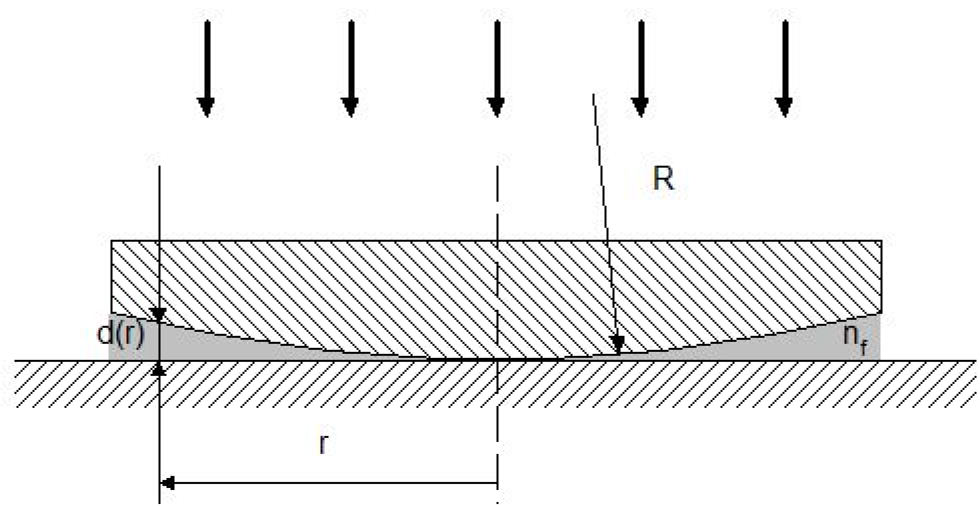
INTERFERENCE

Newton's rings

Circular fringes can be observed when an (air) film is formed between a convex and a plane glass surface. A light ray is reflected from the hollow and the plane surface as well. If the phase difference, 2.nf .d(r)=(m+1/2).l, there will be constructive interference where m is an integer.



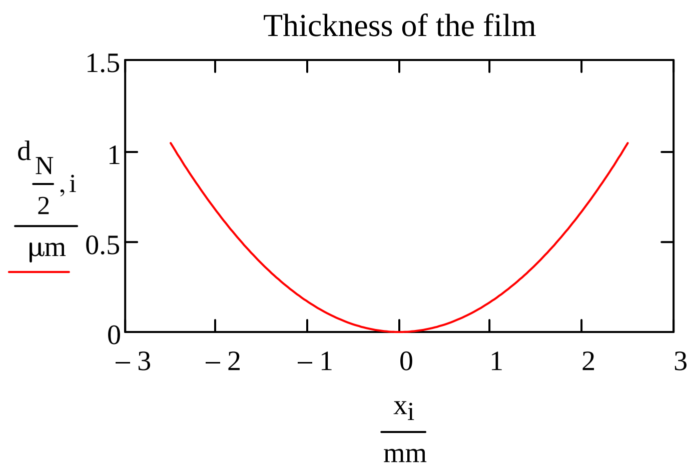
$$\mu m \equiv 10^{-6} \cdot m \quad nm \equiv 10^{-9} \cdot m \qquad k := \frac{2 \cdot \pi}{\lambda}$$

For the thickness, d, of the film with refractive index, n_f, as a function of the radius, r, we can write approximately:

$$i := 0 .. N-1 \qquad x_i := \frac{-size}{2} + i \cdot \frac{size}{N-1}$$

$$j := 0 .. N-1 \qquad y_j := \frac{-size}{2} + j \cdot \frac{size}{N-1}$$

$$r_{i,j} := \sqrt{(x_i)^2 + (y_j)^2} \qquad d_{i,j} := \frac{(r_{i,j})^2}{2 \cdot R}$$



The phase becomes: $\Delta\phi := 2 \cdot n_f \cdot d \cdot k$

Because of the internal reflection from the air-glass interface we have to add π radians to the phase:

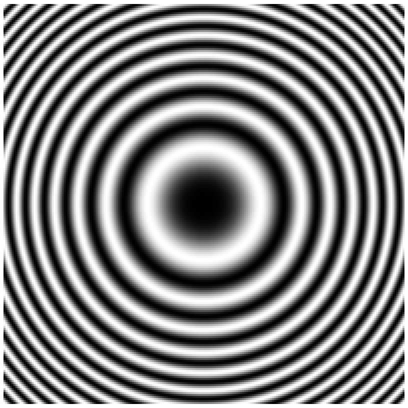
$$\Delta\phi := \Delta\phi + \pi$$

We substitute the phase in the field: $F_1 := \mathrm{LPBegin}\left(\frac{size}{m}, \frac{\lambda}{m}, N\right)$, $F_1 := \mathrm{LPSubPhase}(\Delta\phi, F_1)$ to obtain the field reflected from the hollow surface of the convex lens.

Next we define a second field, $F_2 := \mathrm{LPBegin}\left(\frac{size}{m}, \frac{\lambda}{m}, N\right)$, reflected from the plane surface and add it to F_1: $F := \mathrm{LPBeamMix}(F_1, F_2)$.

Finally we calculate the intensity and observe the fringes:

$I := \mathrm{LPIntensity}(2, F)$



$size \equiv 5 \cdot mm$

$\lambda \equiv 500 \cdot nm$

$N \equiv 200$

$R \equiv 3 \cdot m$

$n_f \equiv 1.5$

Interference pattern, or Newton's rings, by reflection just above the lens.

If the transmitted light is observed there will be a bright spot in the middle because in that case there is no extra π radians phase shift. This can be observed by deleting the extra addition of π to the phase.