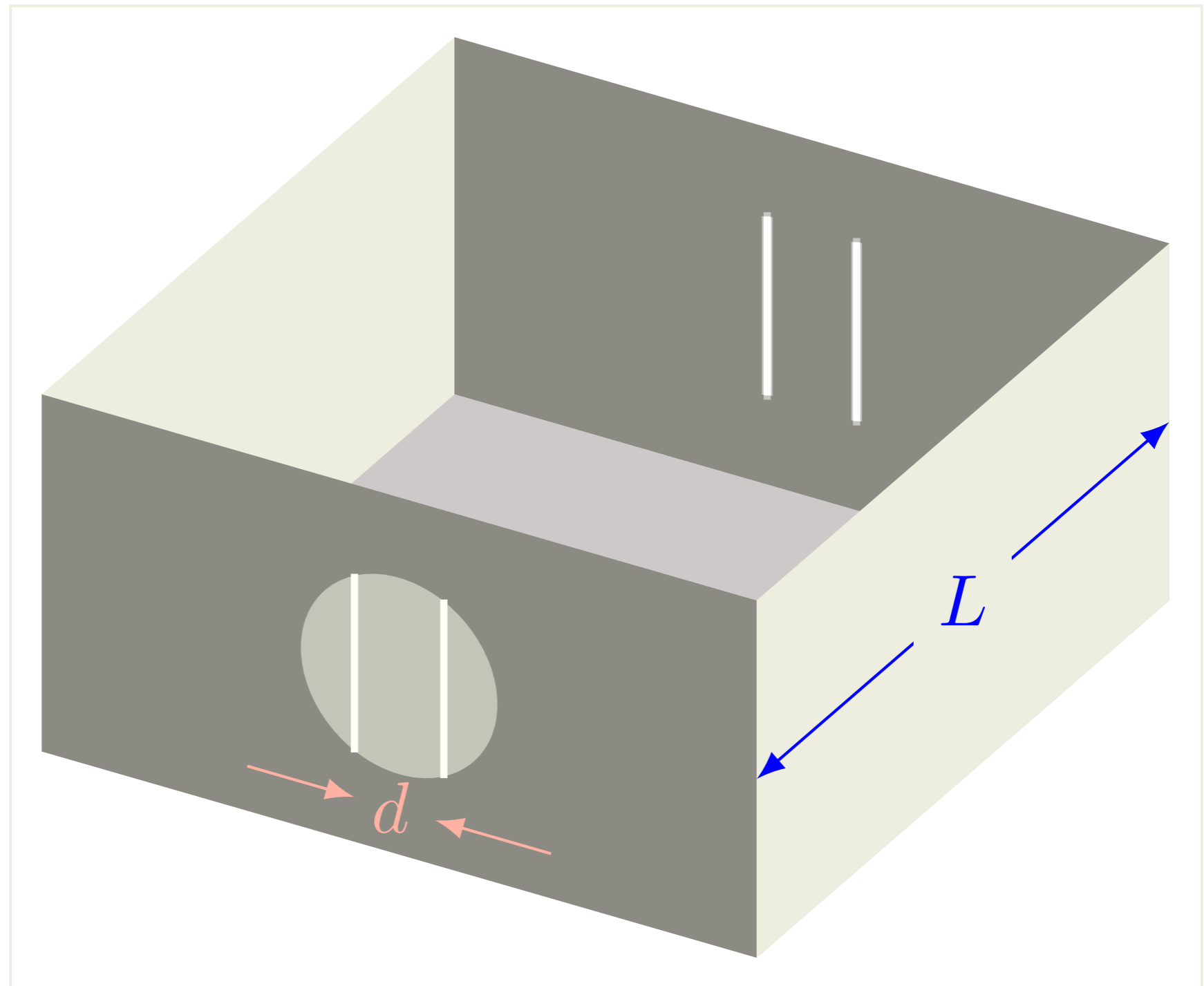


Física IV

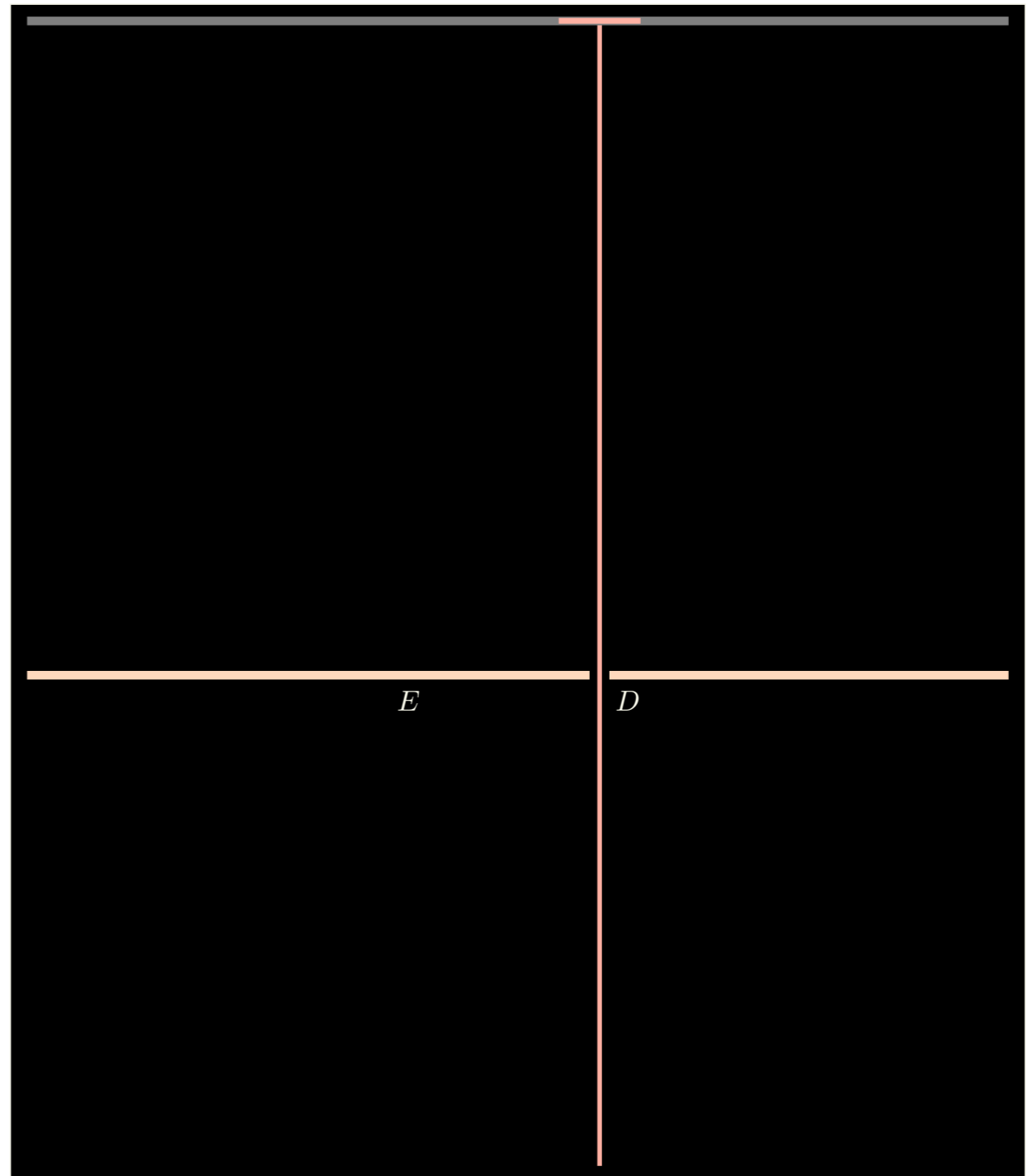
10 novembro 2020
Ótica

Experiência de Young



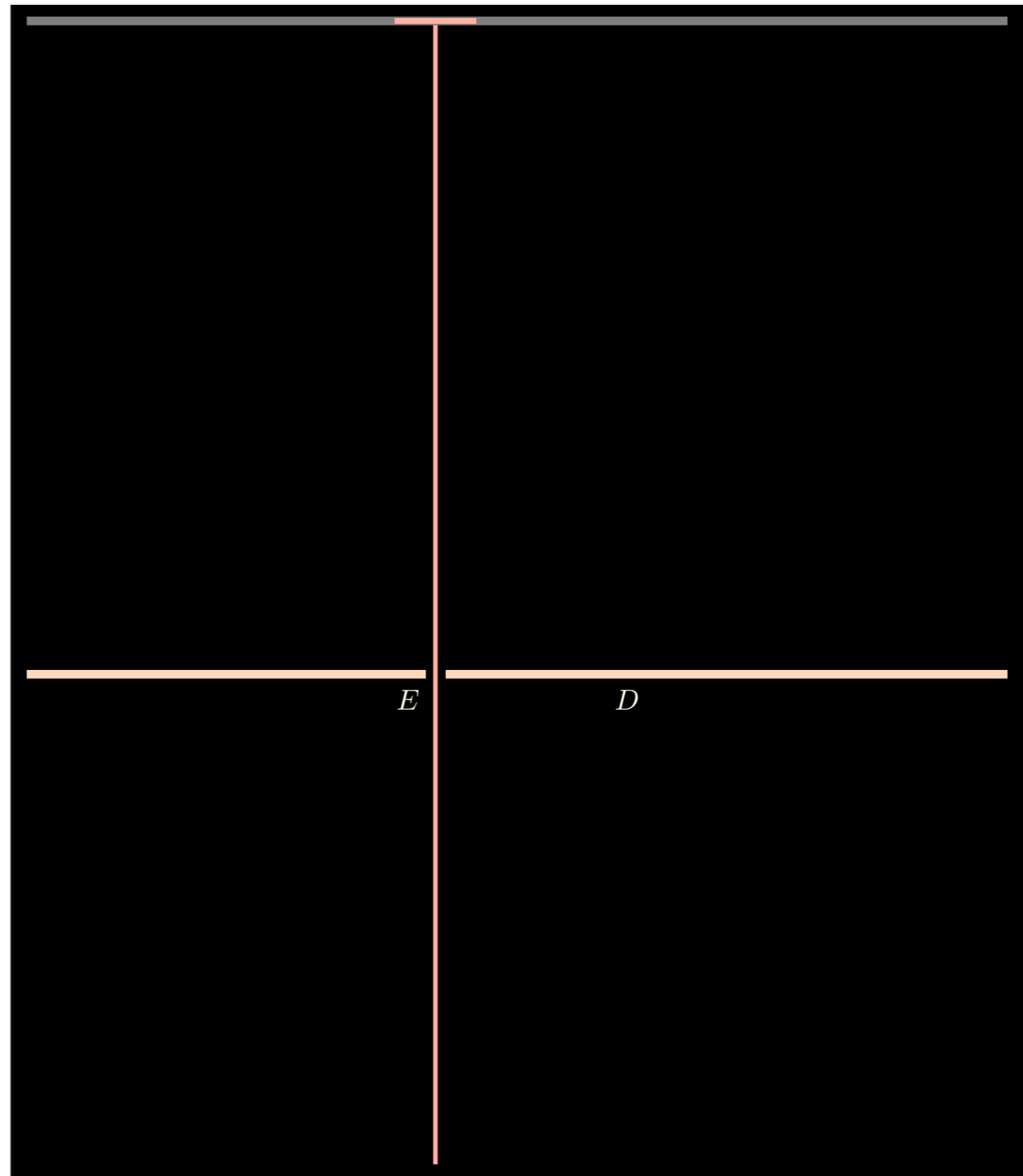
Experiência de Young

Somente uma fenda



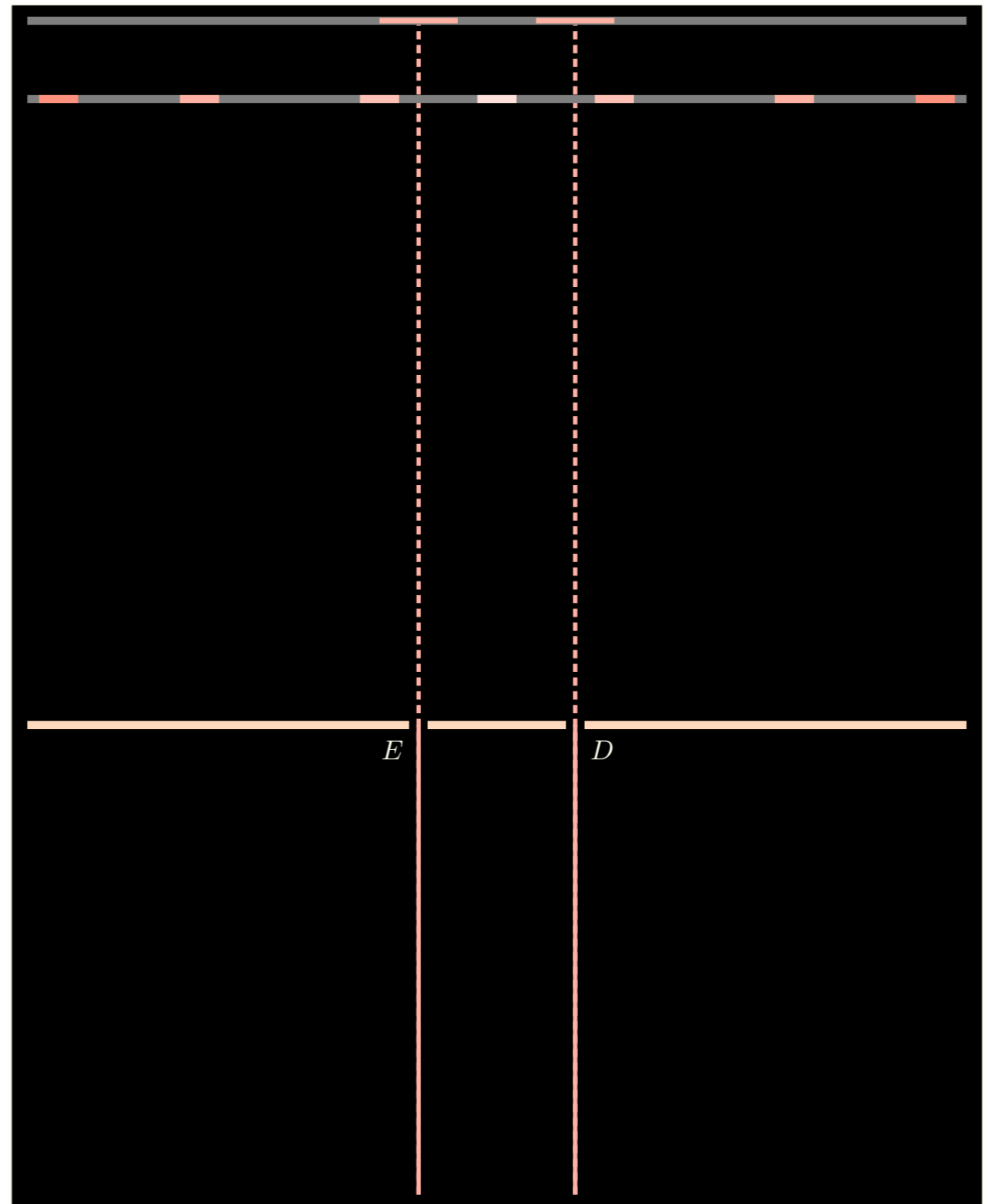
Experiência de Young

Somente uma fenda



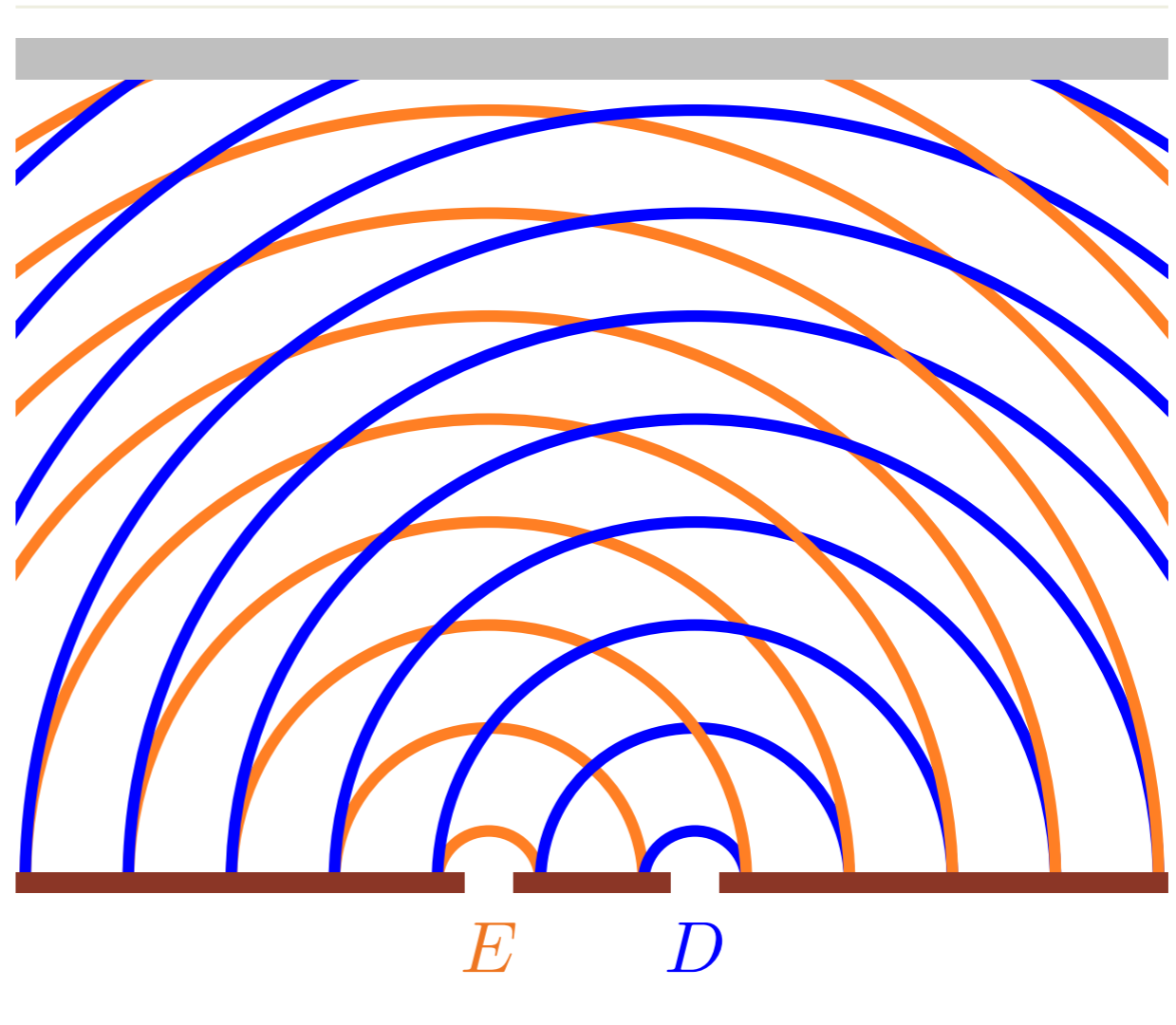
