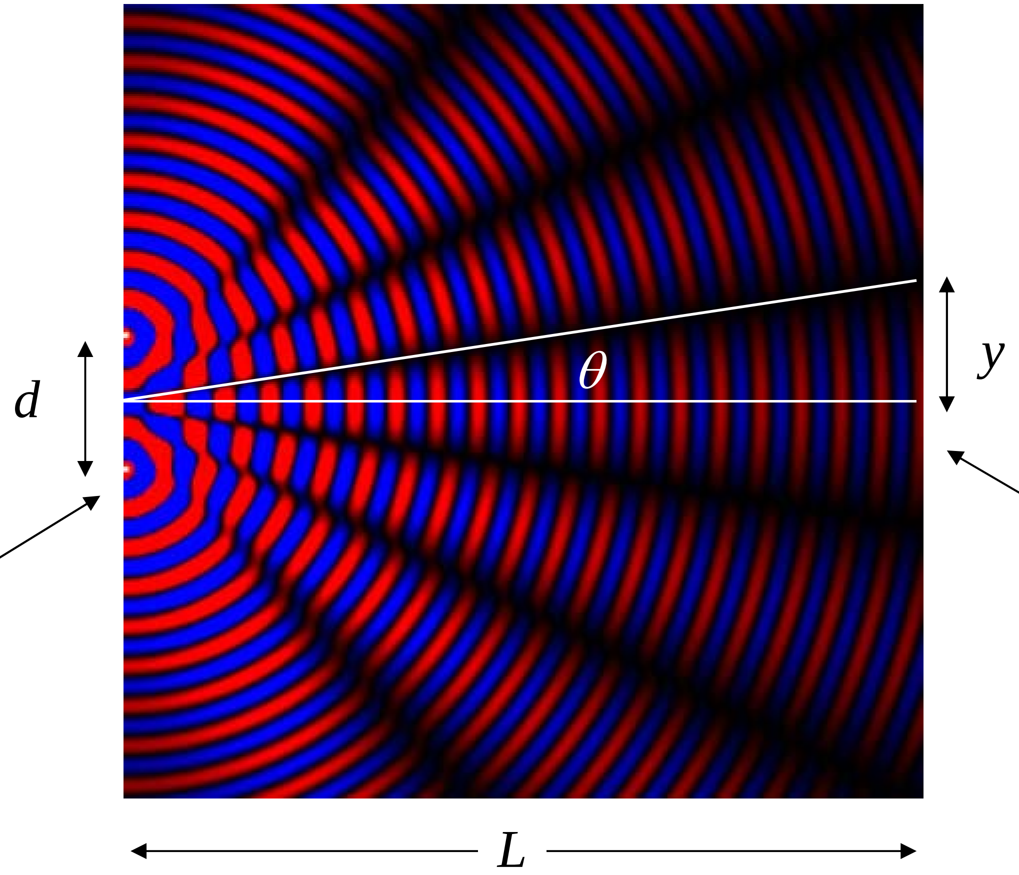
$T =$ 0.5 [s]

plot at $t =$ 0 [s].

$$c = \frac{\lambda}{T}$$

$$y(r,t) = \frac{A_1}{\sqrt{|r-r_1|}}\cos\left(k|r-r_1| - \omega t + \varphi_1\right) + \frac{A_2}{\sqrt{|r-r_2|}}\cos\left(k|r-r_2| - \omega t + \varphi_2\right)$$

