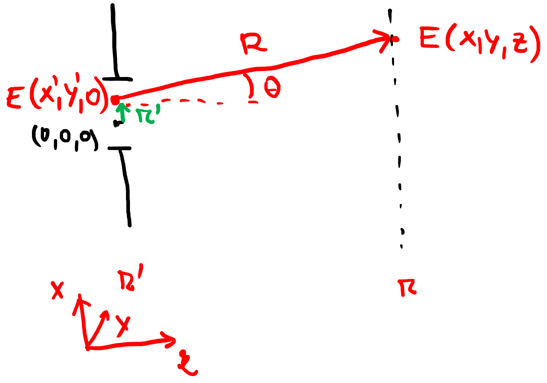
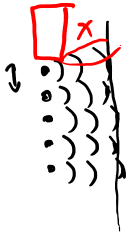
DIFRAKCE:



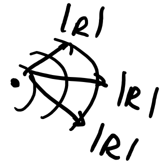


$$\vec{R} = (x-x')\hat{x} + (y-y')\hat{y} + z\hat{z} \quad \leftrightarrow \quad \vec{R} = \vec{r} - \vec{r}'$$

$$R = \sqrt{(x-x')^2+(y-y')^2+z^2}$$

rovinná vlna: $E_0 e^{i\vec{k}\cdot\vec{R}}$

kulová vlna: $E_0 \frac{e^{ikR}}{R}$



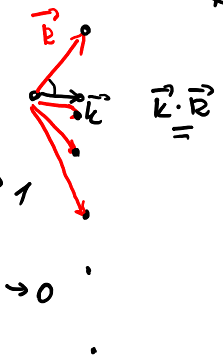
$$E(x,y,z) = -\frac{i}{\lambda}\iint_{ap} E(x',y',0)\,\frac{e^{ikR}}{R}\,F(\theta)\,dx'dy'$$

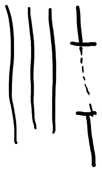
- $\frac{i}{\lambda}$ … síla E
- ap … apertura
- $E(x',y',0)$, $\frac{e^{ikR}}{R}$ … kulová vlna

$$F(\theta) = \frac{1+\cos\theta}{2}$$

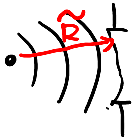
$\theta \sim 0° \rightarrow F(0°) \rightarrow 1$

$\theta \sim 180°$ $F(180°) \rightarrow 0$





$\Rightarrow E(x',y',0) = \text{konst} = E_0$



$\Rightarrow E(x',y',0) = E_0 \frac{e^{ik\tilde{R}}}{\tilde{R}}$

→ **Fresnel:** $R \equiv z$ ve jmenovateli $\Rightarrow$ paraxiální aprox. $\Rightarrow$ $\theta \sim$ malé

v čitateli: $$R = z\sqrt{1+\underbrace{\frac{(x-x')^2+(y-y')^2}{z^2}}_{\ll 1}} \approx z\left[1+\frac{(x-x')^2+(y-y')^2}{2z^2}\right]$$

$\sqrt{1+x} \sim 1 + \frac{x}{2} + \dots$

$(a-b)^2 = a^2 - 2ab + b^2$

$a = x, y$

$b = x', y'$

$$E(x,y,z) \approx \frac{i e^{ikz} e^{i\frac{k}{2z}(x^2+y^2)}}{\lambda z} \iint E(x',y',0)\, e^{i\frac{k}{2z}(x'^2+y'^2)}\, e^{-i\frac{k}{z}(xx'+yy')}\, dx'dy'$$

≈ 1 Fraunhoferova aprox.

$e^{i0} \approx 1$

velké vzdálenosti oproti ap. a λ

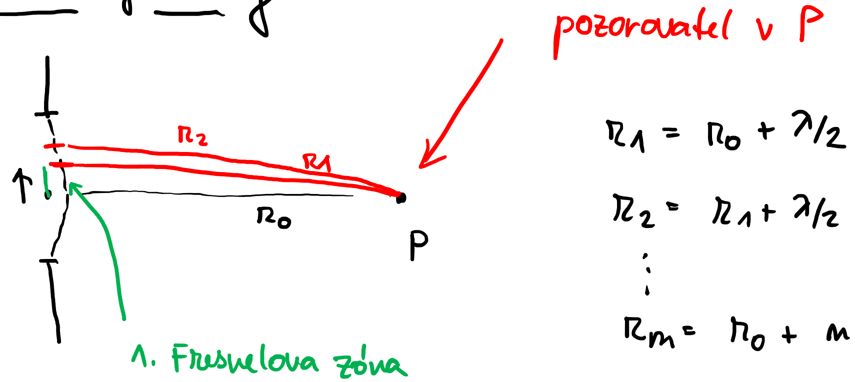
$z \gg \frac{k}{2}(\text{poloměr ap.})^2$

$k = \frac{2\pi}{\lambda}$

$F[A(x)] = \int A(x)\, e^{-iXx}\, dx \rightarrow$ FFT

FT(☼)

Fresnelovy zóny:



$r_1 = r_0 + \lambda/2 \rightarrow$ destrukt. int.