Experiência de Young

Duas fendas abertas



Experiência de Young

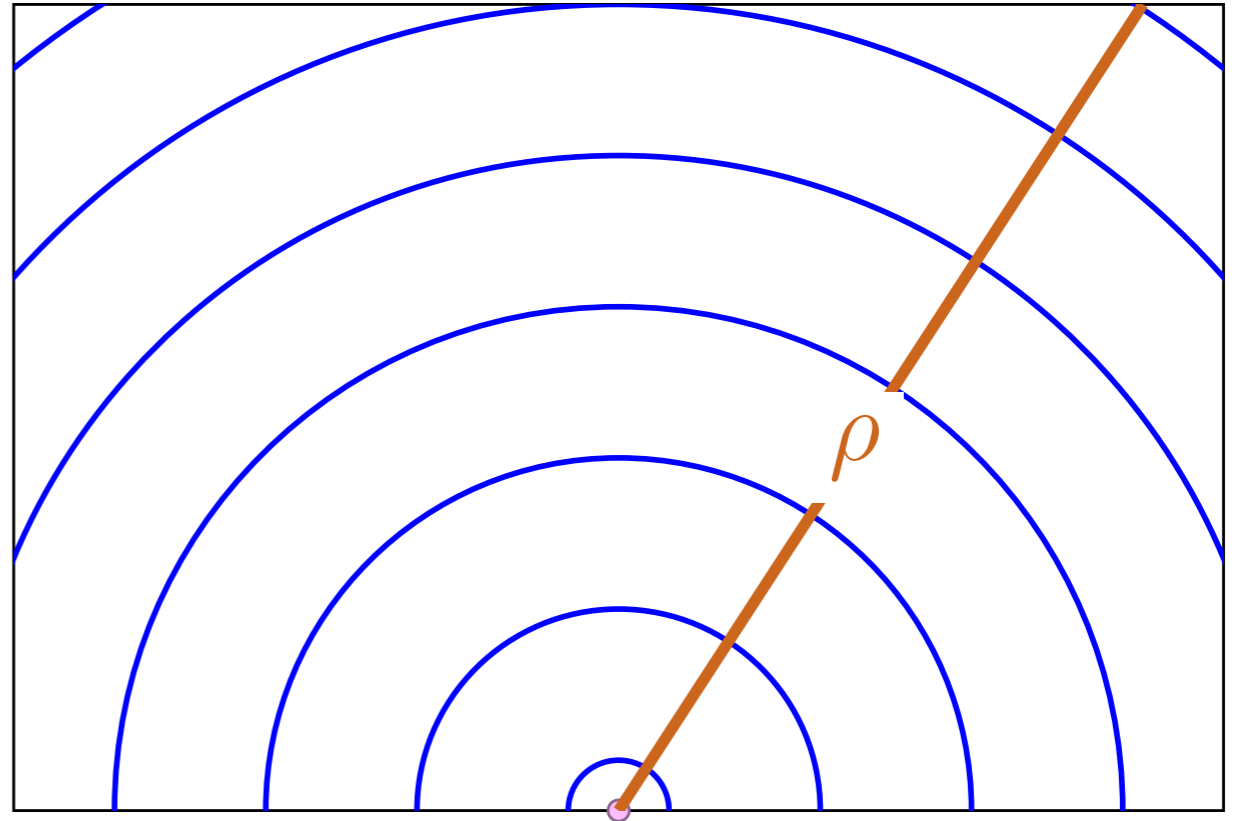
Explicação de Young



Experiência de Young

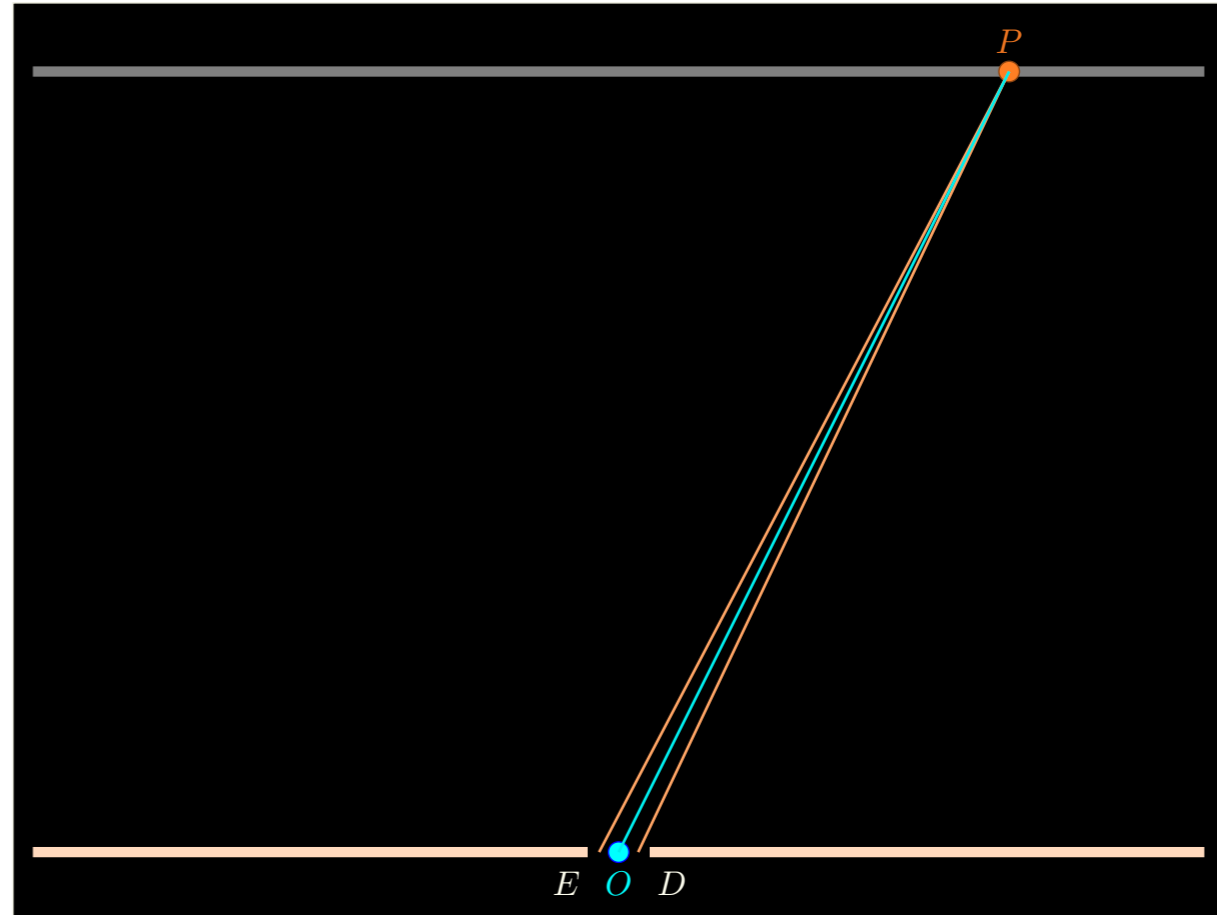
Explicação algébrica

$$E(\rho, t) = \frac{\cos(k\rho - \omega t)}{\sqrt{k\rho}}$$

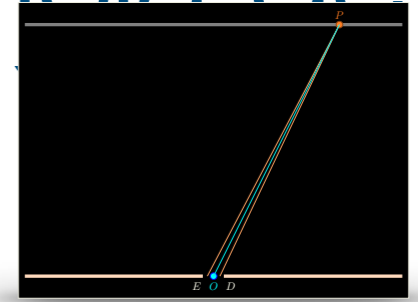


Experiência de Young