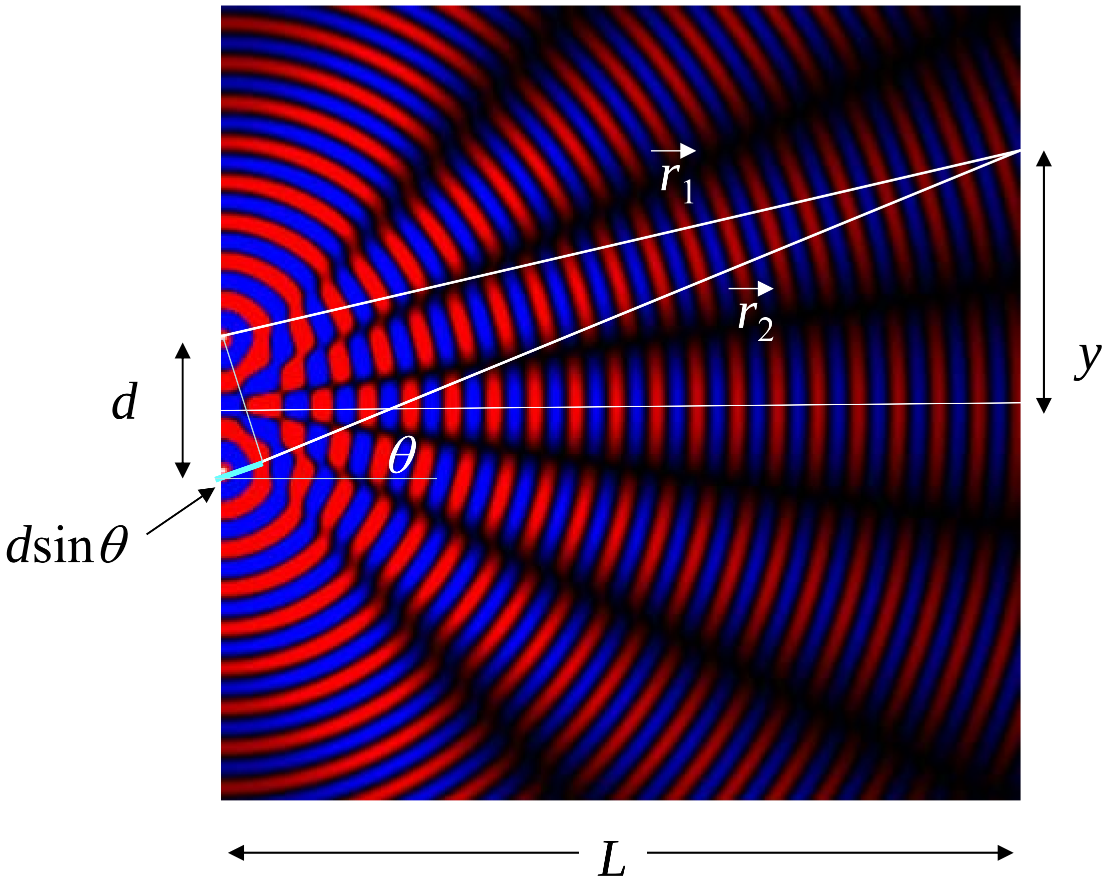
Nahfeld / Fernfeld



Nahfeld
L < λ

Fernfeld
L >> λ

Fernfeld

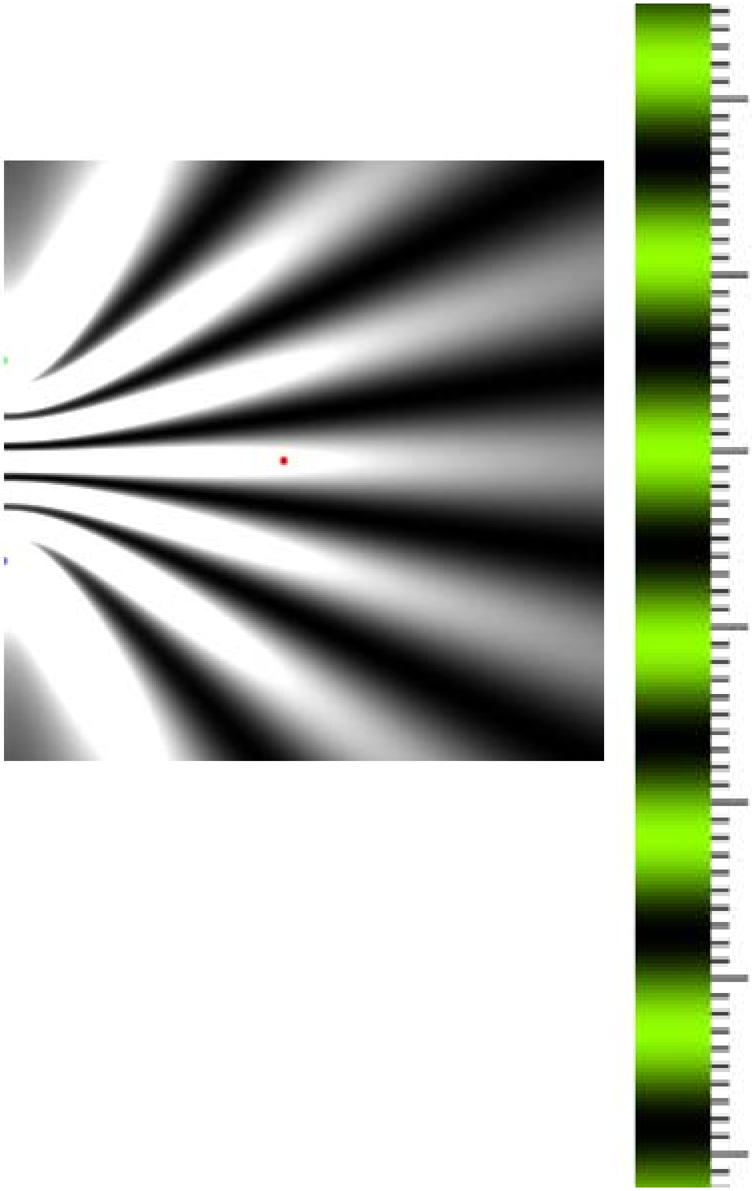


$$\theta \approx \frac{y}{L}$$

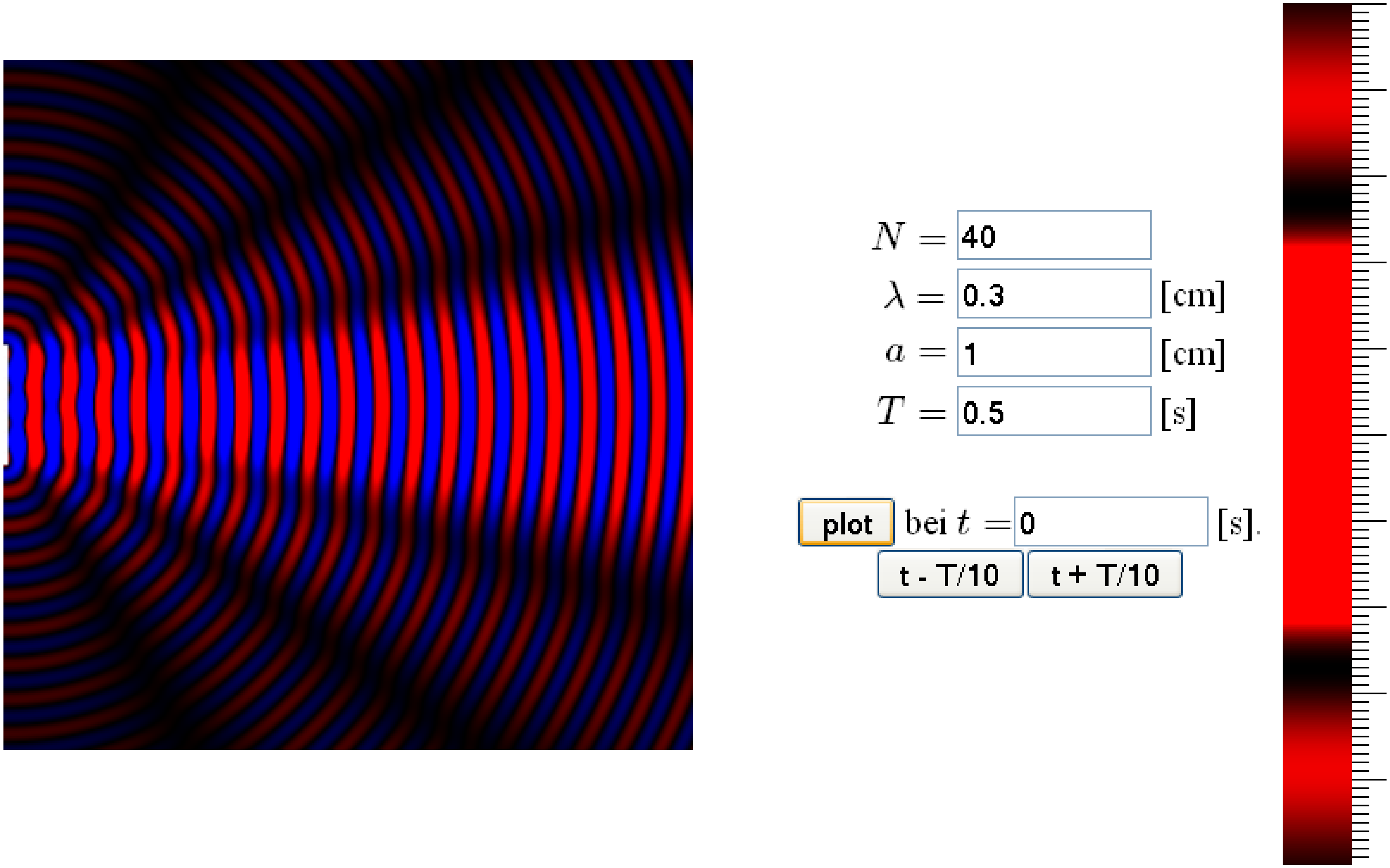
Konstruktive Interferenz: $|\vec{r}_2| - |\vec{r}_1| = n\lambda \approx d\sin\theta \approx \frac{yd}{L}$

Destruktive Interferenz: $|\vec{r}_2| - |\vec{r}_1| = \left(n + \tfrac{1}{2}\right)\lambda \approx d\sin\theta \approx \frac{yd}{L}$

Doppelspalt



Einfachspalt



$N =$ 40

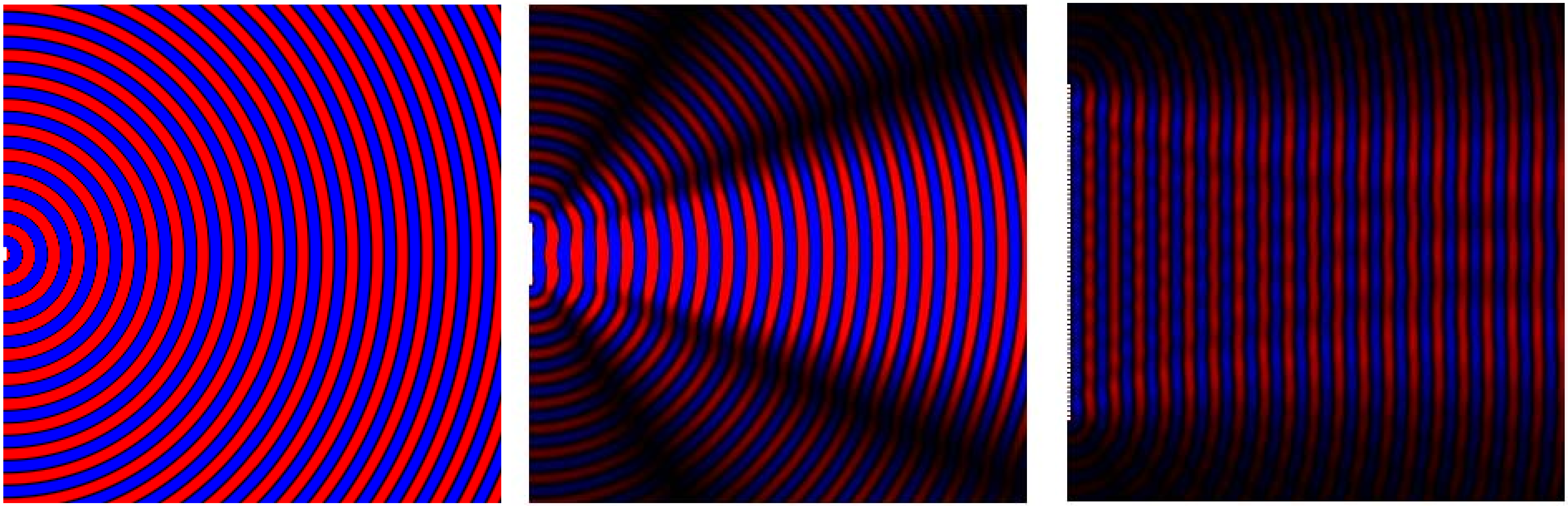
$\lambda =$ 0.3 [cm]

