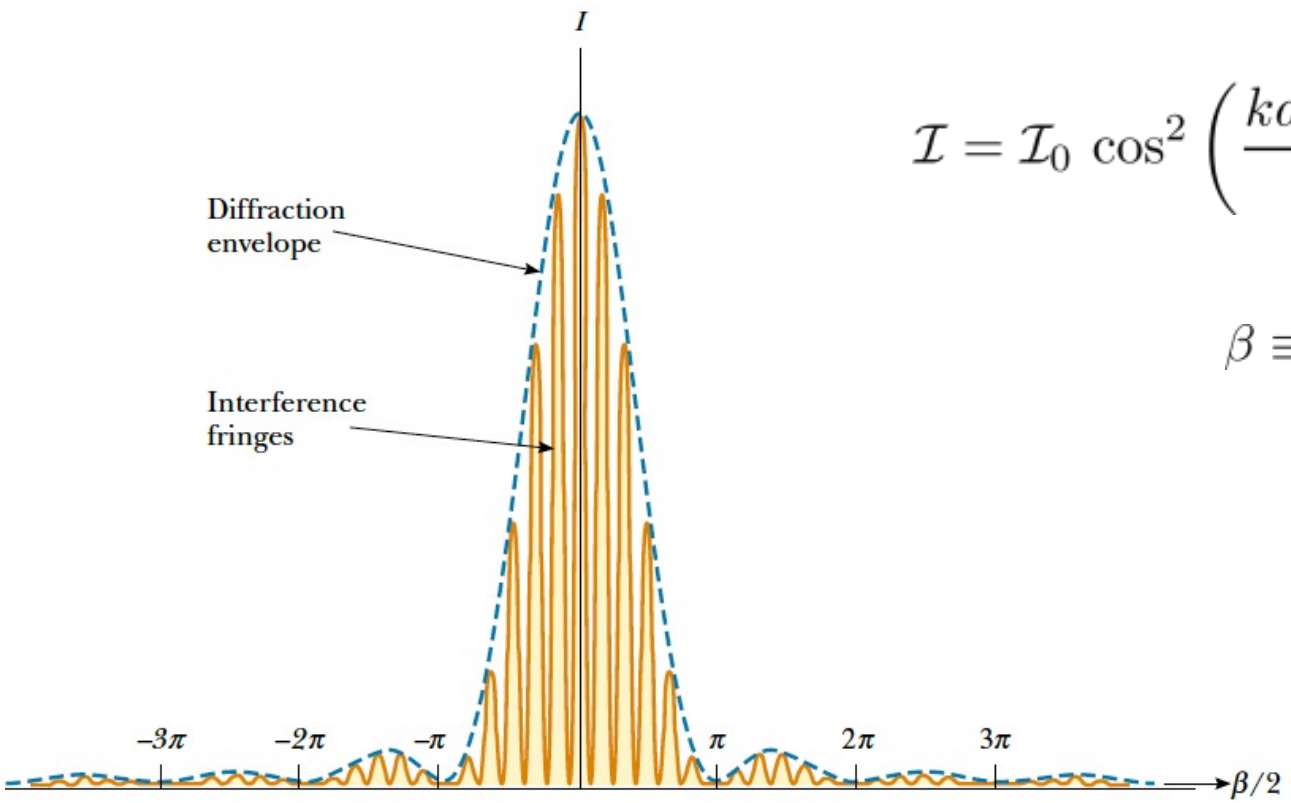
4302212 – Física IV

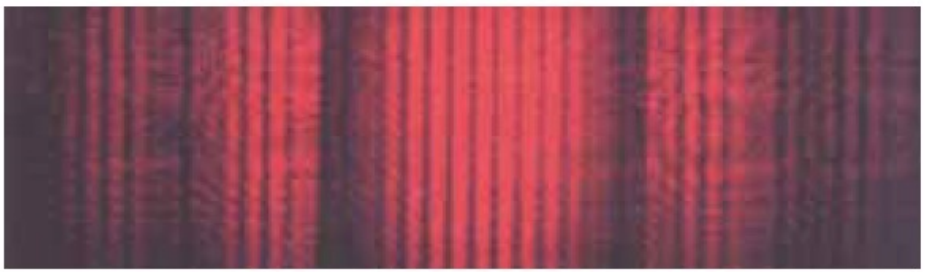
Difração – III

Difração por Duas Fendas

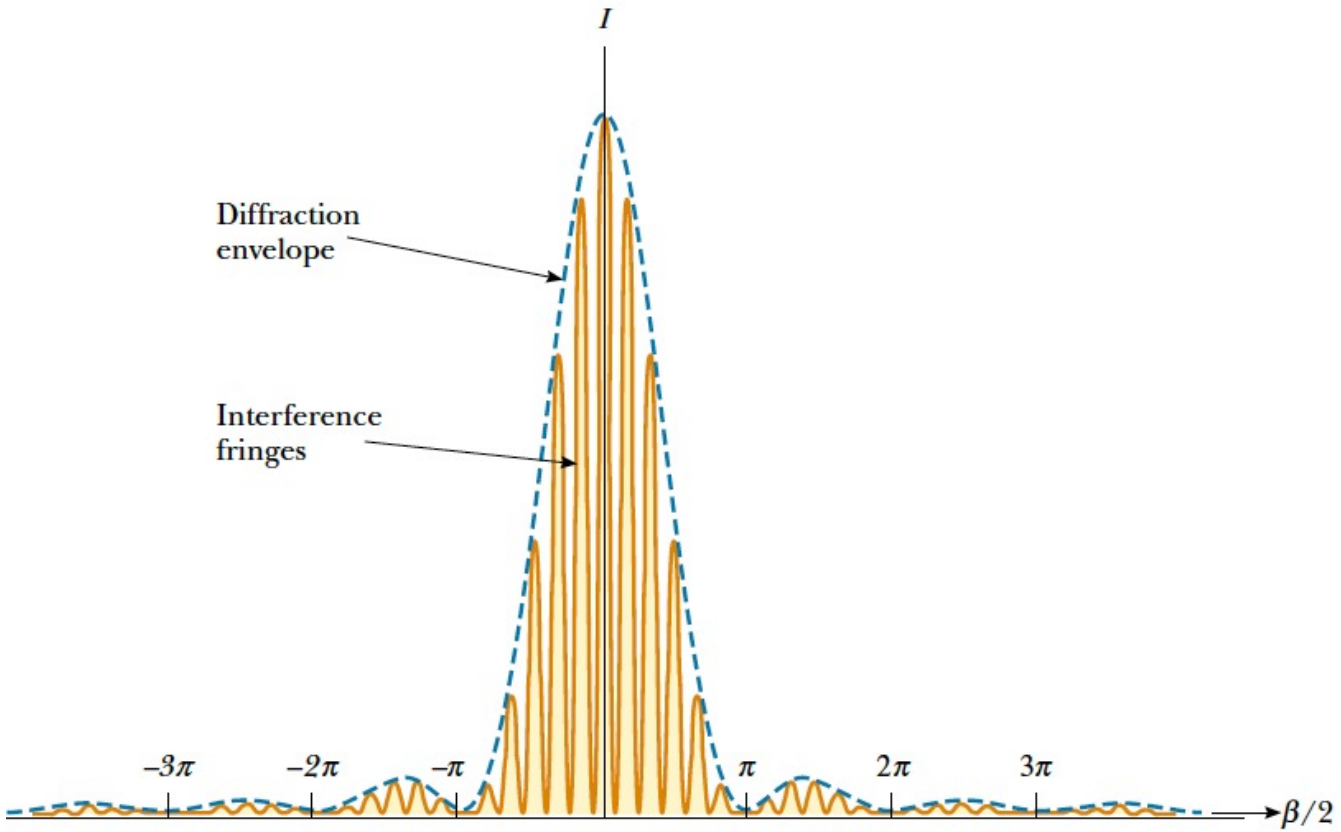