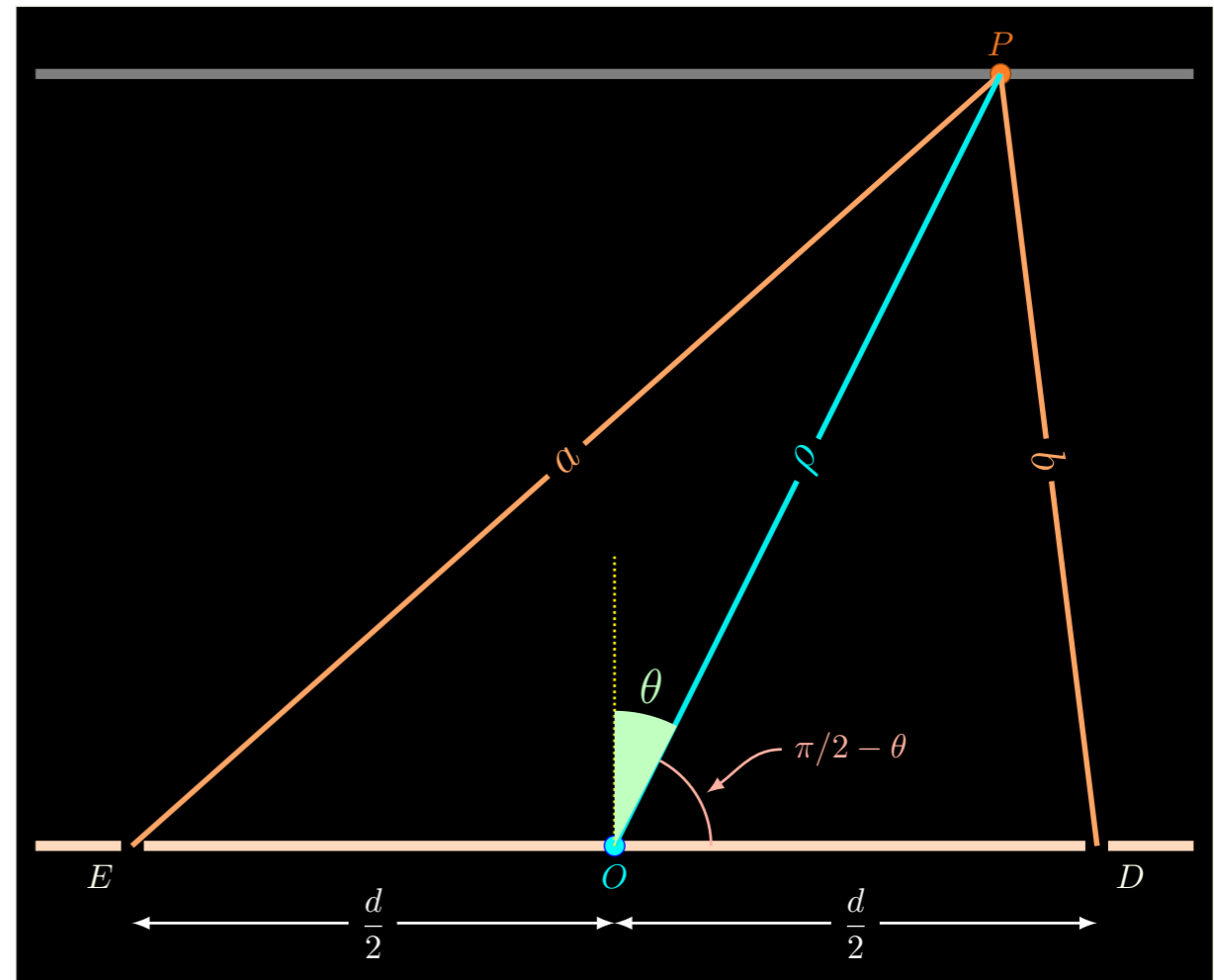
Explicação algébrica



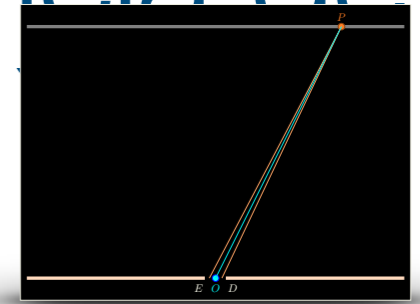
Experiência de



Explicação algébrica

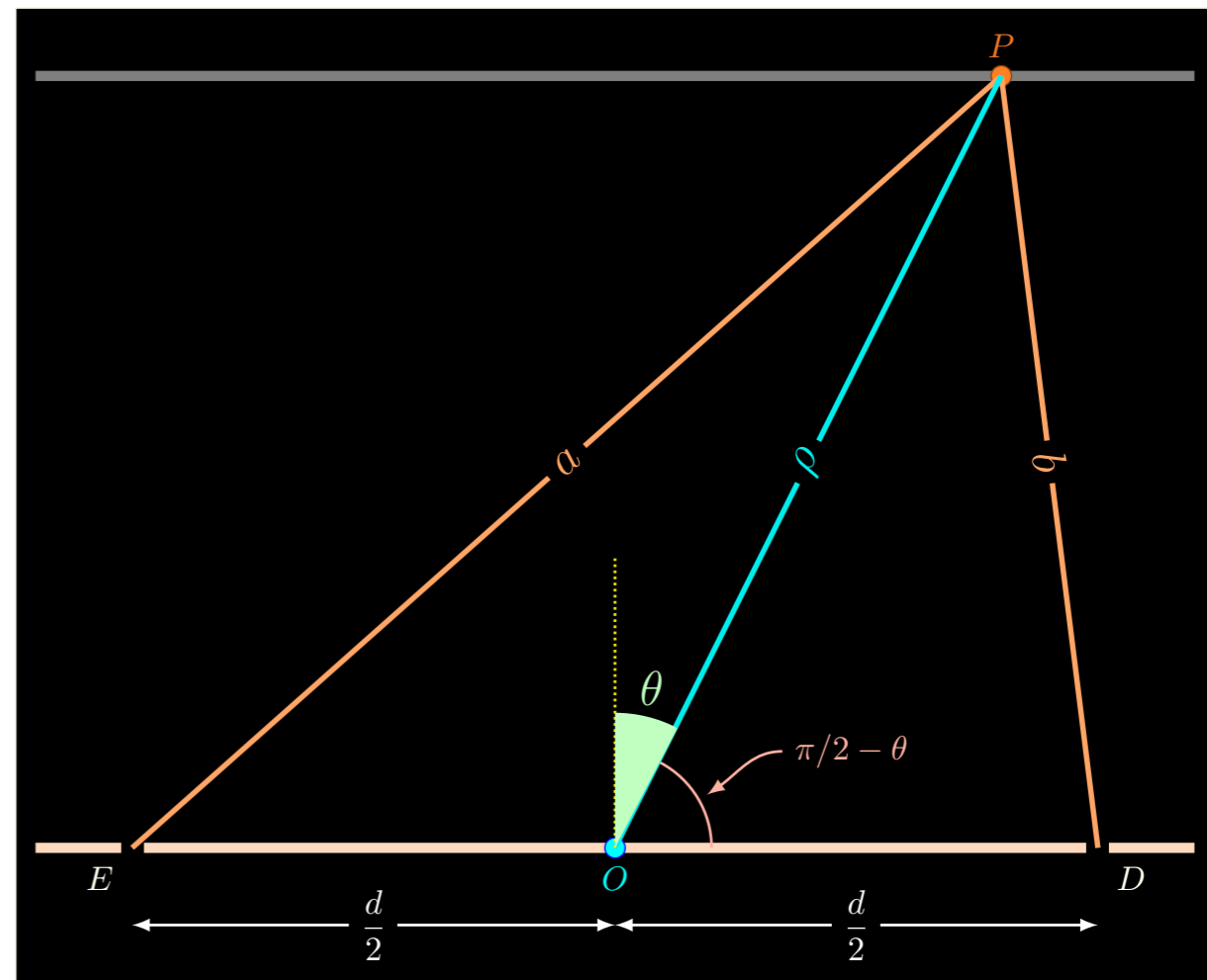


Experiência de

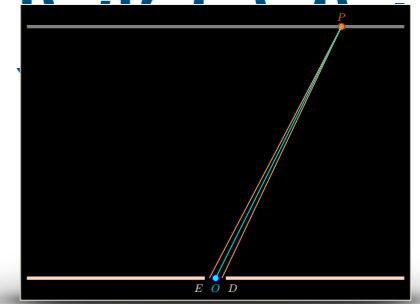


Explicação algébrica

$$b^2 = \left(\frac{d}{2}\right)^2 + \rho^2 - 2\rho\frac{d}{2}\cos\left(\frac{\pi}{2} - \theta\right)$$