$r_2 = r_1 + \lambda/2 = r_0 + \lambda$

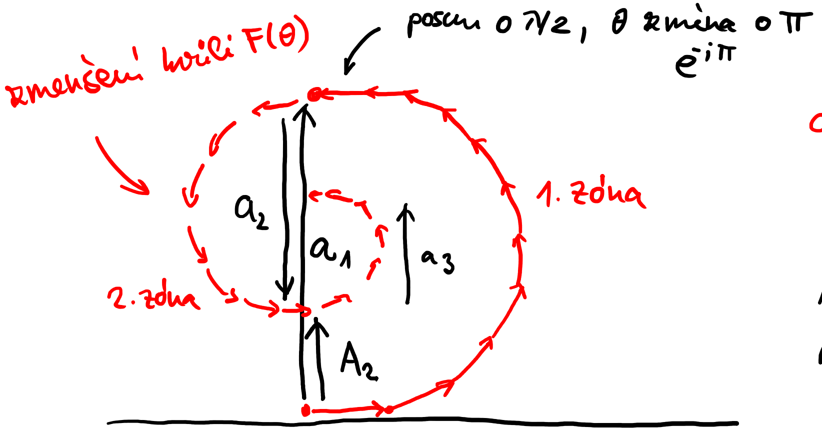
$\vdots$

$r_m = r_0 + m\,\lambda/2$

$E = \underline{\underline{E_0}}\, e^{i\theta}$

fázor E

1. F. zónu rozdělíme na ∞ počet kroků:



a_1 ampl. Σ v 1. zóně

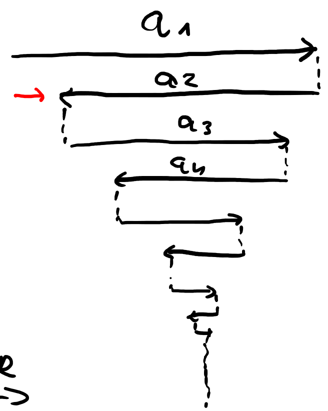
$A_1 = a_1$

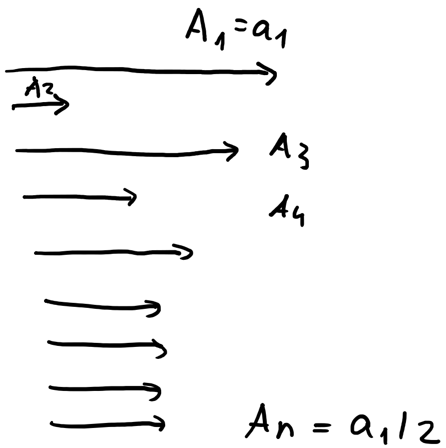
$A_2 = a_1 - a_2$

$A_3 = a_1 - a_2 + a_3$

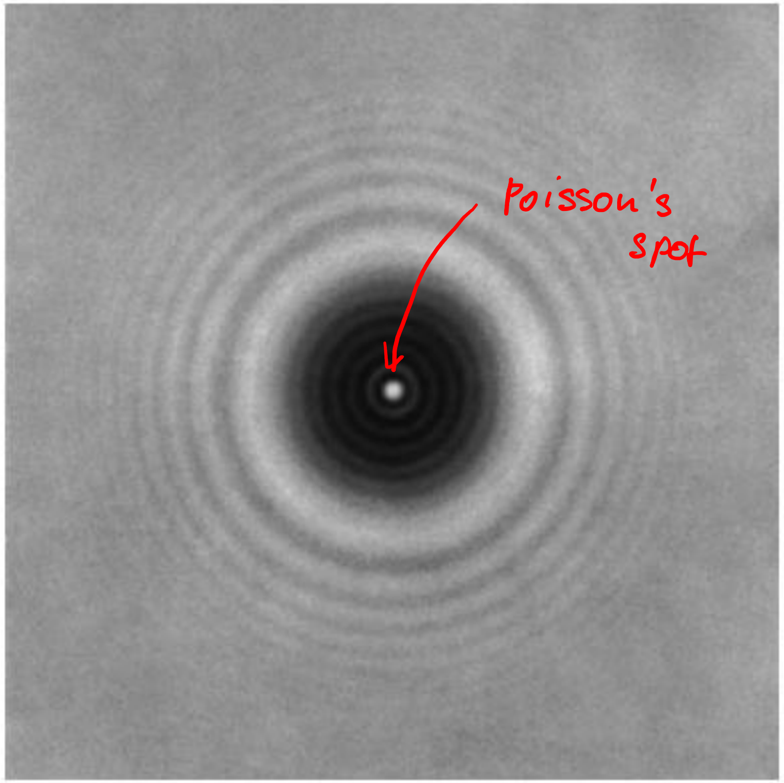
$A_n = a_1 + a_2 e^{i\pi} + a_3 e^{i2\pi} + \dots$