$a =$ 1 [cm]

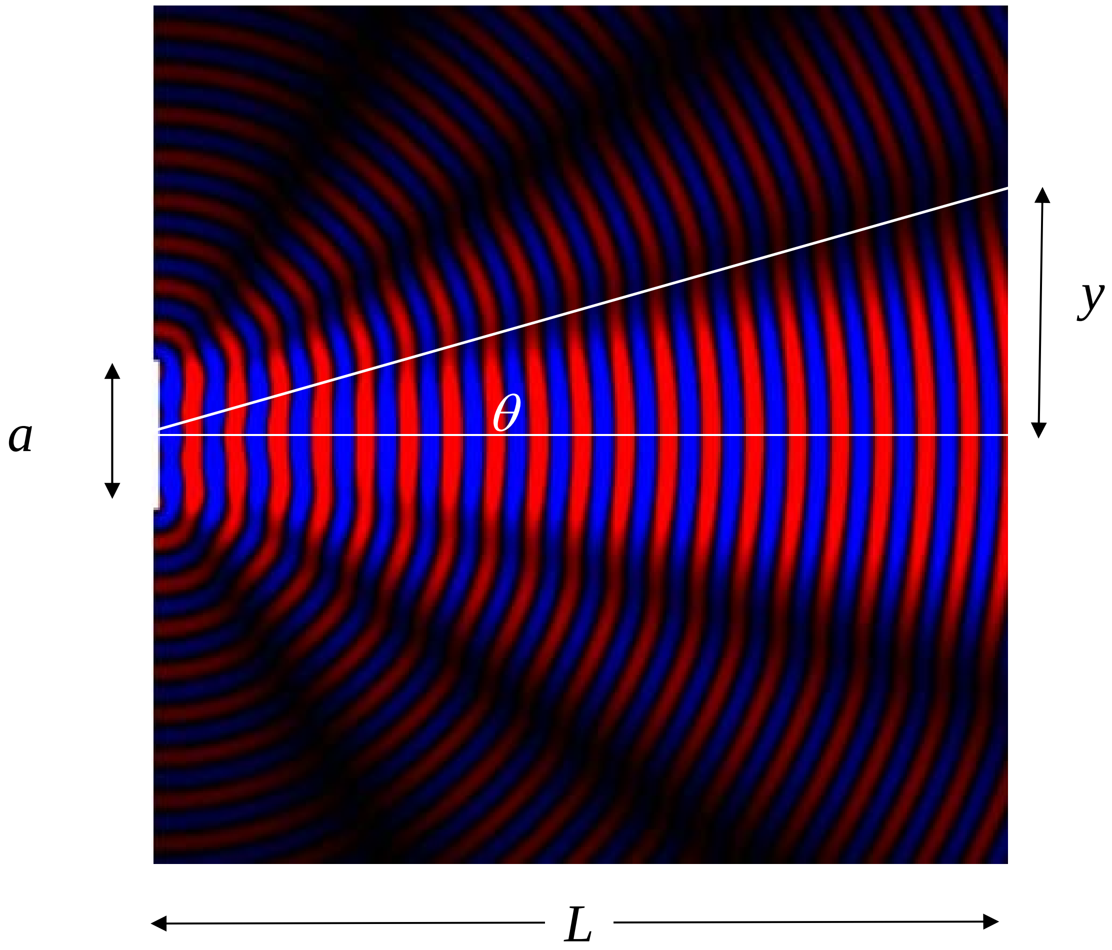
$T =$ 0.5 [s]

plot bei $t =$ 0 [s].

Beugung



Einfachspalt Beugung



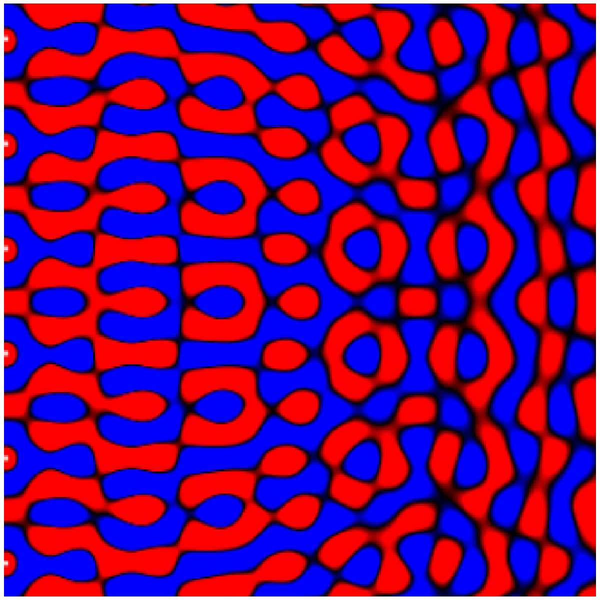
$$\theta \approx \frac{\lambda}{a}$$

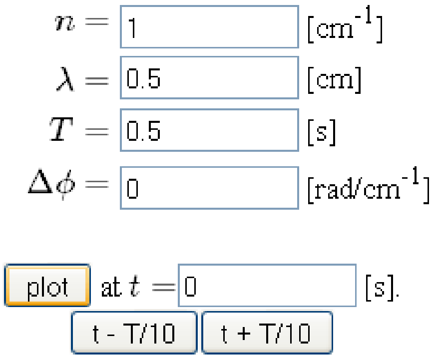
Destruktive Interferenz: $|\vec{r}_2| - |\vec{r}_1| = \frac{\lambda}{2} \approx \frac{a}{2}\sin\theta \approx \frac{ya}{2L}$

(Fernfeld)

ebene Wellen

1 Quelle/cm





$n =$ 1 [cm^{-1}]

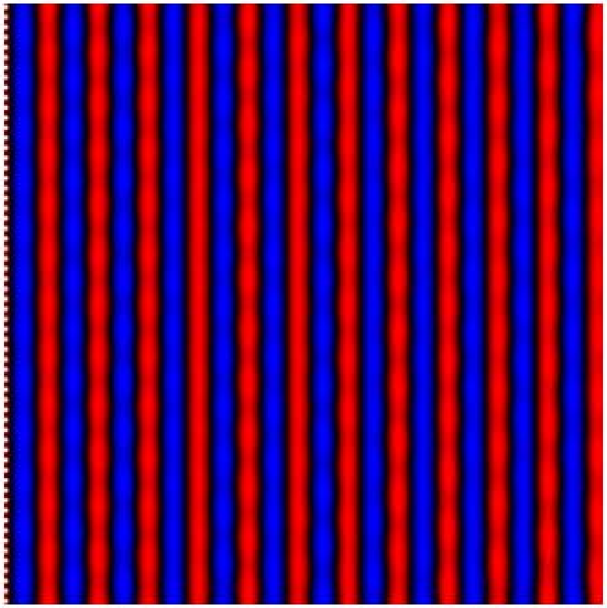
$\lambda =$ 0.5 [cm]

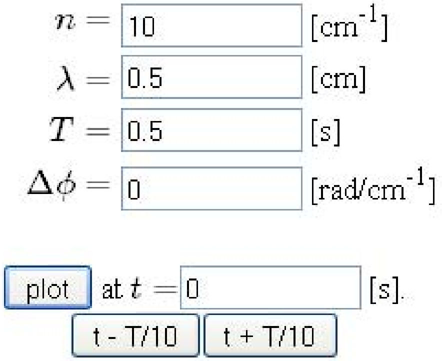
$T =$ 0.5 [s]

$\Delta\phi =$ 0 [rad/cm^{-1}]

plot at $t =$ 0 [s].