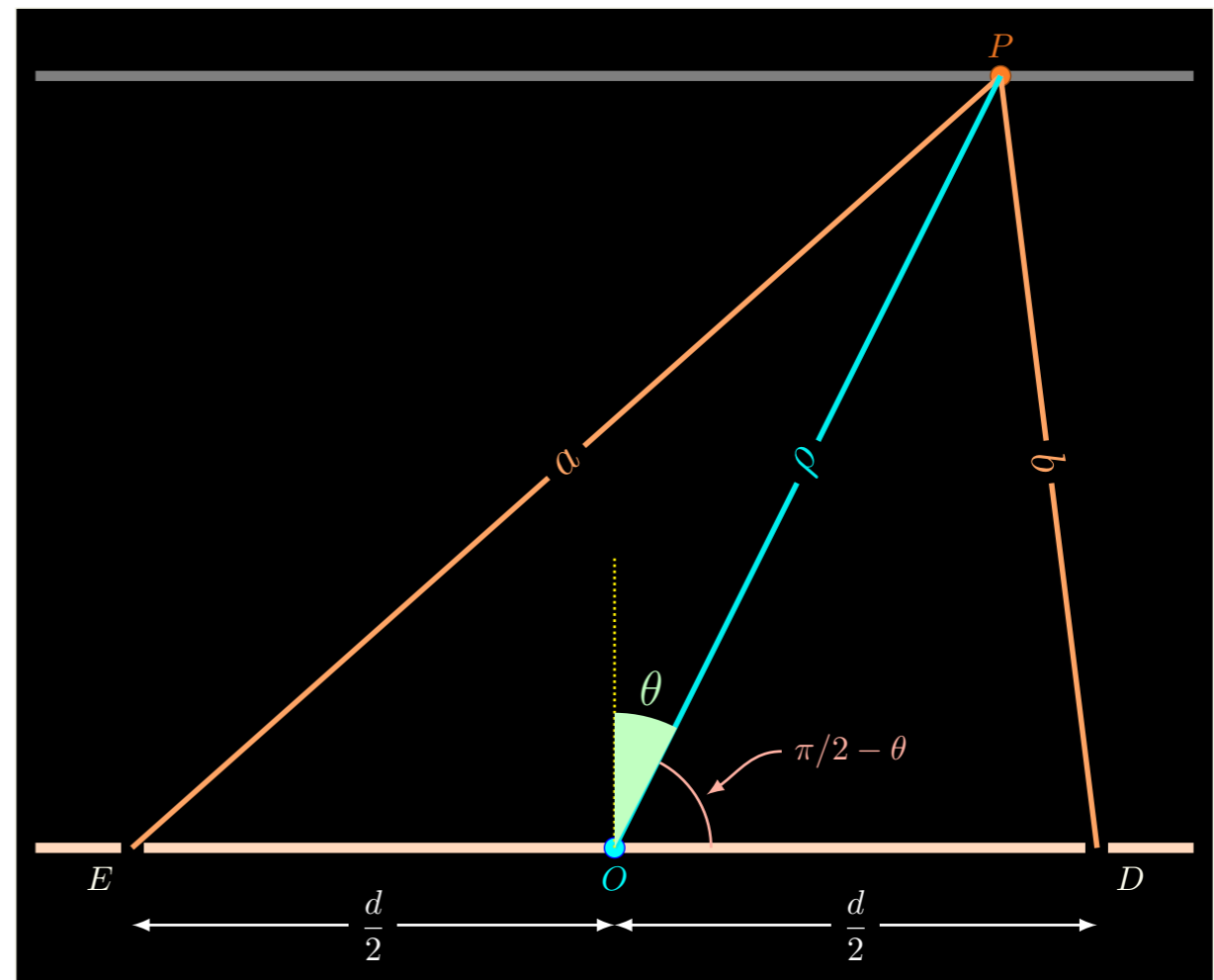


Experiência de

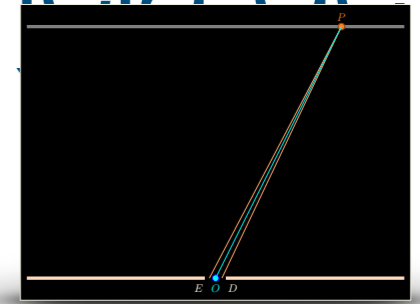


$$b^2 = \left(\frac{d}{2}\right)^2 + \rho^2 - 2\rho\frac{d}{2}\cos\left(\frac{\pi}{2} - \theta\right)$$

$$b^2 = \left(\frac{d}{2}\right)^2 + \rho^2 - \rho d \sin(\theta)$$

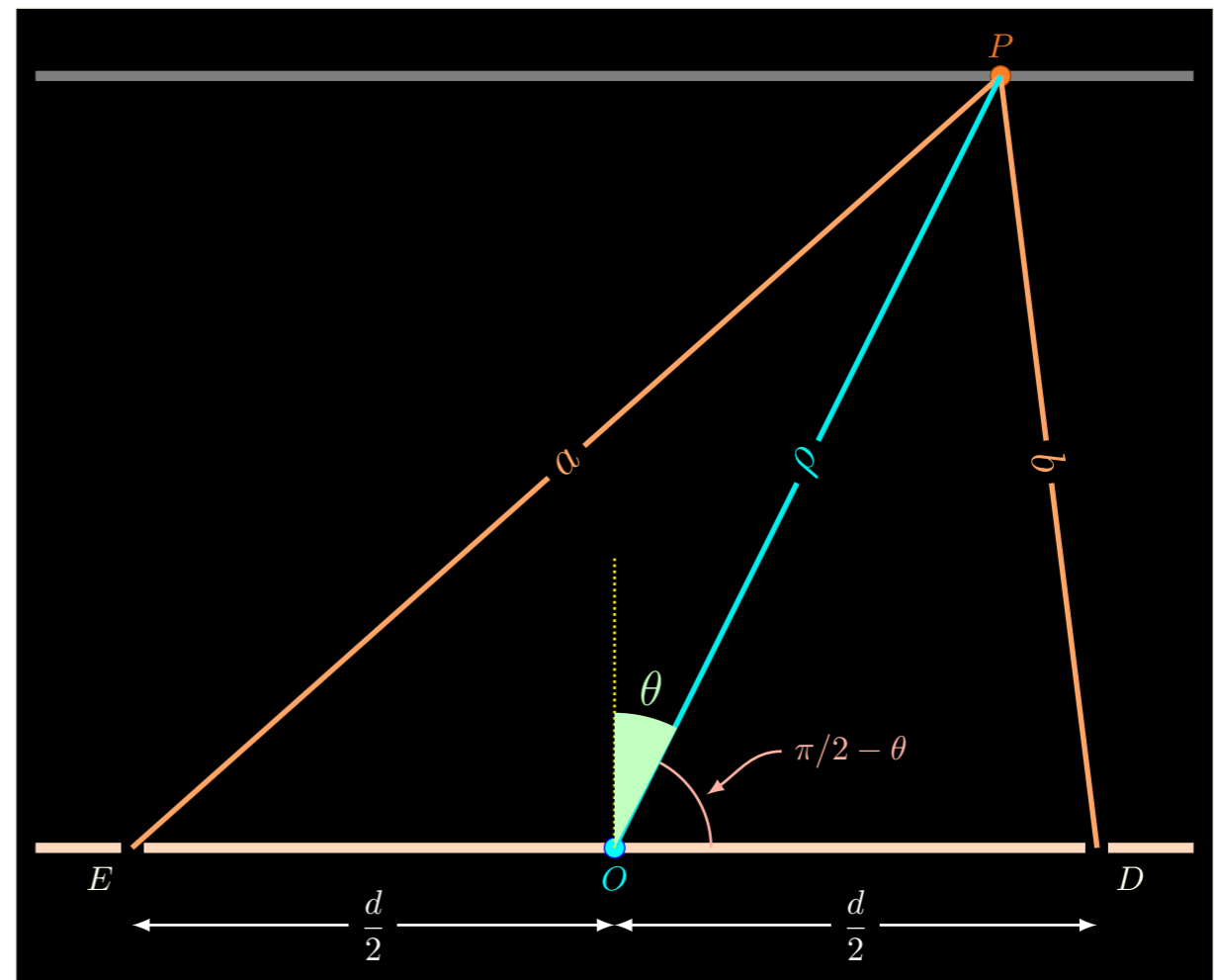


Experiência de

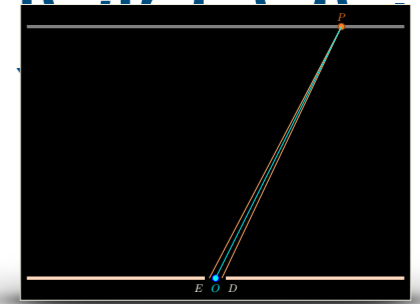


$$b^2 = \left(\frac{d}{2}\right)^2 + \rho^2 - 2\rho\frac{d}{2}\cos\left(\frac{\pi}{2} - \theta\right)$$

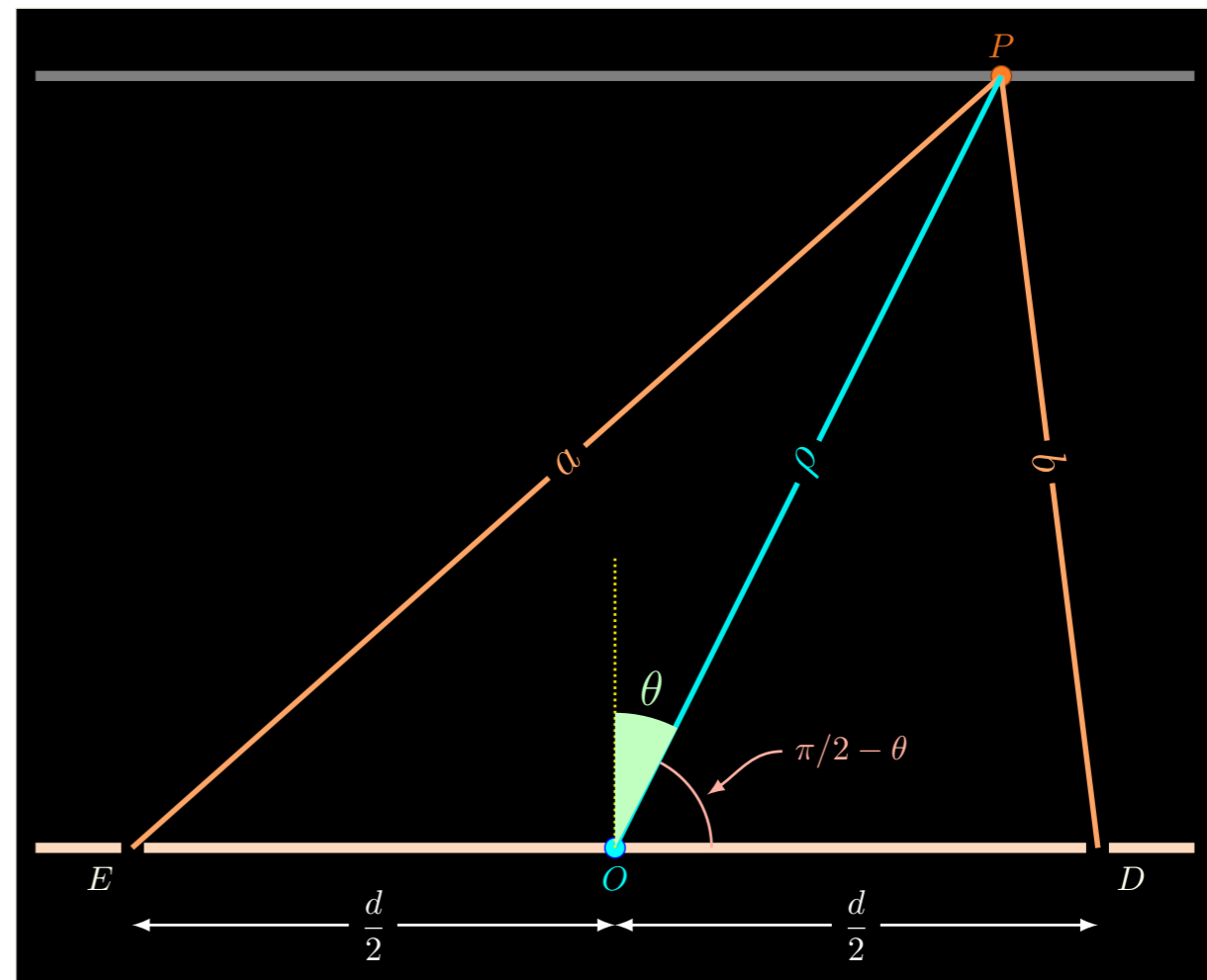
$$b^2 = \left(\frac{d}{2}\right)^2 + \rho^2 - \rho d \sin(\theta)$$