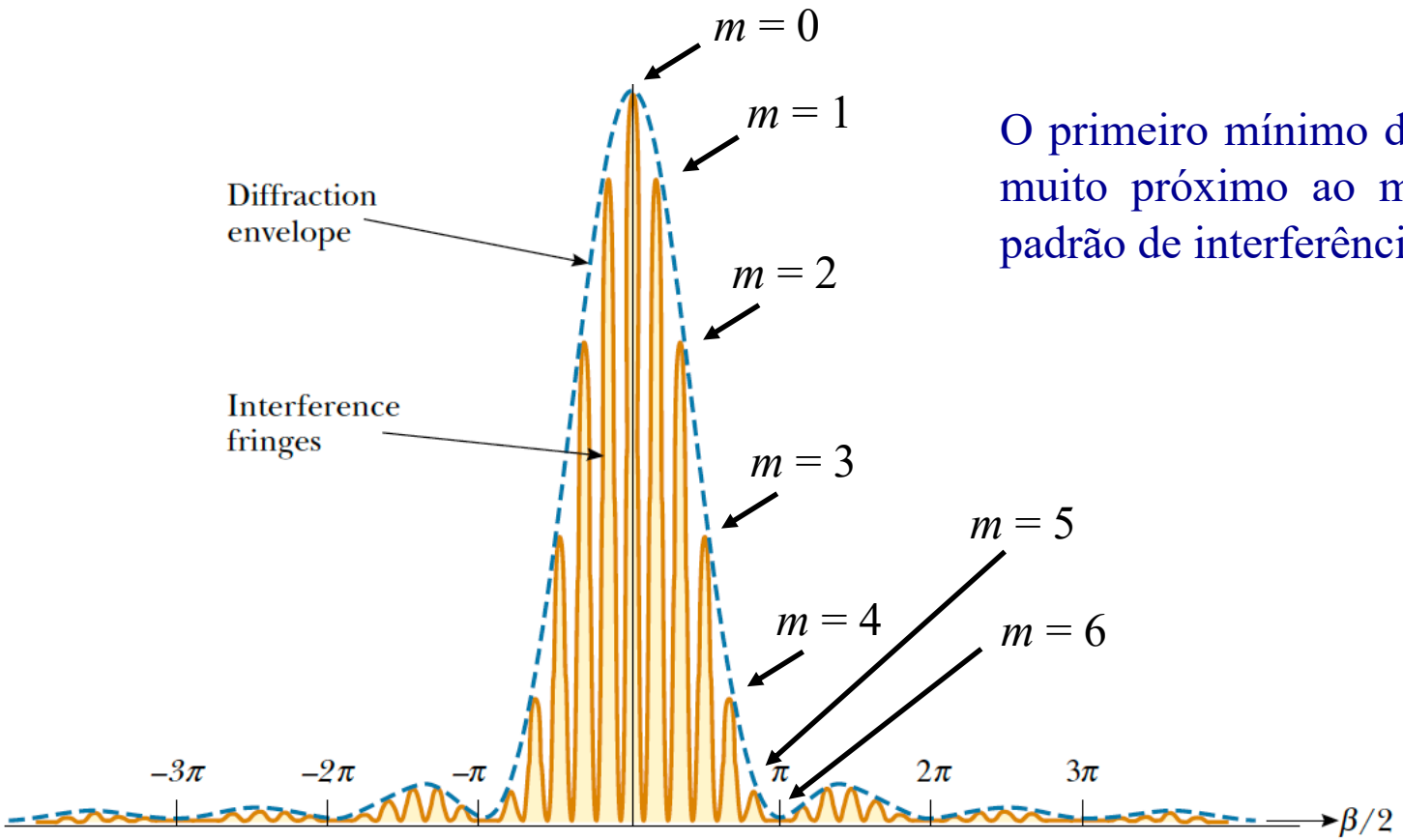
$$\mathcal{I} = \mathcal{I}_0 \cos^2\left(\frac{kd\,\mathrm{sen}\theta}{2}\right) \frac{\mathrm{sen}^2(\beta/2)}{(\beta/2)^2}$$

$$\beta \equiv ka\,\mathrm{sen}\theta$$



Exercício: Explorando o padrão de difração por duas fendas mostrado na figura abaixo, estime o comprimento de cada fenda (a) em relação à separação entre as fendas (d).