10 Quellen/cm





$n =$ 10 [cm^{-1}]

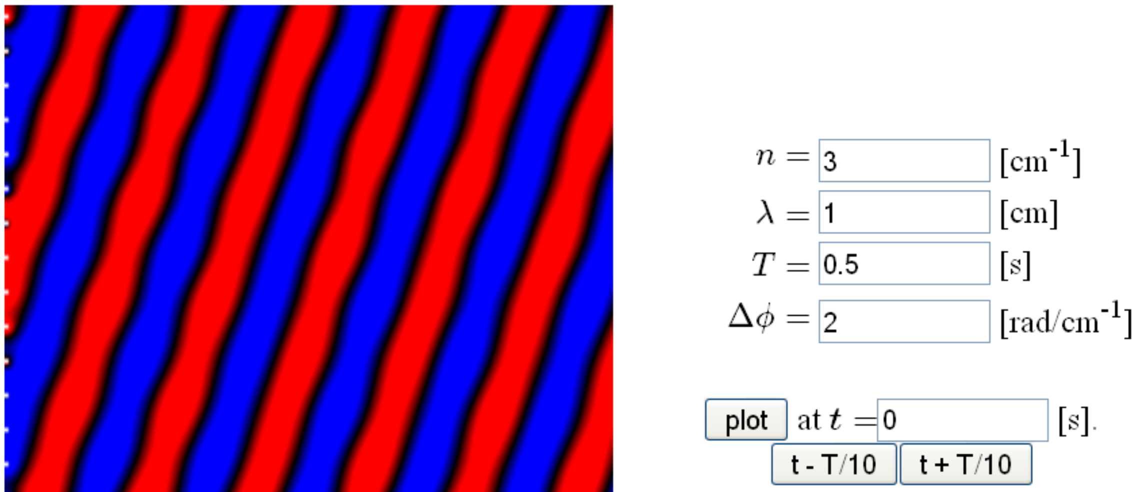
$\lambda =$ 0.5 [cm]

$T =$ 0.5 [s]

$\Delta\phi =$ 0 [rad/cm^{-1}]

plot at $t =$ 0 [s].

ebene Wellen



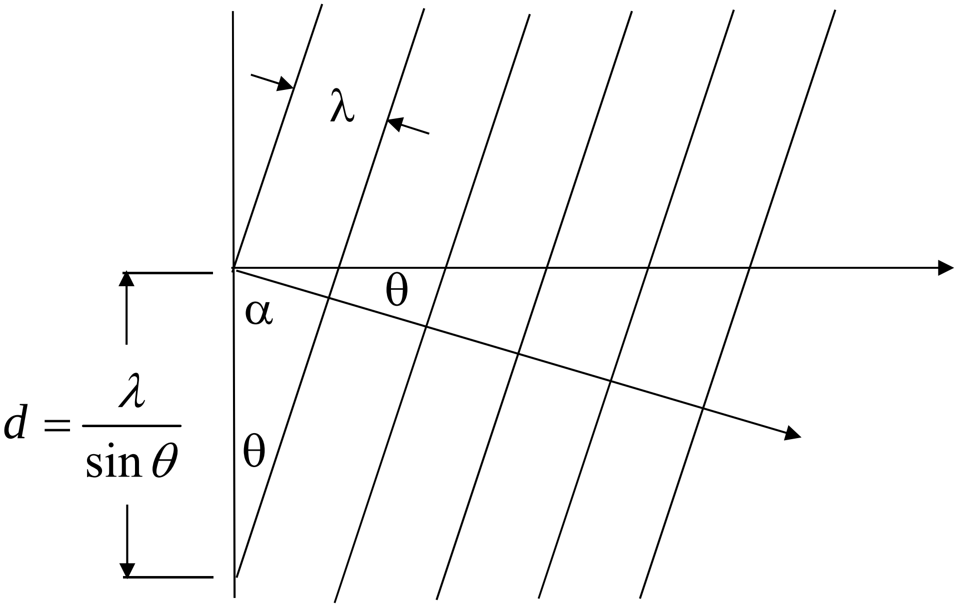
$n =$ 3 [cm^{-1}]

$\lambda =$ 1 [cm]

$T =$ 0.5 [s]

$\Delta\phi =$ 2 [rad/cm^{-1}]

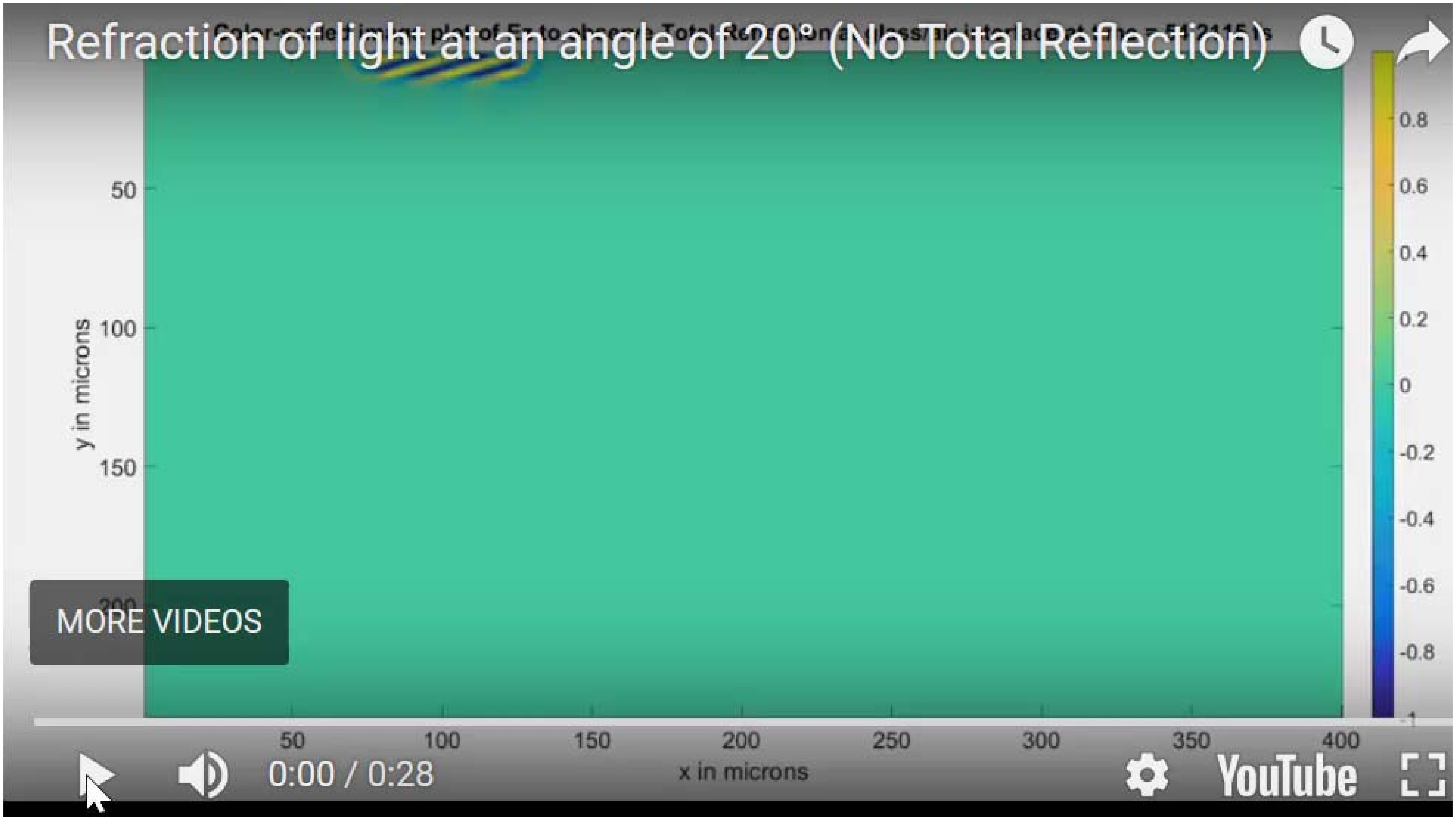
plot at $t =$ 0 [s].