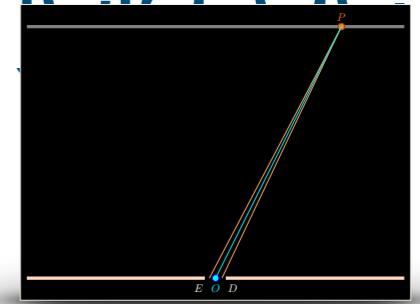
Experiência de



$$b^2 = \left(\frac{d}{2}\right)^2 + \rho^2 - \rho d \sin(\theta)$$

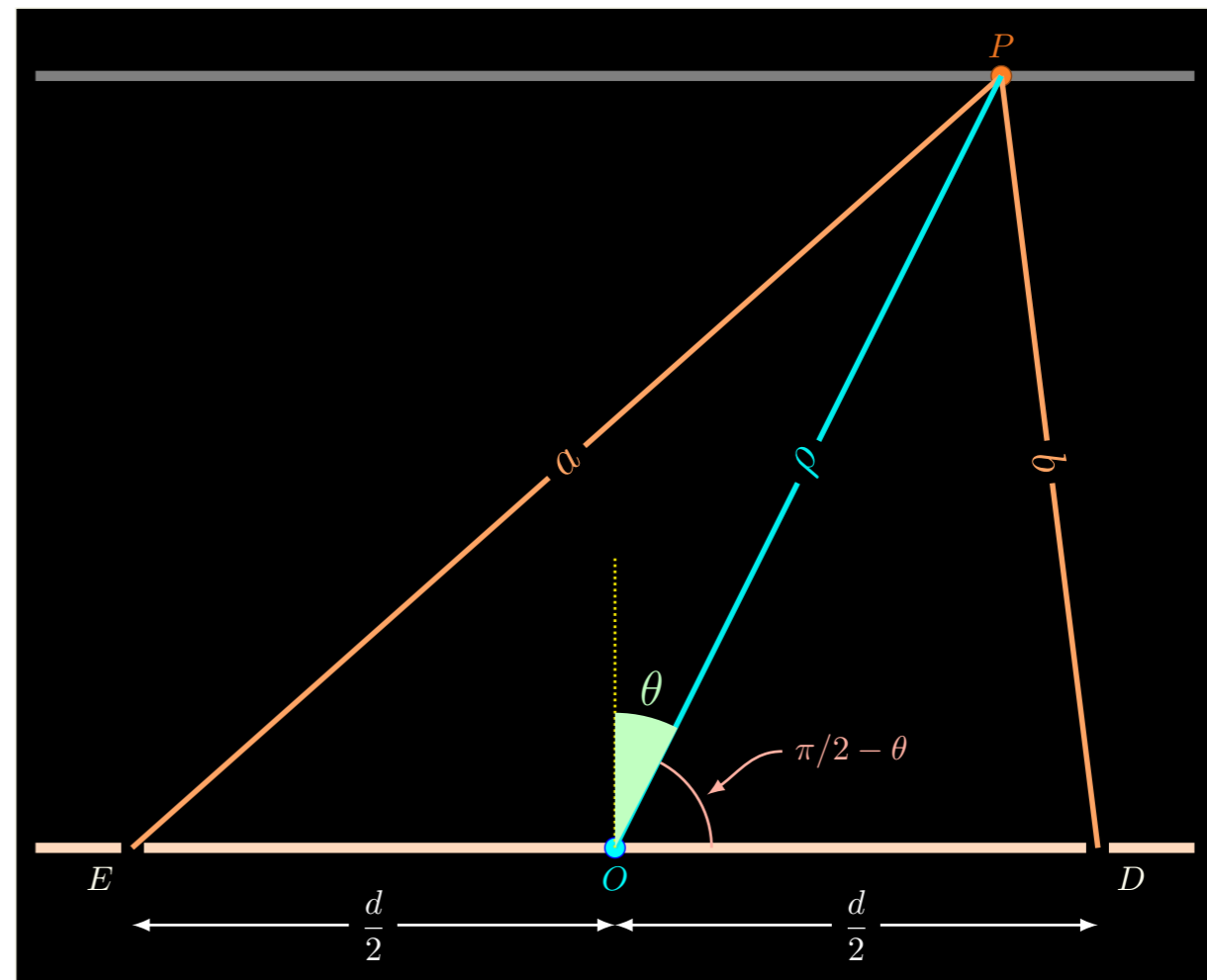


Experiência de

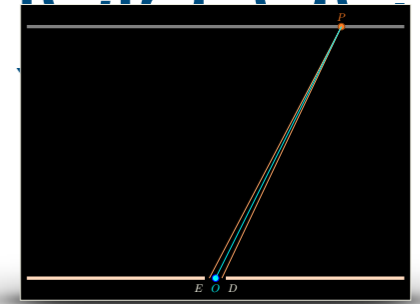


$$b^2 = \left(\frac{d}{2}\right)^2 + \rho^2 - \rho d \sin(\theta)$$

$$a^2 = \left(\frac{d}{2}\right)^2 + \rho^2 + \rho d \sin(\theta)$$



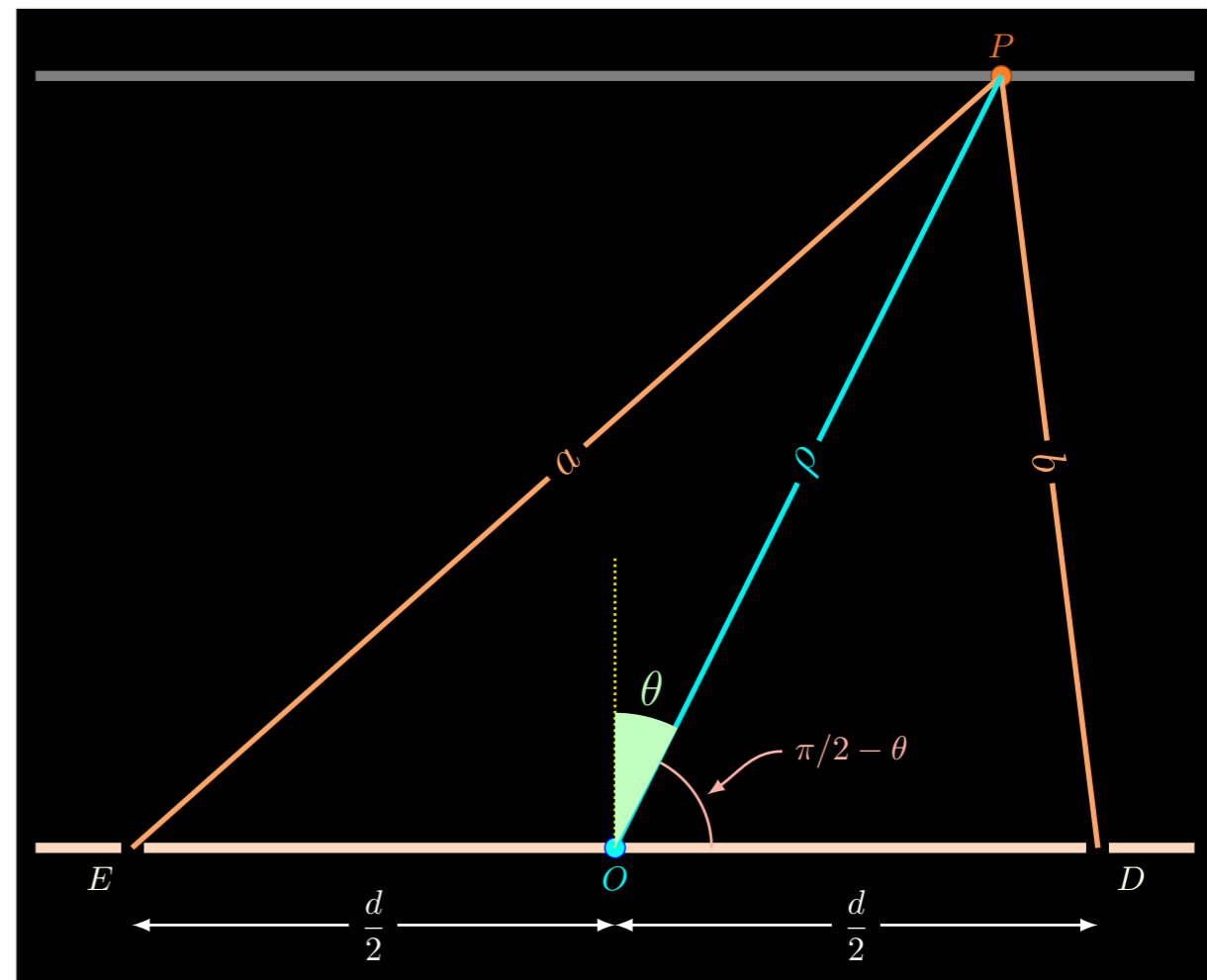
Experiência de



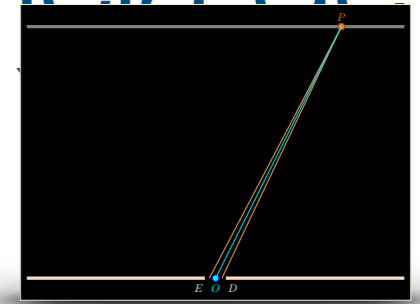
$$b^2 = \left(\frac{d}{2}\right)^2 + \rho^2 - \rho d \sin(\theta)$$

$$a^2 = \left(\frac{d}{2}\right)^2 + \rho^2 + \rho d \sin(\theta)$$

$$a^2 - b^2 = 2\rho d \sin(\theta)$$



Experiência de

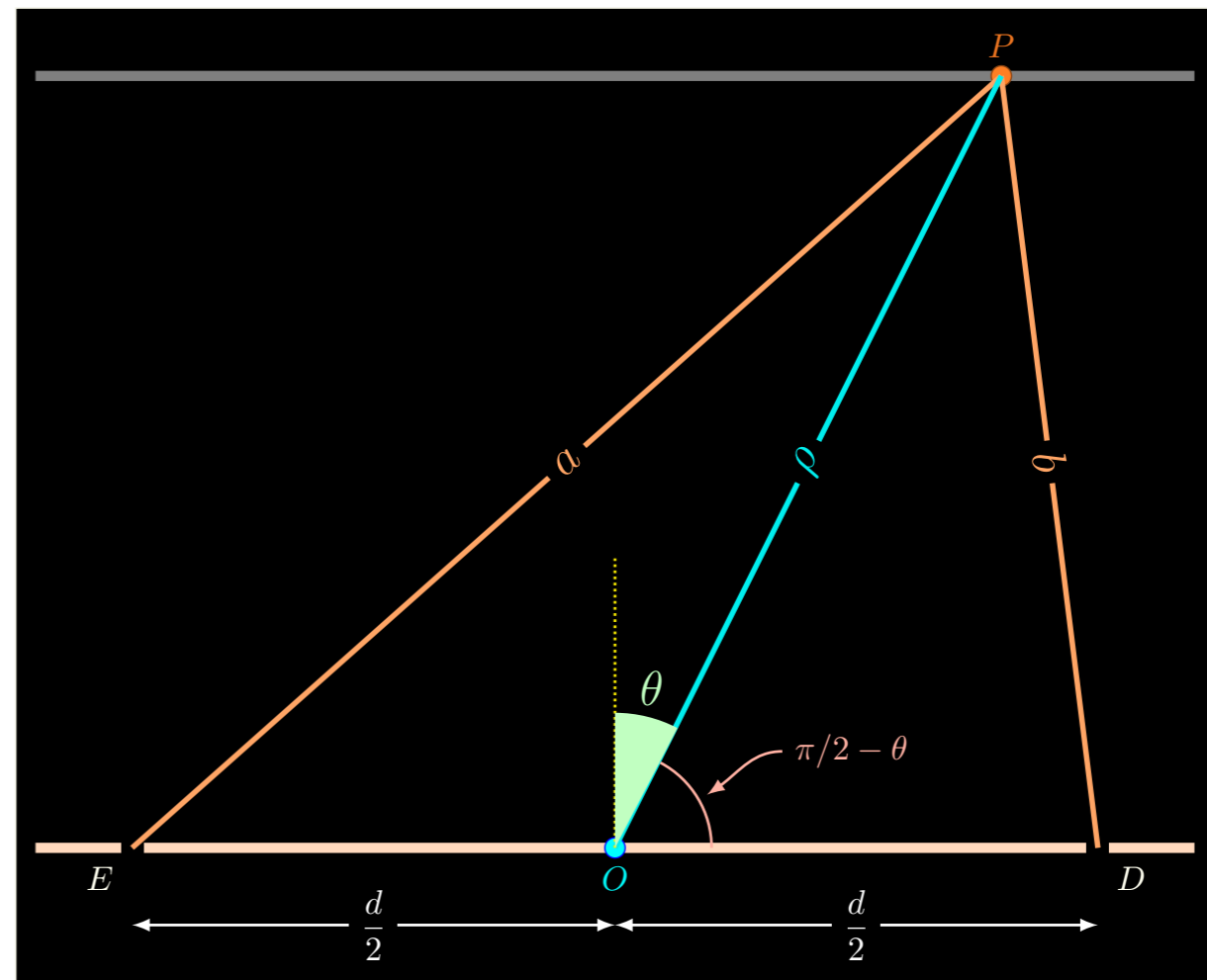


$$b^2 = \left(\frac{d}{2}\right)^2 + \rho^2 - \rho d \sin(\theta)$$

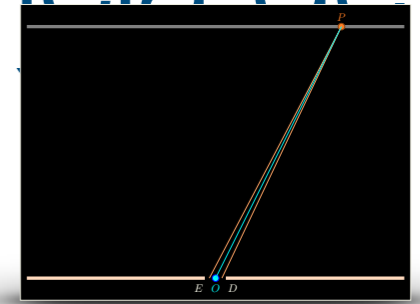
$$a^2 = \left(\frac{d}{2}\right)^2 + \rho^2 + \rho d \sin(\theta)$$