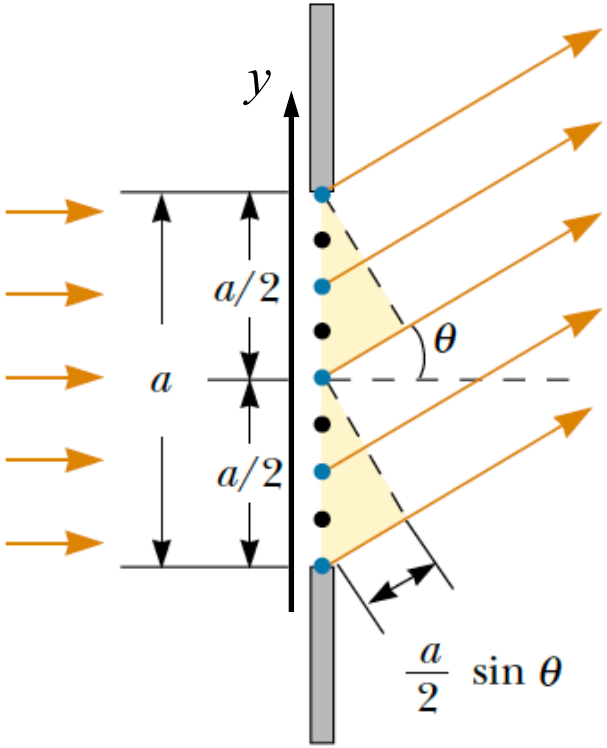
O primeiro mínimo de difração está muito próximo ao máximo $m = 6$ padrão de interferência.

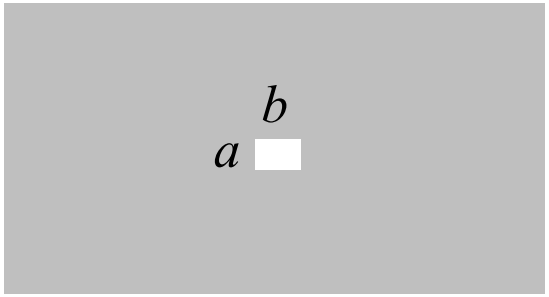
(interferência) $d \operatorname{sen}\theta = 6\lambda$