$$d = \frac{\lambda}{\sin\theta}$$

$$\alpha = \pi/2 - \theta$$

Snelliussches Brechungsgesetz



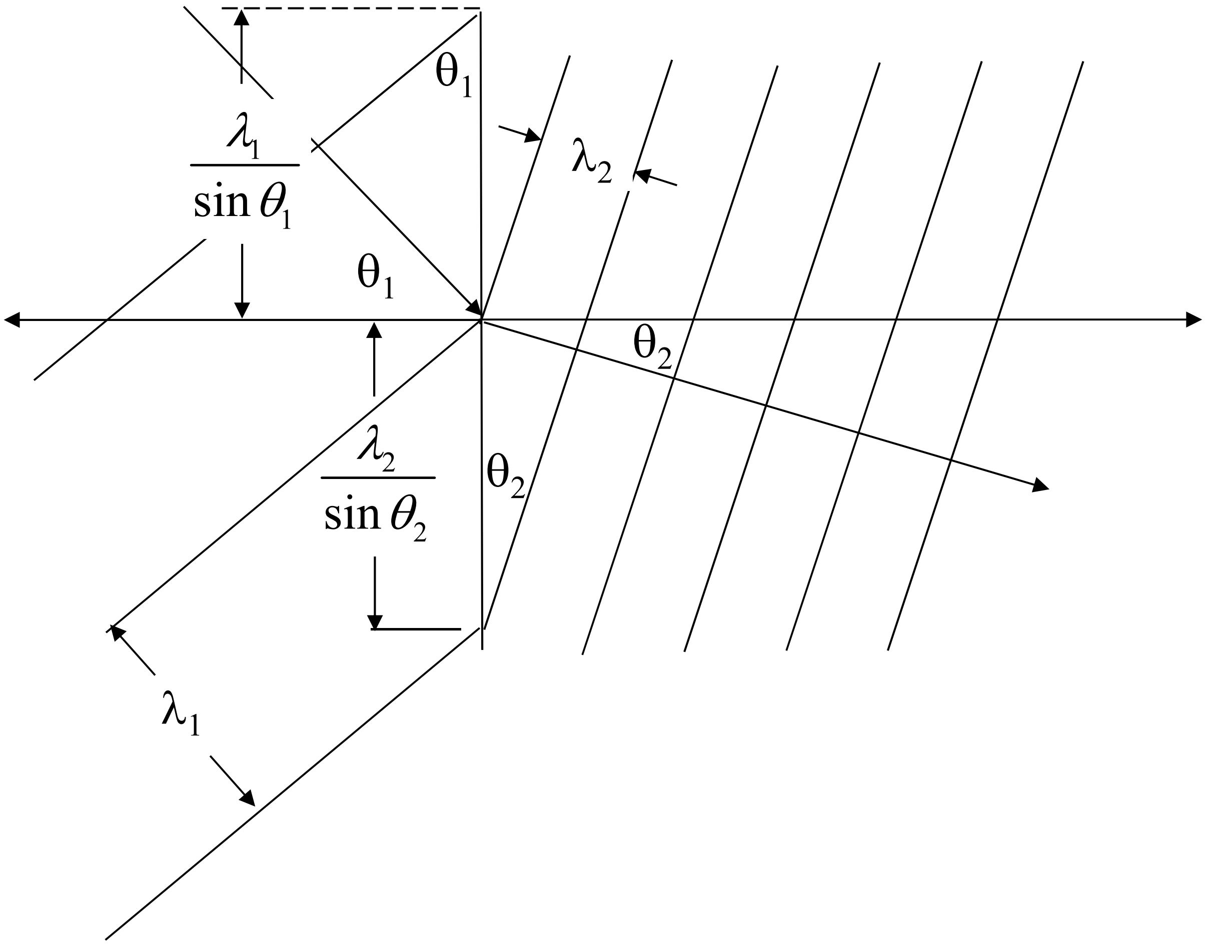
Refraction of light at an angle of 20° (No Total Reflection)

Snelliussches Brechungsgesetz

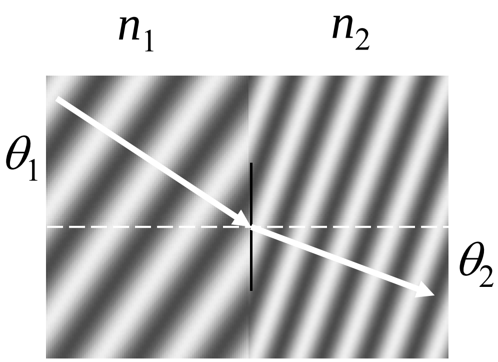
$$\frac{\lambda_1}{\sin\theta_1} = \frac{\lambda_2}{\sin\theta_2}$$

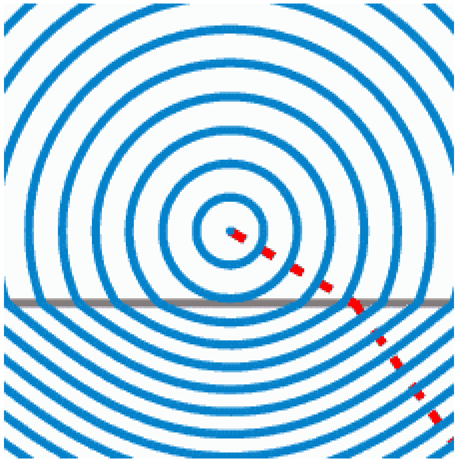
$$\lambda_1 = \frac{c_1}{f} \qquad \lambda_2 = \frac{c_2}{f}$$

$$\boxed{\frac{c_1}{\sin\theta_1} = \frac{c_2}{\sin\theta_2}}$$



Snelliussches Brechungsgesetz





$$\frac{\lambda_1}{\sin\theta_1} = \frac{\lambda_2}{\sin\theta_2}$$

$$\lambda_1 = \frac{c}{n_1 f} \qquad \lambda_2 = \frac{c}{n_2 f}$$

Brechungsindex

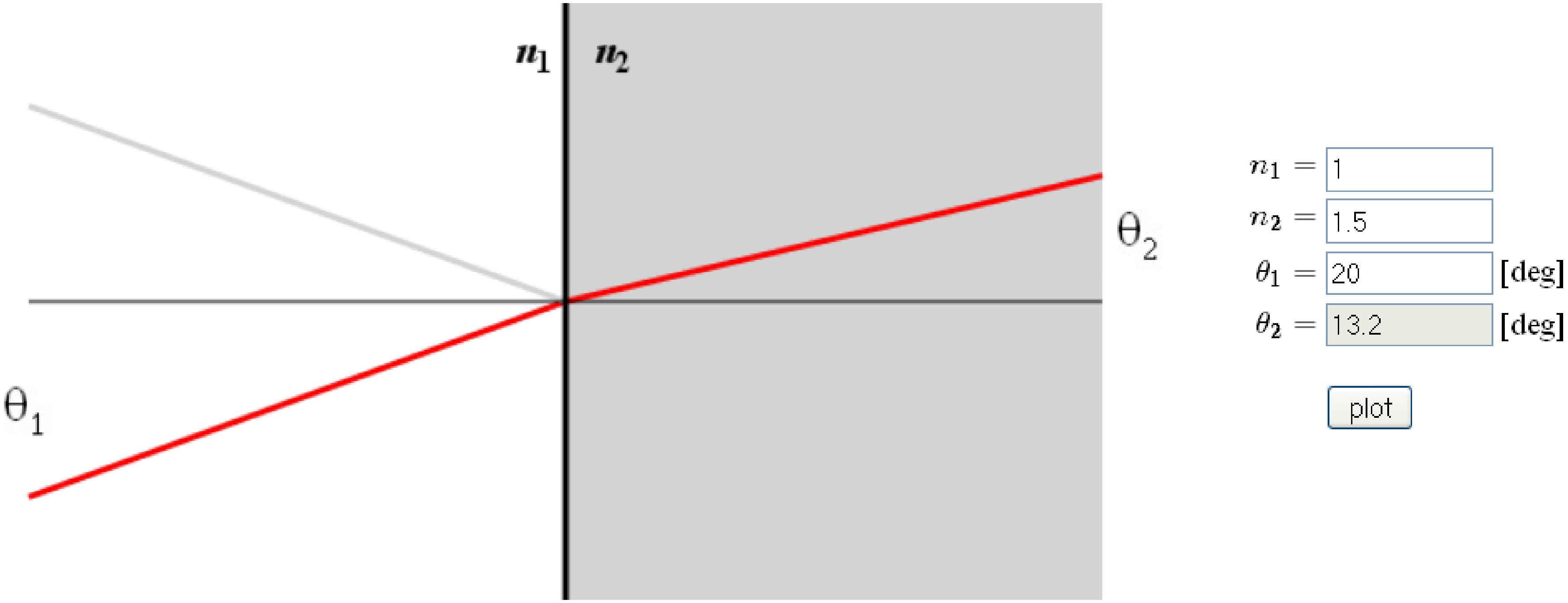
$$\boxed{n_1 \sin\theta_1 = n_2 \sin\theta_2}$$