$$a^2 - b^2 = 2\rho d \sin(\theta)$$

$$(a - b)(a + b) = 2\rho d \sin(\theta)$$



Experiência de

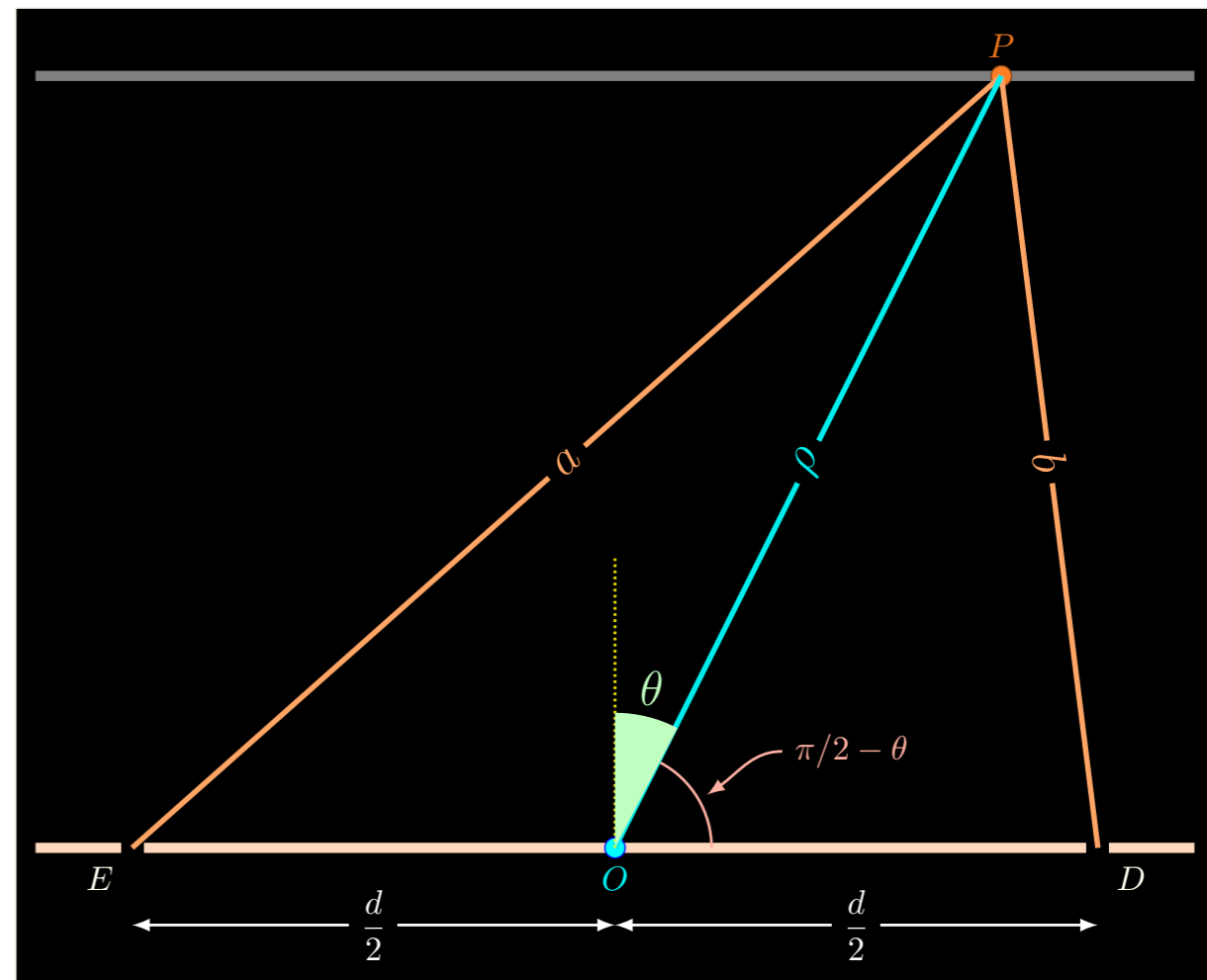


$$b^2 = \left(\frac{d}{2}\right)^2 + \rho^2 - \rho d \sin(\theta)$$

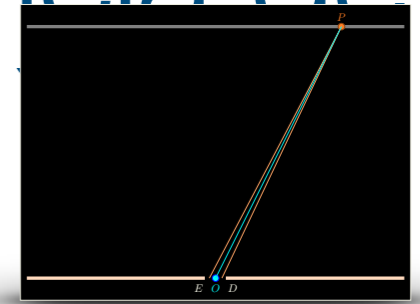
$$a^2 = \left(\frac{d}{2}\right)^2 + \rho^2 + \rho d \sin(\theta)$$

$$a^2 - b^2 = 2\rho d \sin(\theta)$$

$$(a - b)(a + b) = 2\rho d \sin(\theta)$$



Experiência de

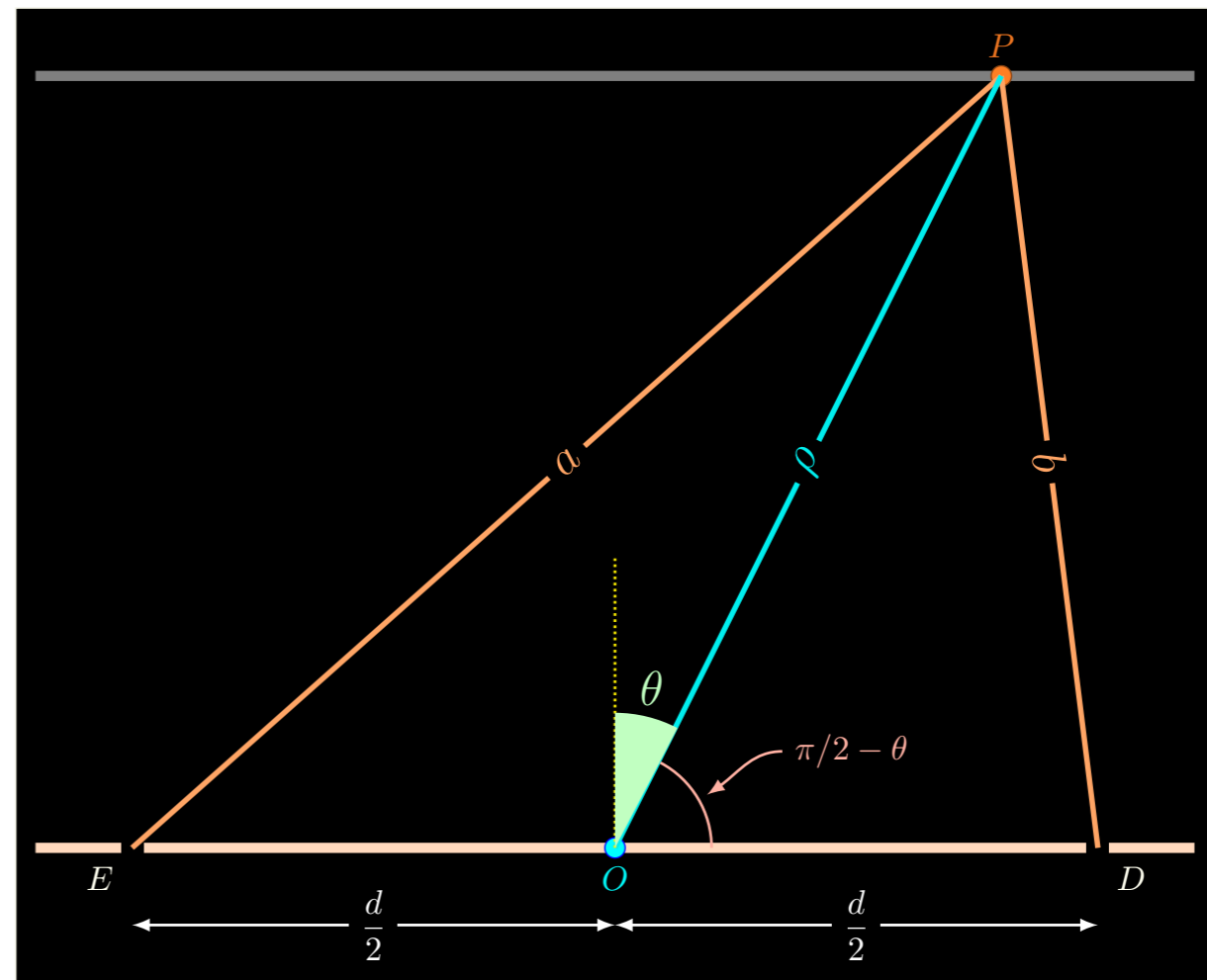


$$b^2 = \left(\frac{d}{2}\right)^2 + \rho^2 - \rho d \sin(\theta)$$

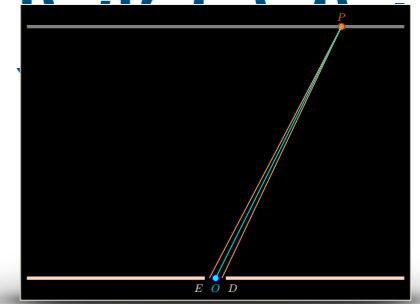
$$a^2 = \left(\frac{d}{2}\right)^2 + \rho^2 + \rho d \sin(\theta)$$