$d = 6a$

(difração) $a \operatorname{sen}\theta = \lambda$

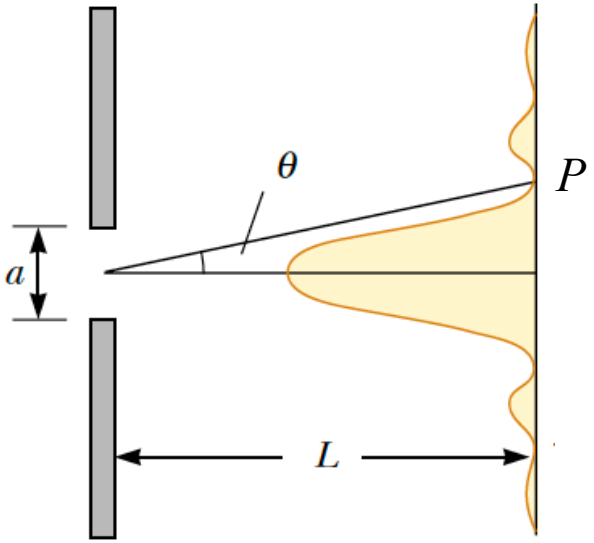
Abertura Retangular





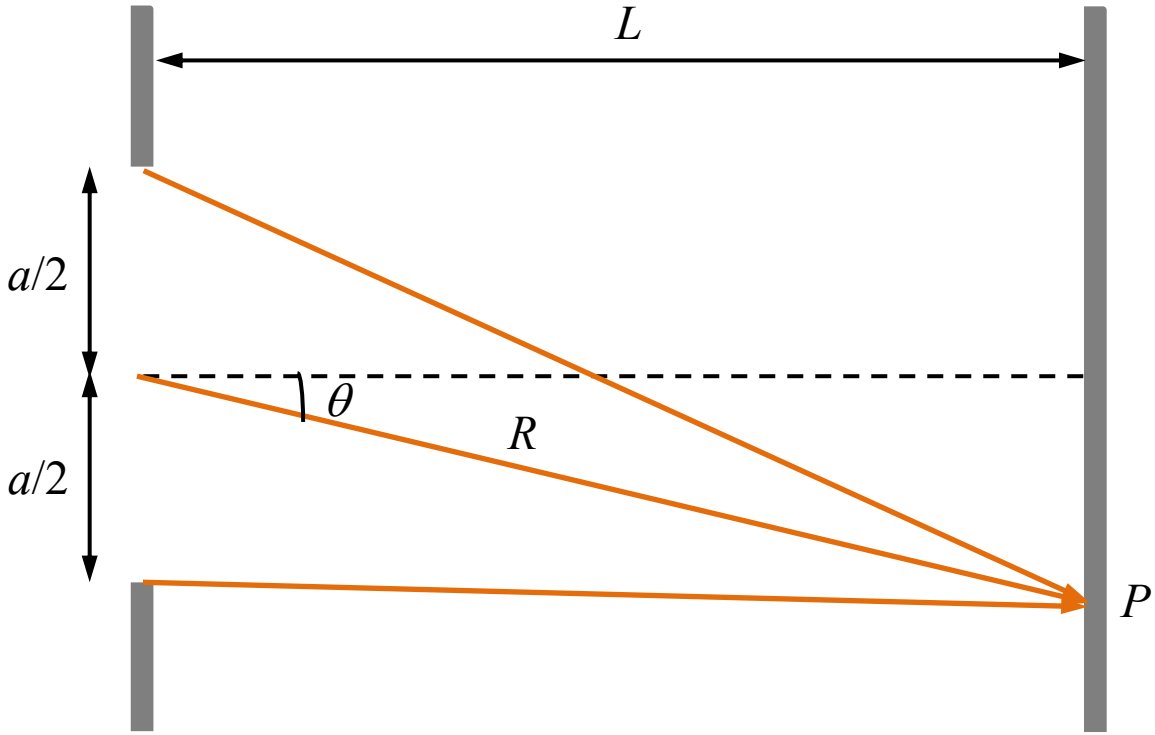
(difração em 2D)