http://commons.wikimedia.org/wiki/File:Wave_refraction.gif

http://commons.wikimedia.org/wiki/File:Snells_law_wavefronts.gif

Brechung

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



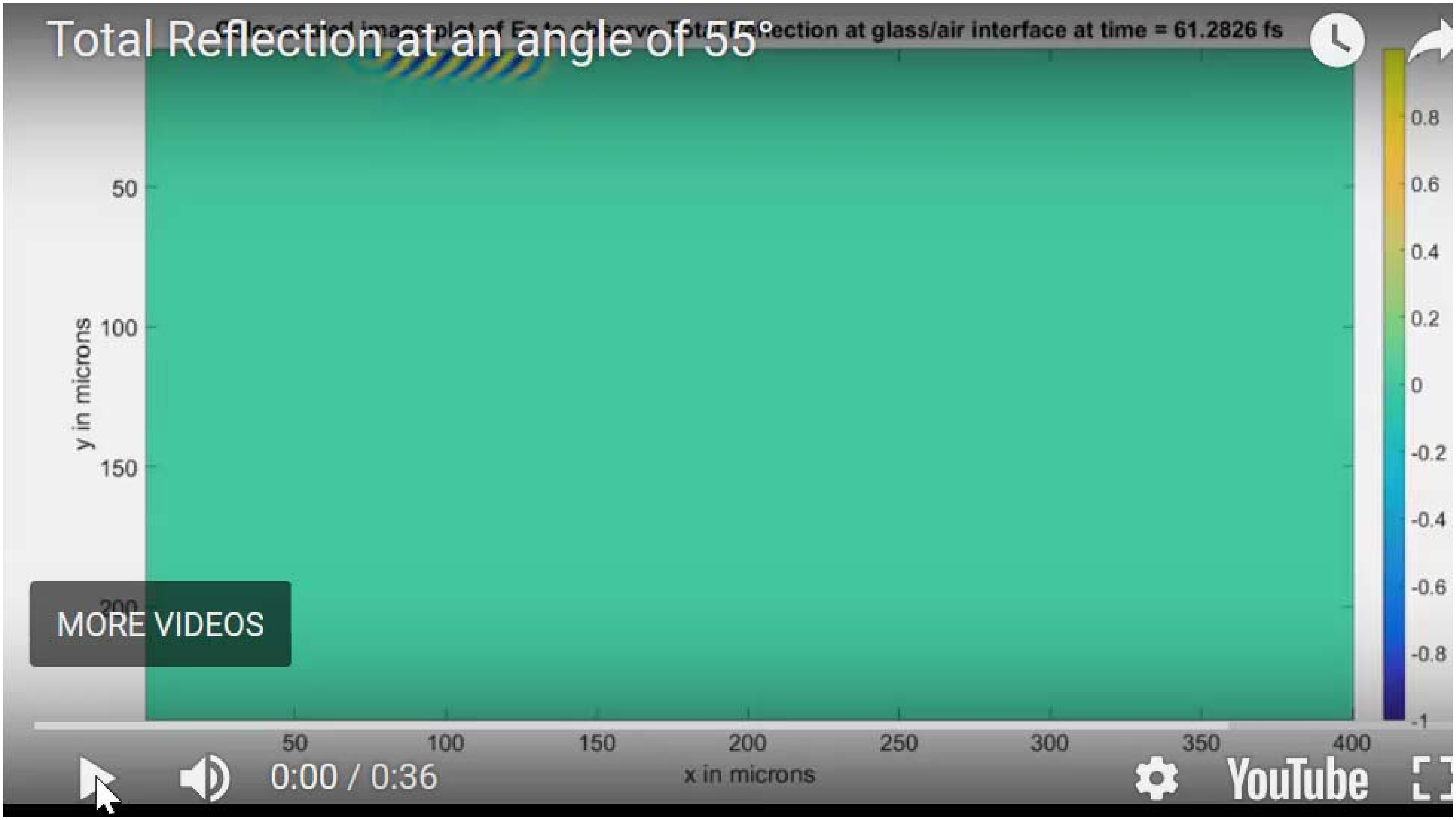
n_1 = 1

n_2 = 1.5

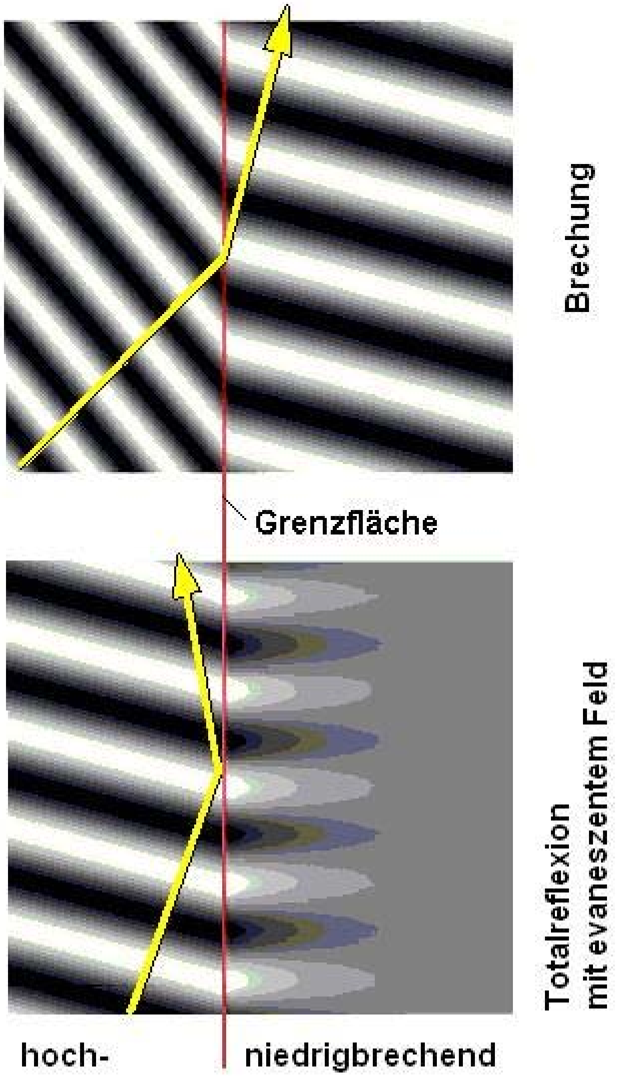
θ_1 = 20 [deg]

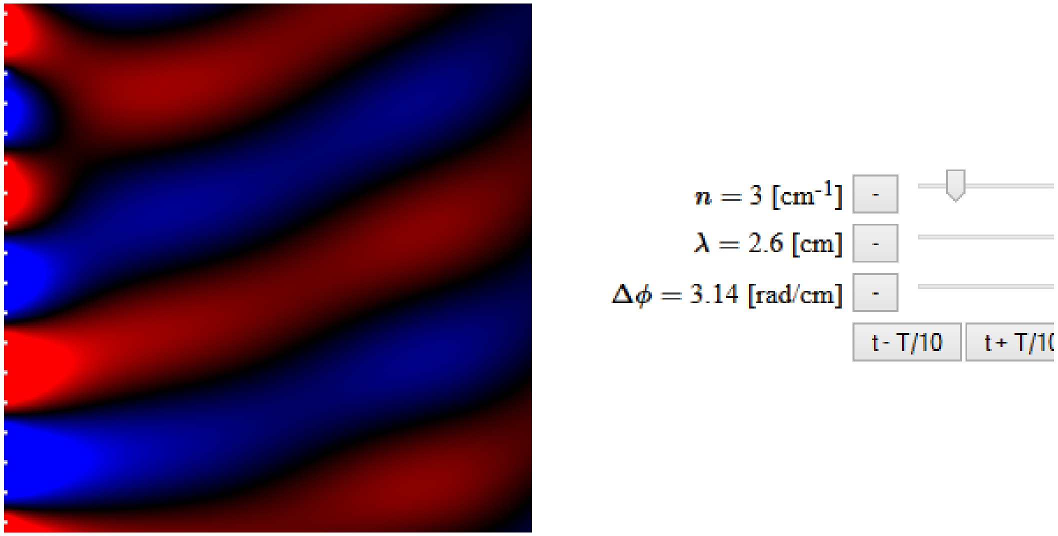
θ_2 = 13.2 [deg]

Totalreflexion



Evaneszenz




$n = 3$ [cm^{-1}]