$$a^2 - b^2 = 2\rho d \sin(\theta)$$

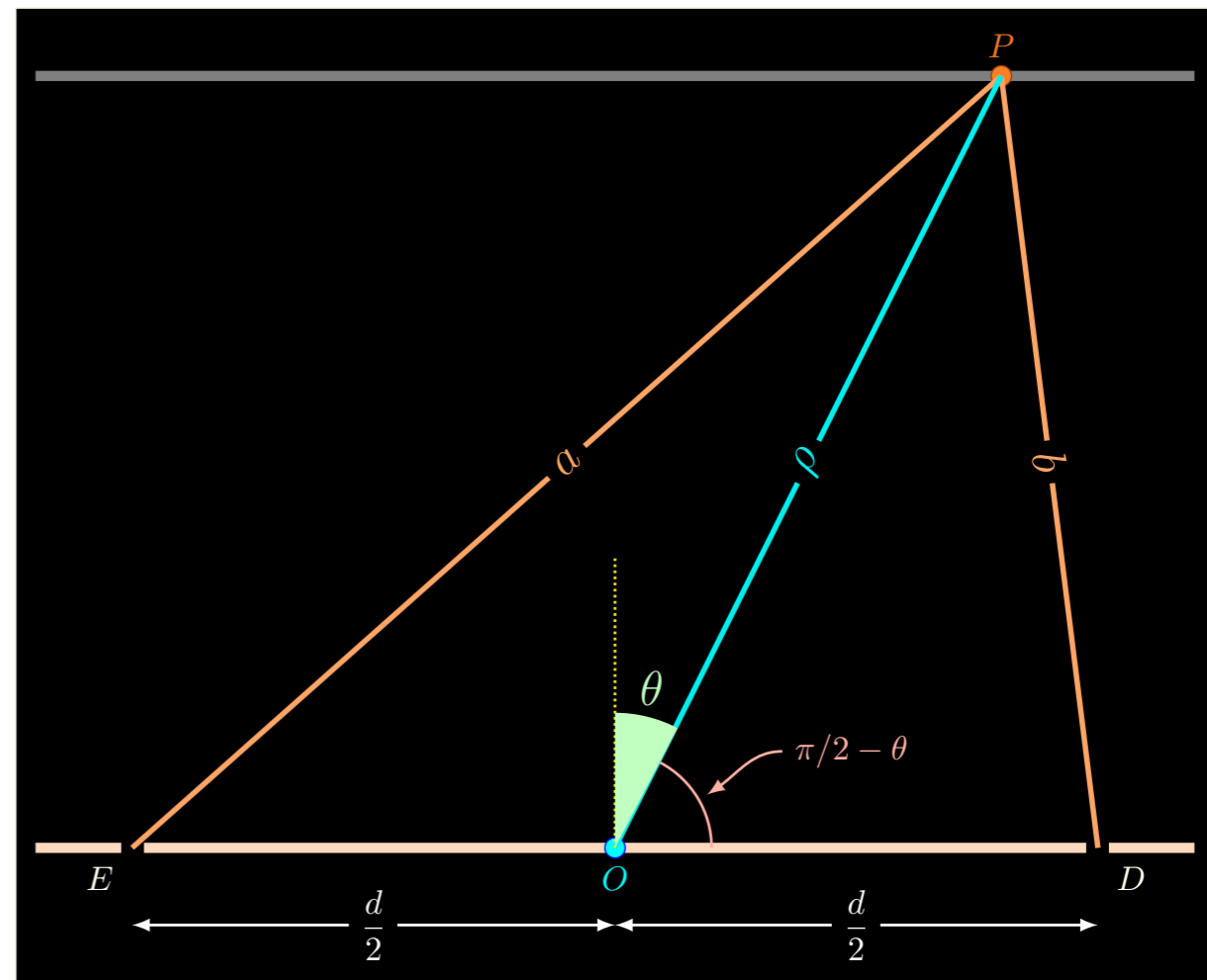
$$a - b = d \sin(\theta)$$



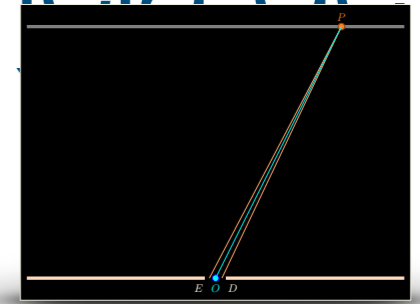
Experiência de



$$a - b = d \sin(\theta)$$



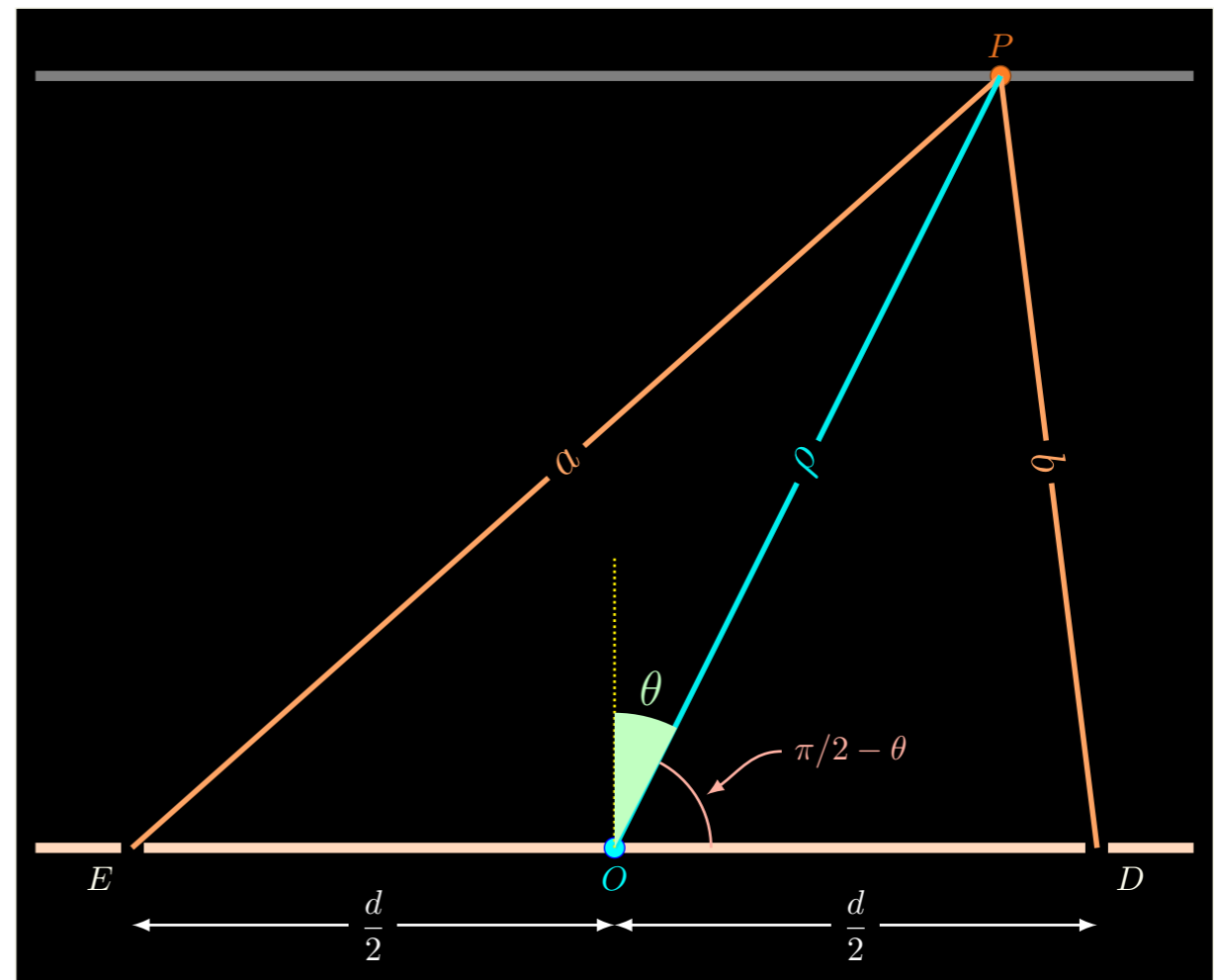
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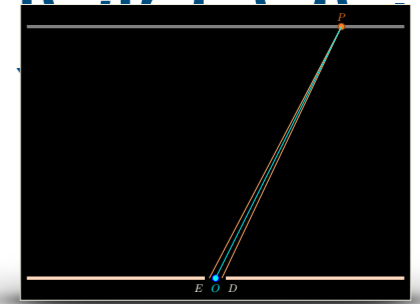
$$a - b = d \sin(\theta)$$

$$E_E(P) = \frac{\cos(ka - \omega t)}{\sqrt{k\rho}}$$

$$E_D(P) = \frac{\cos(kb - \omega t)}{\sqrt{k\rho}}$$



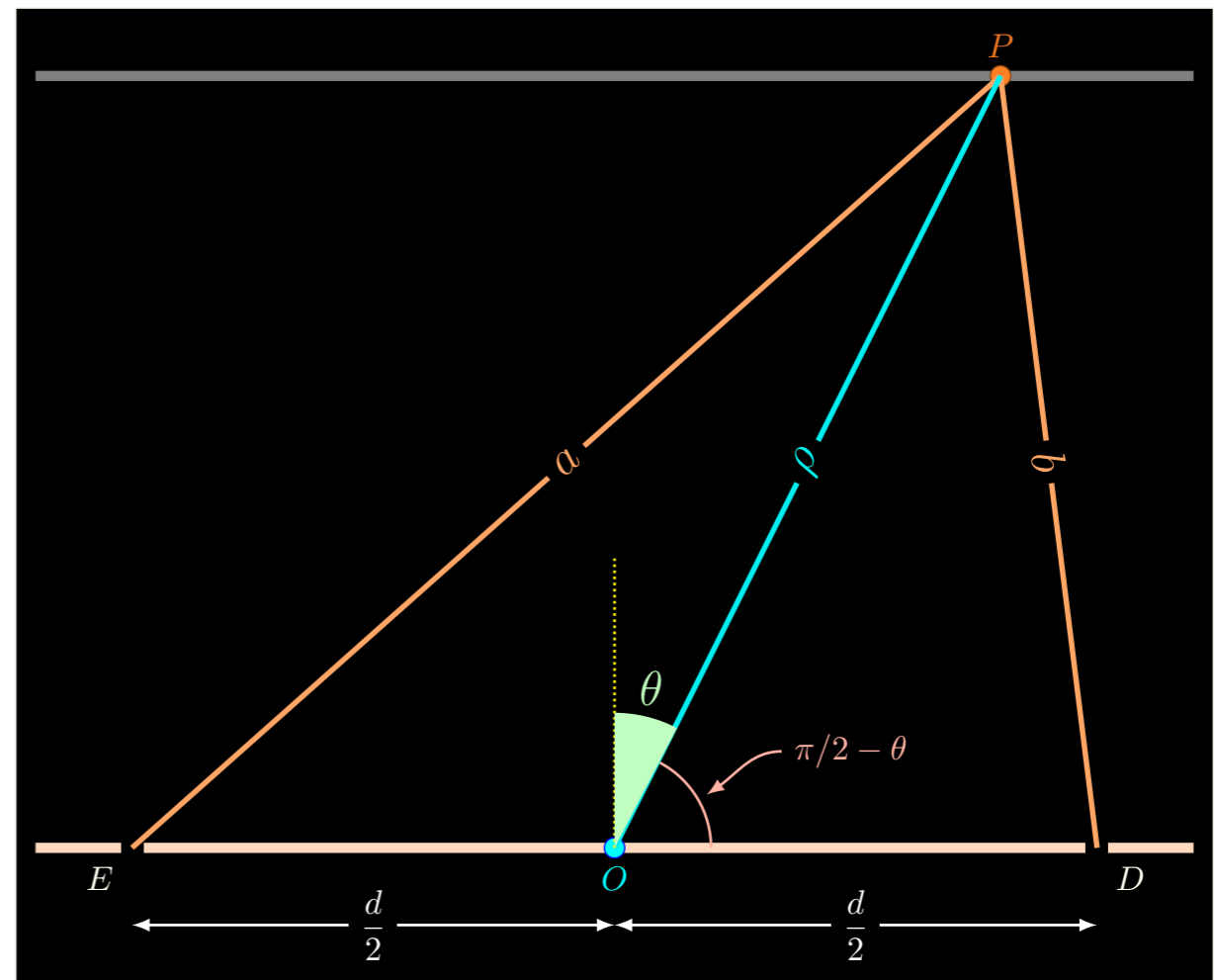
Experiência de



$$a - b = d \sin(\theta)$$

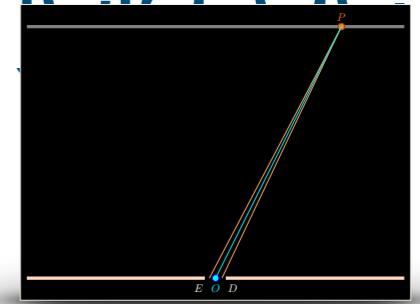
$$E_E(P) = \frac{\cos(ka - \omega t)}{\sqrt{k\rho}}$$