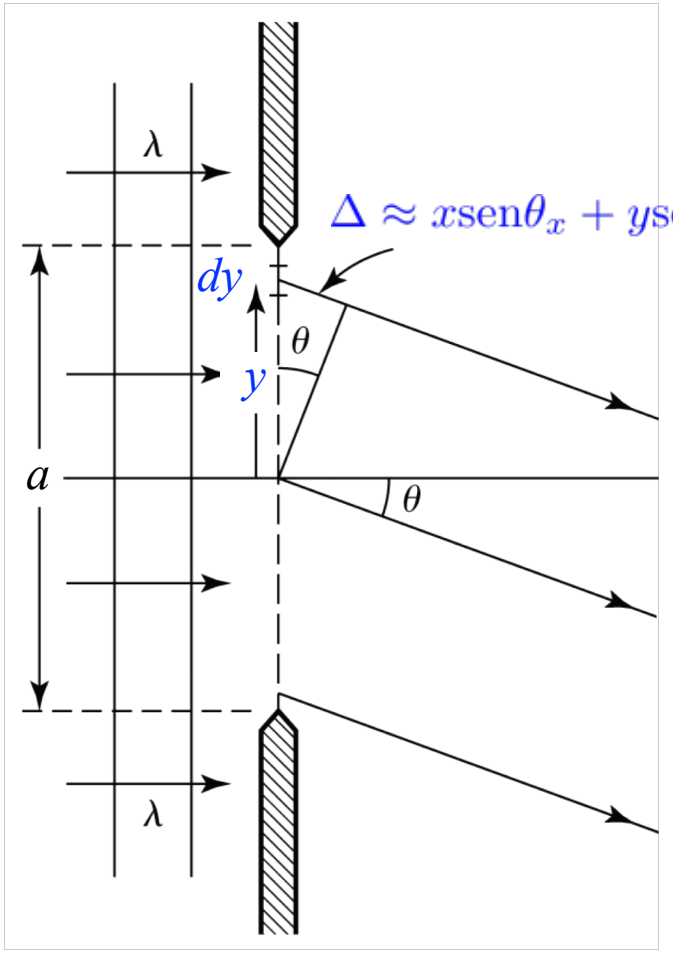
Elementos $ds = dxdy$ tratados como fontes:



$$\nu(P) = \int_{\text{fenda}} d\nu(P)$$

Fenda Estreita





$$d\nu(P) = \frac{A dx dy}{(R+\Delta)} e^{ik(R+\Delta)} \approx \frac{A dx dy}{R} e^{ik(R+\Delta)}$$

$$\nu(P) = \frac{A}{R} e^{ikR} \int_{-a/2}^{a/2} dy \int_{-b/2}^{b/2} dx\, e^{ik\Delta}$$

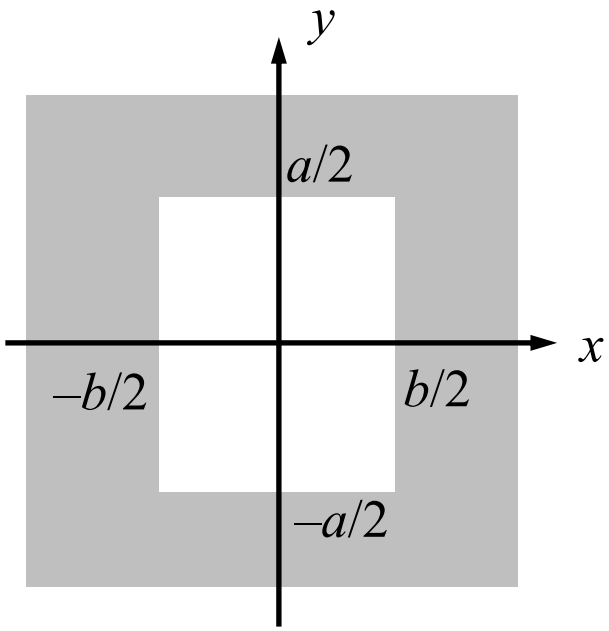
Amplitude e Intensidade:

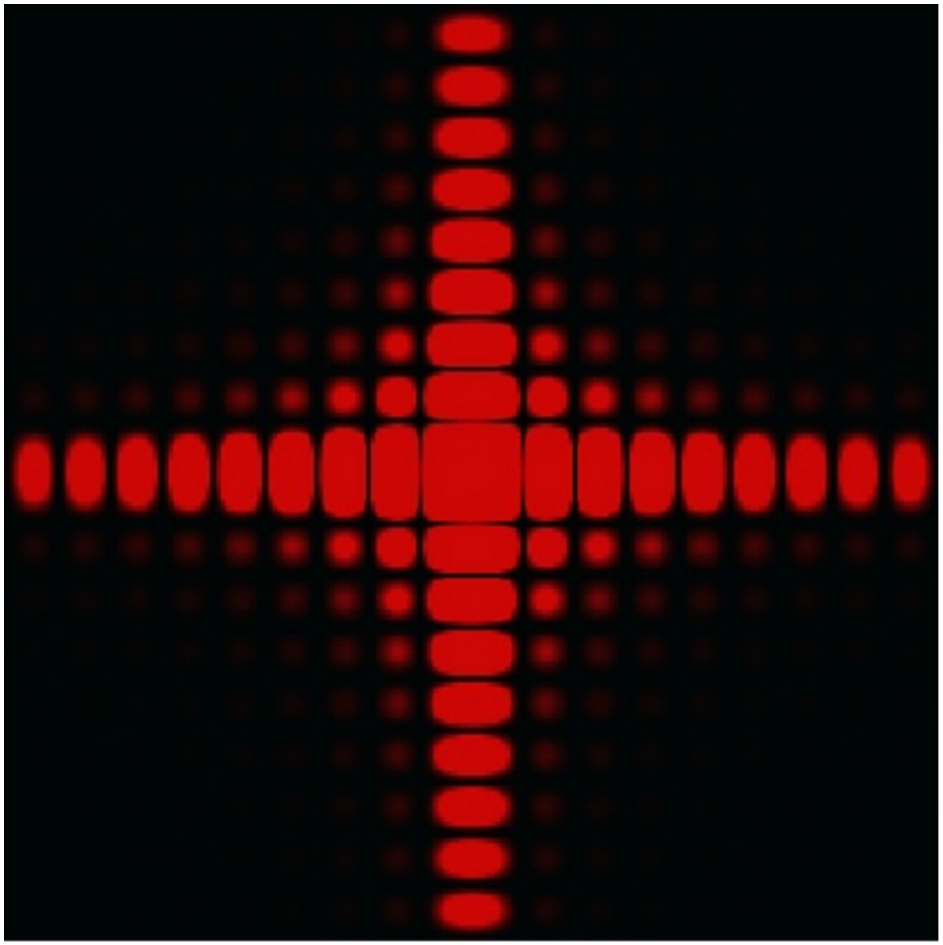
$$\beta \equiv kb\,\mathrm{sen}\theta_x \qquad \alpha \equiv ka\,\mathrm{sen}\theta_y$$

$$\nu(\alpha,\beta) = \frac{abA}{R} e^{ikR} \frac{\mathrm{sen}(\alpha/2)}{(\alpha/2)} \frac{\mathrm{sen}(\beta/2)}{(\beta/2)}$$

$$\mathcal{I}(\beta) = \frac{(abA)^2}{R^2} \frac{\mathrm{sen}^2(\alpha/2)}{(\alpha/2)^2} \frac{\mathrm{sen}^2(\beta/2)}{(\beta/2)^2}$$

Vídeo: https://www.youtube.com/watch?v=4YPxRTFxy2A





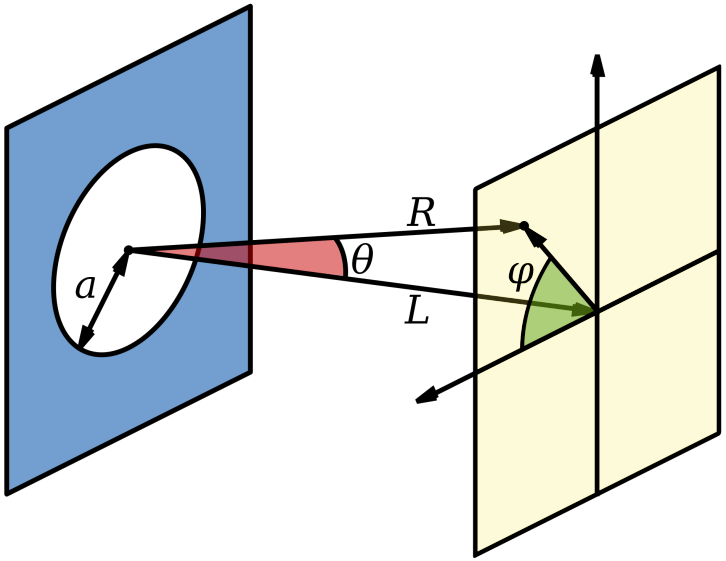
https://www.wikiwand.com/en/Fraunhofer_diffraction