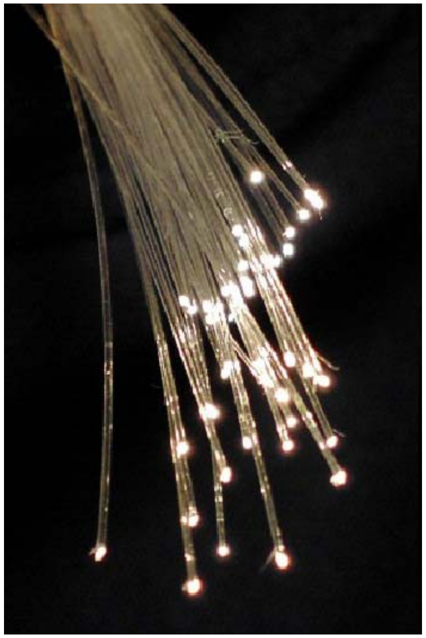
$\lambda = 2.6$ [cm]

$\Delta\phi = 3.14$ [rad/cm]

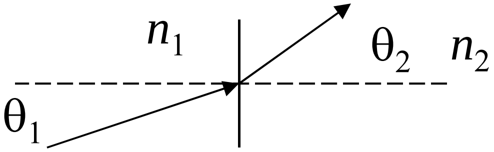
http://de.wikipedia.org/wiki/Evaneszenz#mediaviewer/File:Evaneszenzfeld.jpg

Totalreflexion

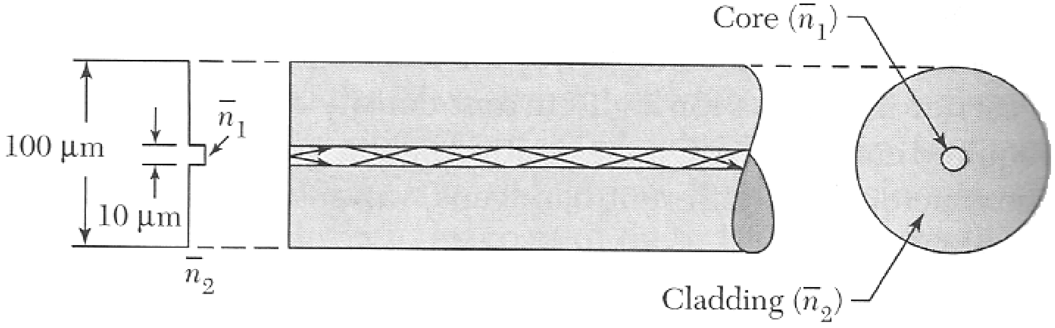
http://commons.wikimedia.org/wiki/File:Fibreoptic.jpg

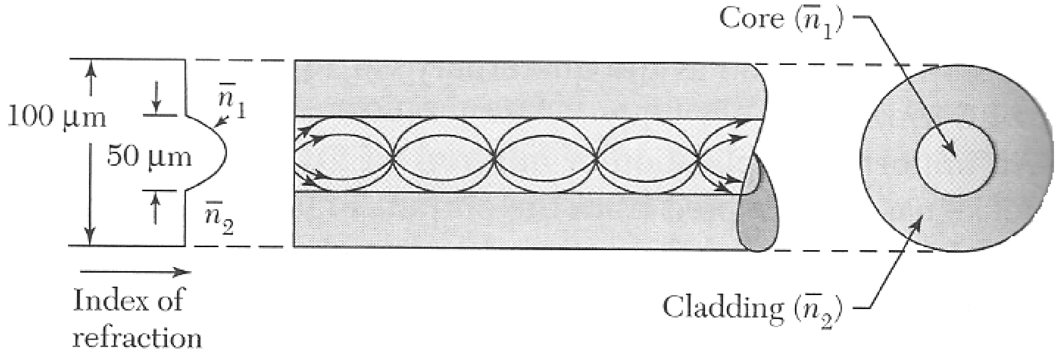


Lichtwellenleiter



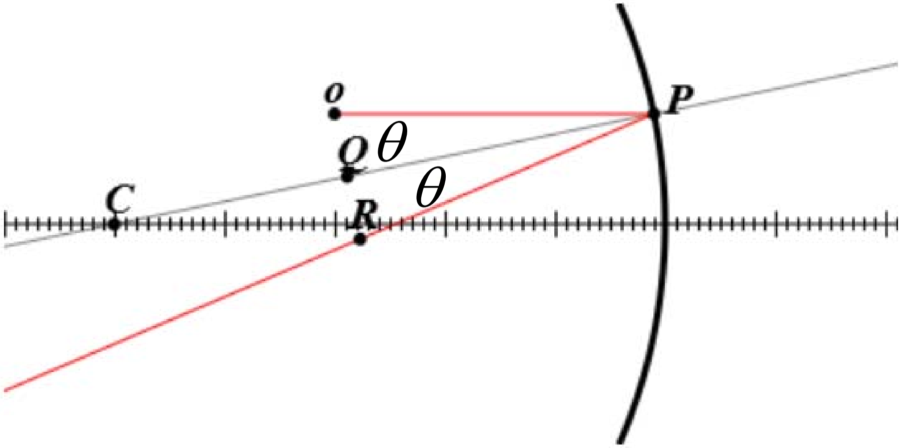
$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$