$A_n = a_1 - a_2 + a_3 - a_4 \dots a_m$





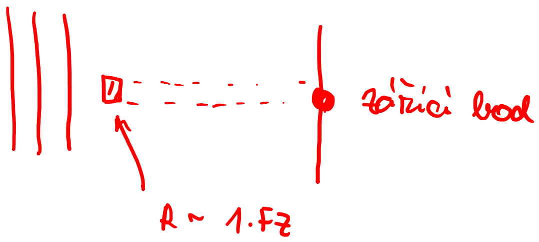
$$I \propto |A|^2$$



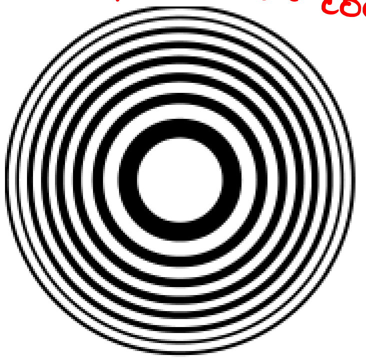
1) 1. zóna přispívá 1/2 ampl., 1/4 výkonu, v porov. bez ap.

2) + 2. zóna → $I \cong 0$

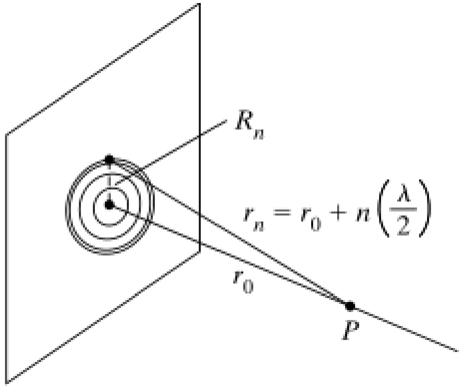
3) pro velké clony žádný vliv její zvětšování



Fresnelova čočka



fólie s kruhy



Jak jsou velké zóny !?

zanedbat $\qquad \lambda \ll r_0$

$$R_n^2 = -r_0^2 + \left(r_0 + n(\lambda/2)\right)^2 = n^2(\lambda/2)^2 + 2r_0 n \lambda/2$$

$$\boxed{R_n = \sqrt{n r_0 \lambda}} \quad \propto \sqrt{n}$$

$R_1 \dots$

$R_2 = \sqrt{2}\, R_1$

- $\lambda = 632{,}8\,\mathrm{nm}$
  $r_0 = 30\,\mathrm{cm}$
  $R_1 = ?$
  $\Bigg\}\quad R_1 \sim 0{,}44\,\mathrm{mm}$

- kolik FZ bude v apert. s polom $100R_1$?

  $R_n = \sqrt{n}\, R_1$
  $\;\;\|$
  $100R_1$

  $\Rightarrow \sqrt{n} = 100 \Rightarrow n = 10^4$

- čočka má 16 FZ, jaký má poloměr, pokud je pozor. $r_0 = 30\,\mathrm{cm}, \lambda \dots$

  $$R_{16} = R_1\sqrt{16} = 4 \cdot 0{,}44 = \underline{\underline{1{,}7\,\mathrm{mm}}}$$

- $F(\theta) = ?$ $\quad R_{16} = 1{,}7\,mm$, $\quad r_0 = 300\,mm$

$$\operatorname{tg}\theta = \frac{1{,}7}{300} \rightarrow 0{,}3^\circ$$

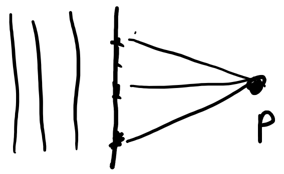
$$\cos\theta \Rightarrow \cos 0{,}3^\circ \cong 1.$$

$$F(\theta) = \frac{1+\cos\theta}{2}$$

- $A_{16} = a_1 + a_3 + a_5 + a_7 \ldots = 8a_1$

- $P = ?$ $\quad P \propto \dfrac{|A_{16}|^2}{|a_1|^2} \rightarrow$ 256x větší výkon, než bez čočky.

→ fólie se chová jako čočka



$$f = 30\,cm = r_0.$$