mínimos:

$$a\,\mathrm{sen}\theta = m\lambda\,, \quad \pm 1, \pm 2\ \pm 3, \cdots$$

$$b\,\mathrm{sen}\theta = m\lambda\,, \quad \pm 1, \pm 2\ \pm 3, \cdots$$

Abertura Circular



Intensidade:

$$\mathcal{I} = \mathcal{I}_0 \left[\frac{2J_1(\beta)}{\beta} \right]^2$$

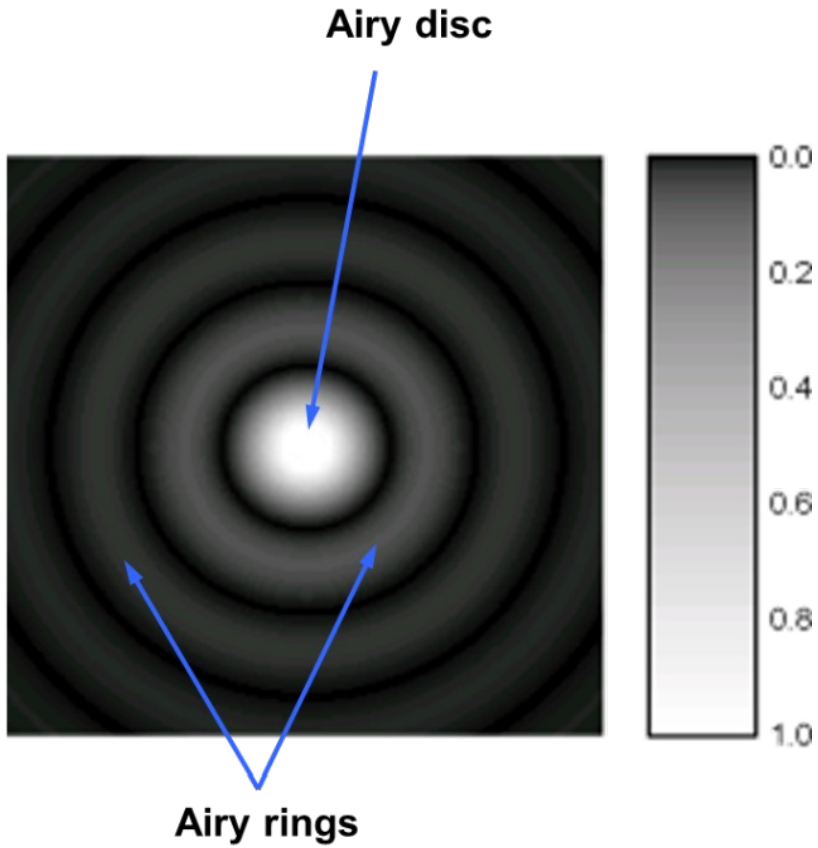
$$\beta = ka\,\mathrm{sen}\theta$$

(J_1(x): Função de Bessel de ordem 1)

Abertura Circular

$$\mathcal{I} = \mathcal{I}_0 \left[\frac{2J_1(\beta)}{\beta} \right]^2$$

(Padrão de Airy)



https://en.wikipedia.org/wiki/Airy_disk

Primeiro mínimo do padrão de Airy ($D = 2a$):

$$ka \operatorname{sen}\theta = 3.832$$

$$\theta \approx 1.22\frac{\lambda}{D}$$

	β	$[2J_1(\beta)/\beta]^2$
1º Máximo	0	1
1º Mínimo	3.832	0
2º Máximo	5.136	0.0175
2º Mínimo	7.016	0
3º Máximo	8.417	0.00416
3º Mínimo	10.173	0