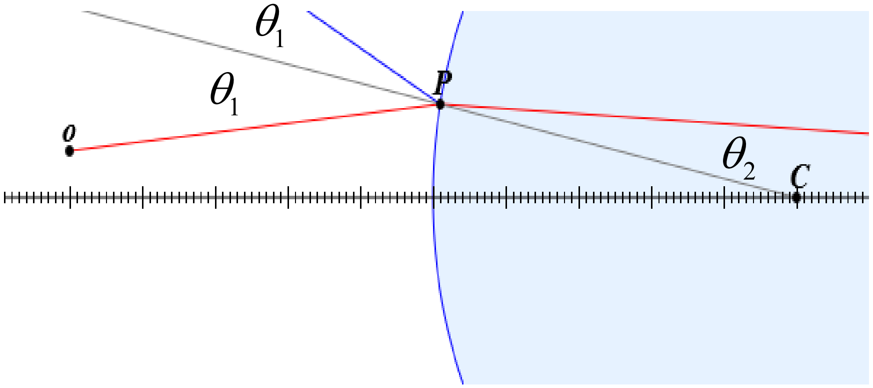


Geometrische Optik

Spiegel:
Einfallswinkel = Reflexionswinkel



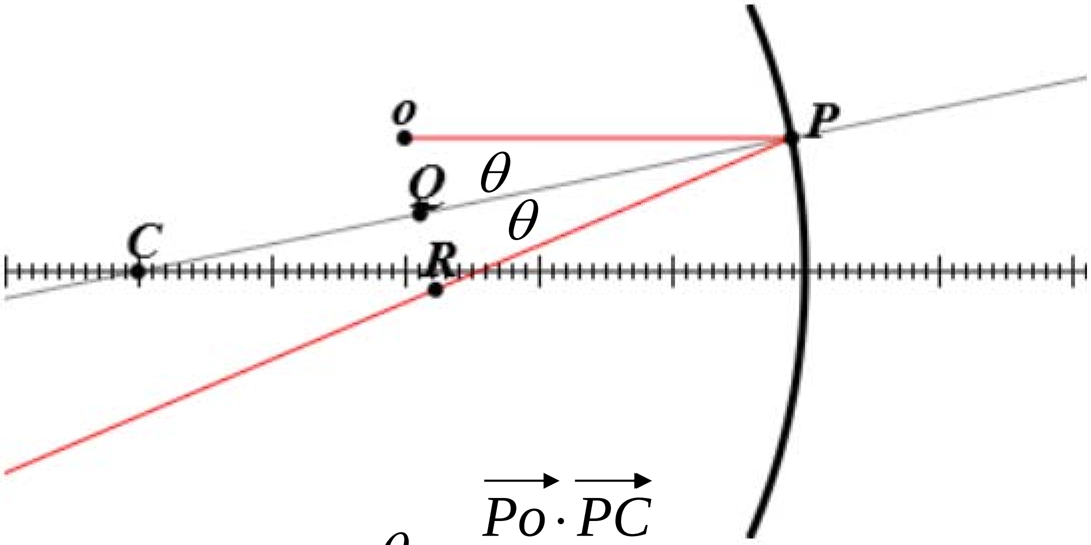
Linsen:
Snelliussches Brechungsgesetz



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

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

Spiegel



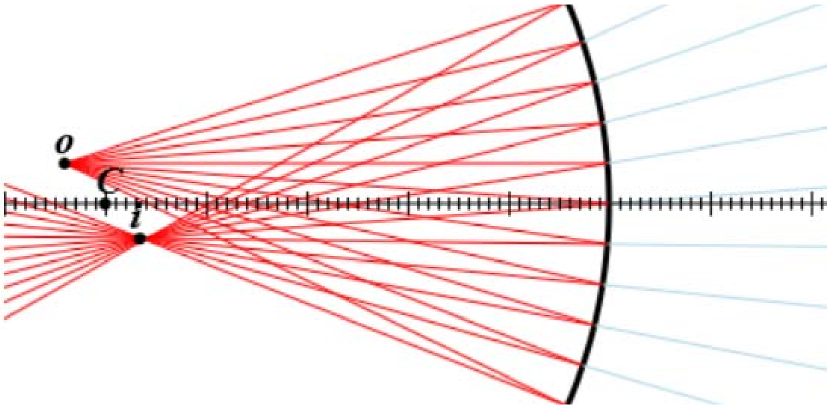
$$\cos\theta = \frac{\overrightarrow{Po}\cdot\overrightarrow{PC}}{\left|\overrightarrow{Po}\right|\left|\overrightarrow{PC}\right|}$$

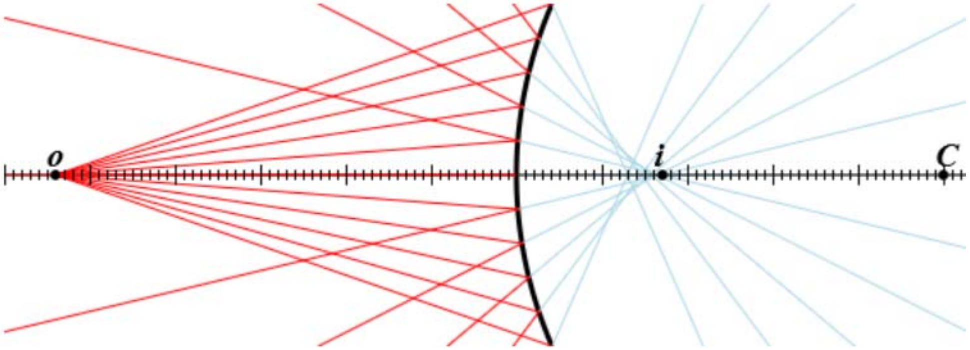
$$\overrightarrow{Po} = (x_o - x_P)\hat{x} + (y_o - y_P)\hat{y}$$

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

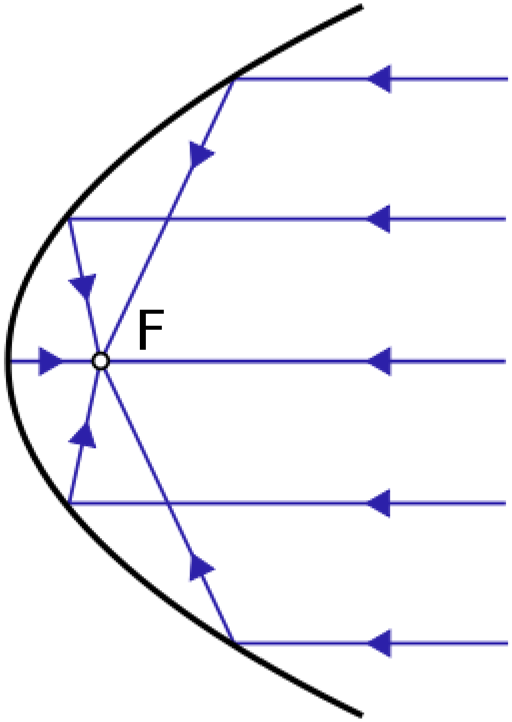
Der Einfallswinkel θ ist gleich dem Reflexionswinkel θ.

Spiegel





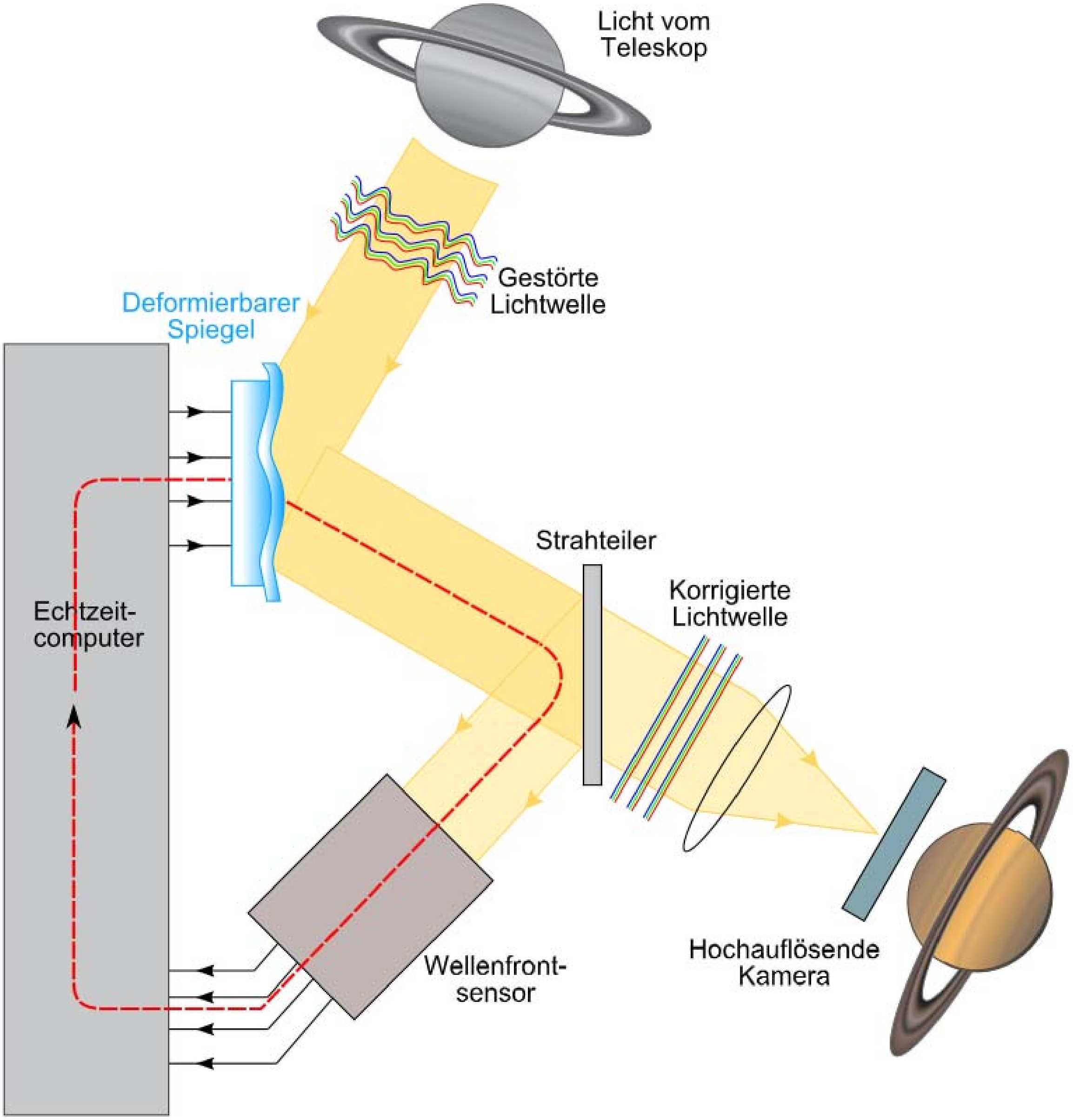
Parabolspiegel



http://commons.wikimedia.org/wiki/File:Radio_telescope_The_Dish.jpg

http://commons.wikimedia.org/wiki/File:Parabolic_mirror-diagram.svg

Adaptive Optik



http://upload.wikimedia.org/wikipedia/de/a/ad/AO_Prinzip_MPIA.svg