$$E_D(P) = \frac{\cos(kb - \omega t)}{\sqrt{k\rho}}$$



$$E(P) = \frac{\cos(ka - \omega t) + \cos(kb - \omega t)}{\sqrt{k\rho}}$$

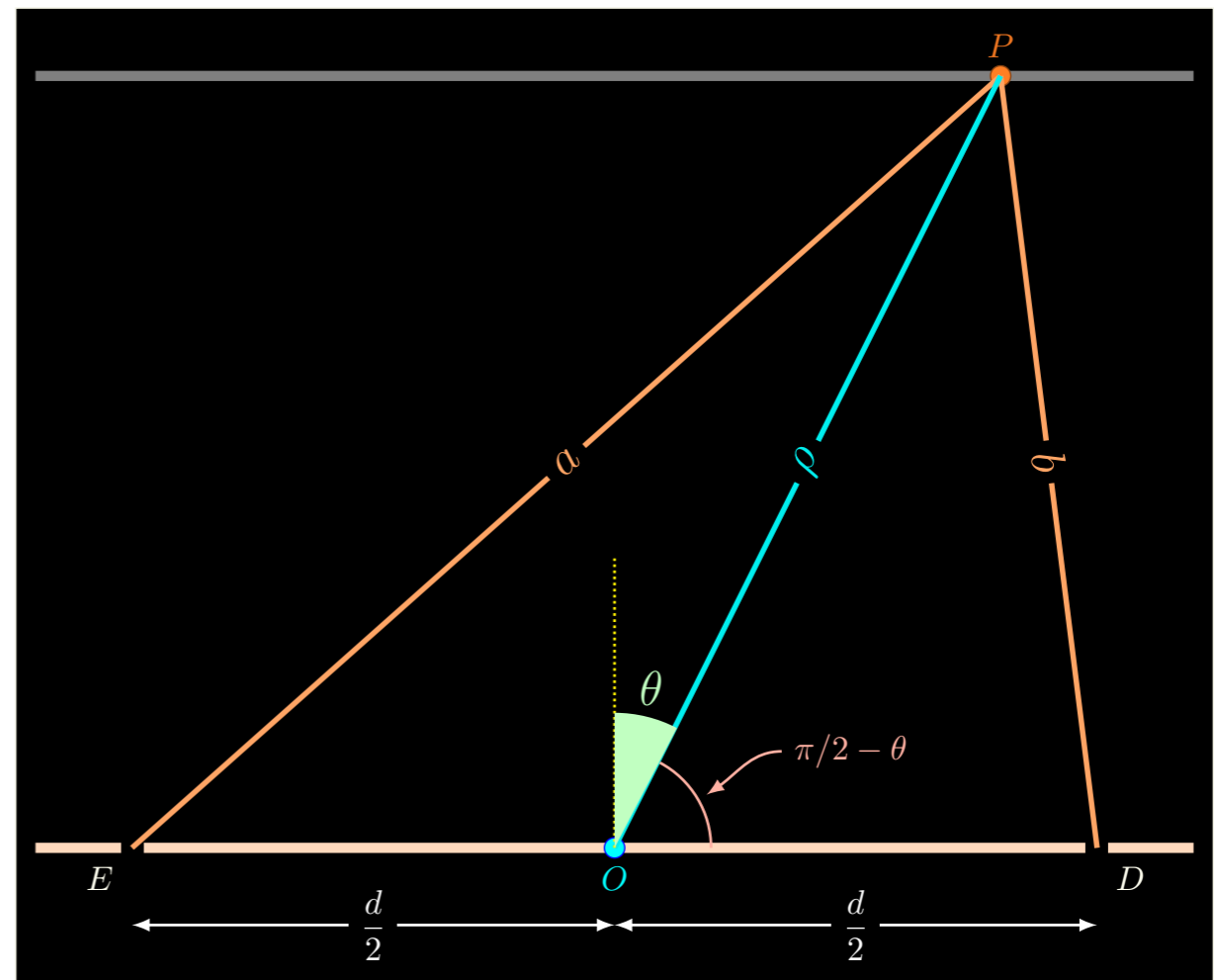
Experiência de



$$a - b = d \sin(\theta)$$

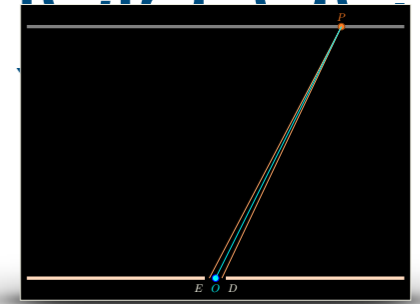
$$E_E(P) = \frac{\cos(ka - \omega t)}{\sqrt{k\rho}}$$

$$E_D(P) = \frac{\cos(kb - \omega t)}{\sqrt{k\rho}}$$

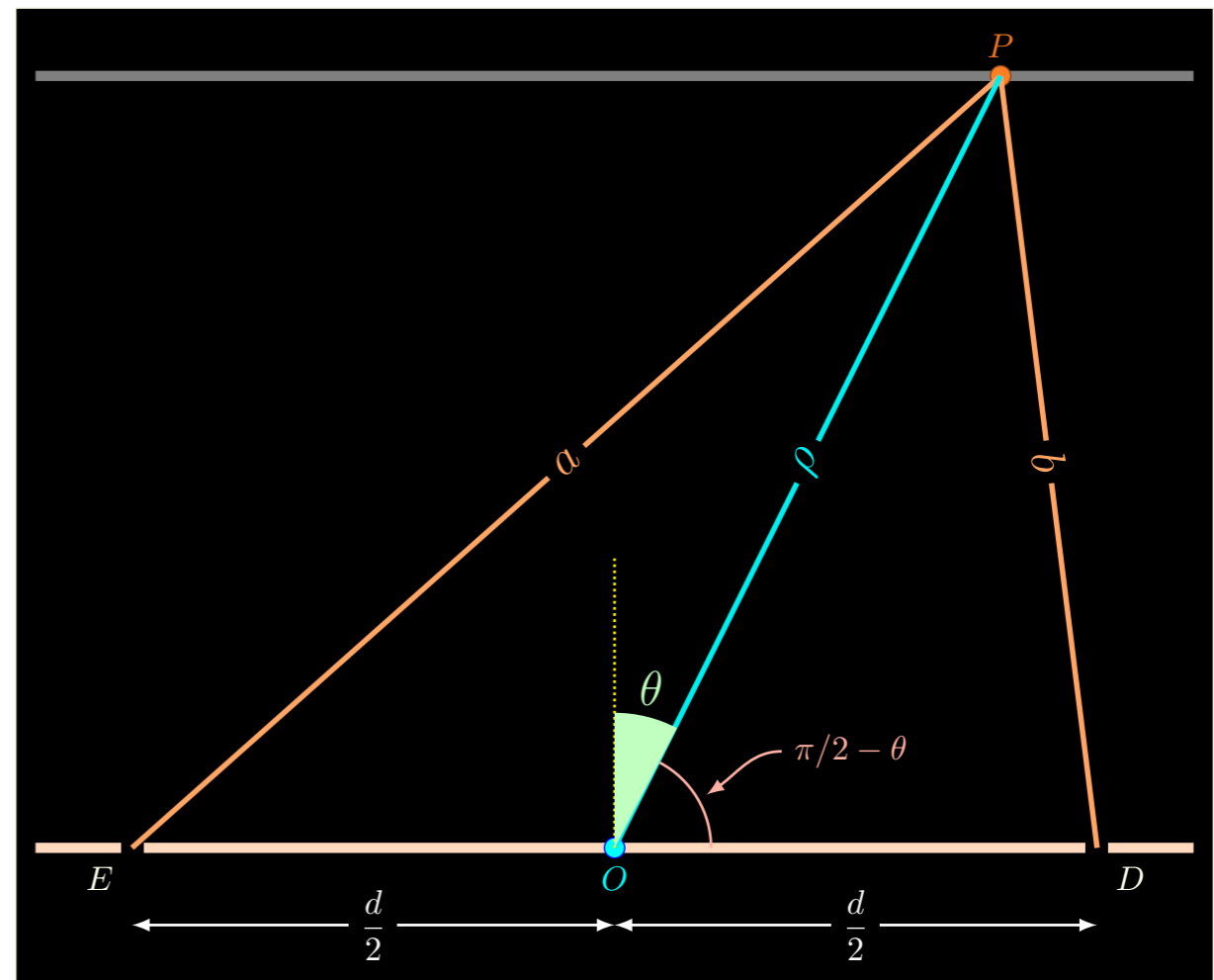


$$E(P) = \frac{\cos(ka - \omega t) + \cos(kb - \omega t)}{\sqrt{k\rho}} \Rightarrow E(P) = \frac{2 \cos(k \frac{a+b}{2} - \omega t) \cos(k \frac{a-b}{2})}{\sqrt{k\rho}}$$

Experiência de

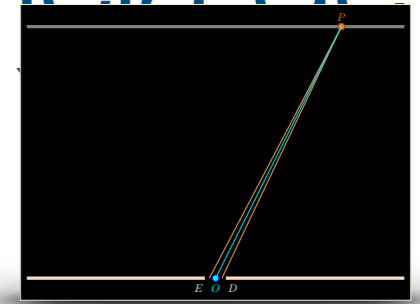


$$a - b = d \sin(\theta)$$



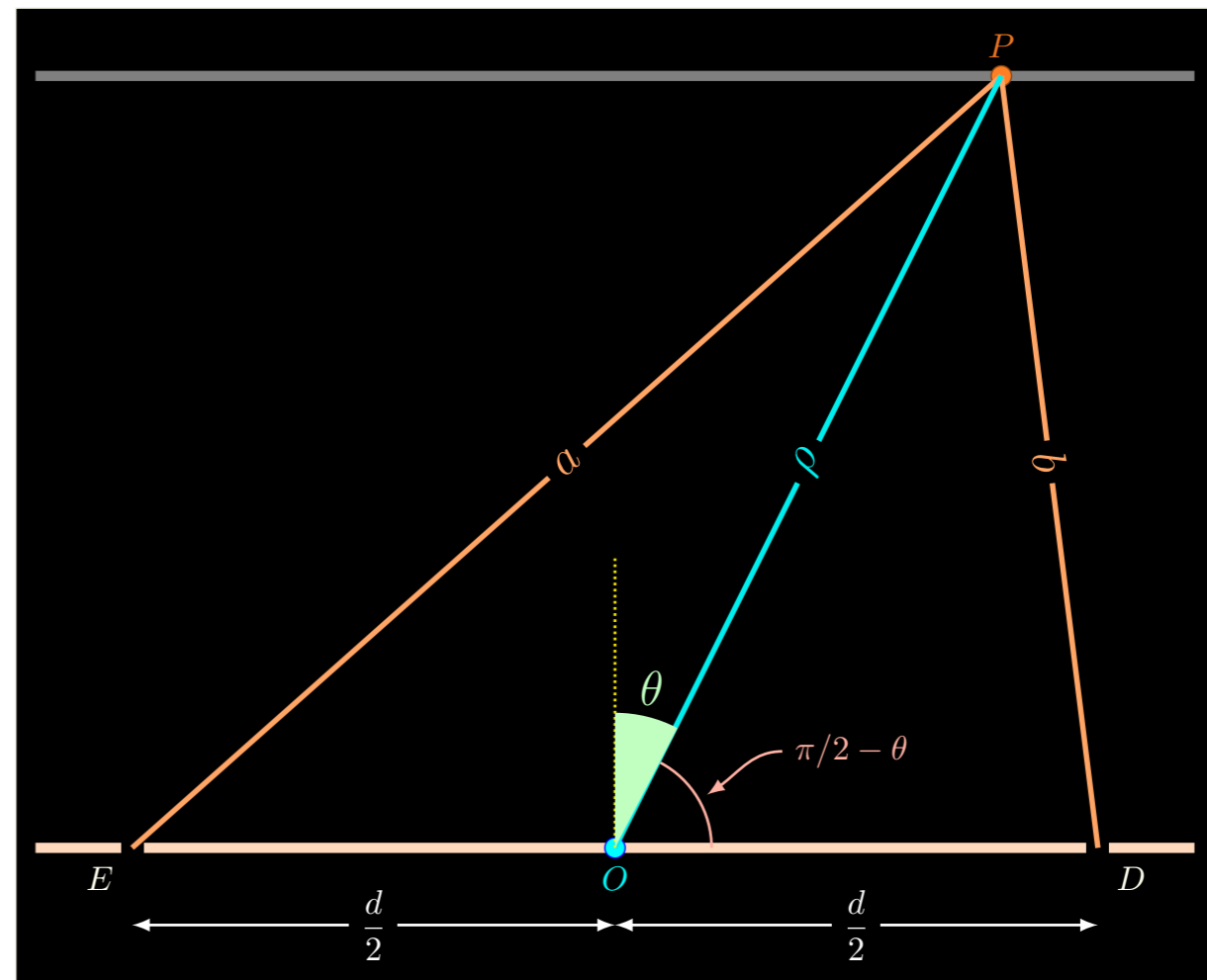
$$\Rightarrow E(P) = \frac{2 \cos\left(k \frac{a+b}{2} - \omega t\right) \cos\left(k \frac{a-b}{2}\right)}{\sqrt{k\rho}}$$

Experiência de

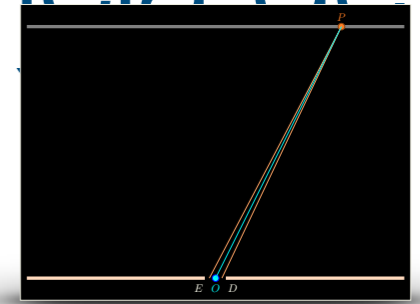


$$a - b = d \sin(\theta)$$

$$E(P) = \frac{2 \cos\left(k \frac{a+b}{2} - \omega t\right) \cos\left(k \frac{a-b}{2}\right)}{\sqrt{k\rho}}$$



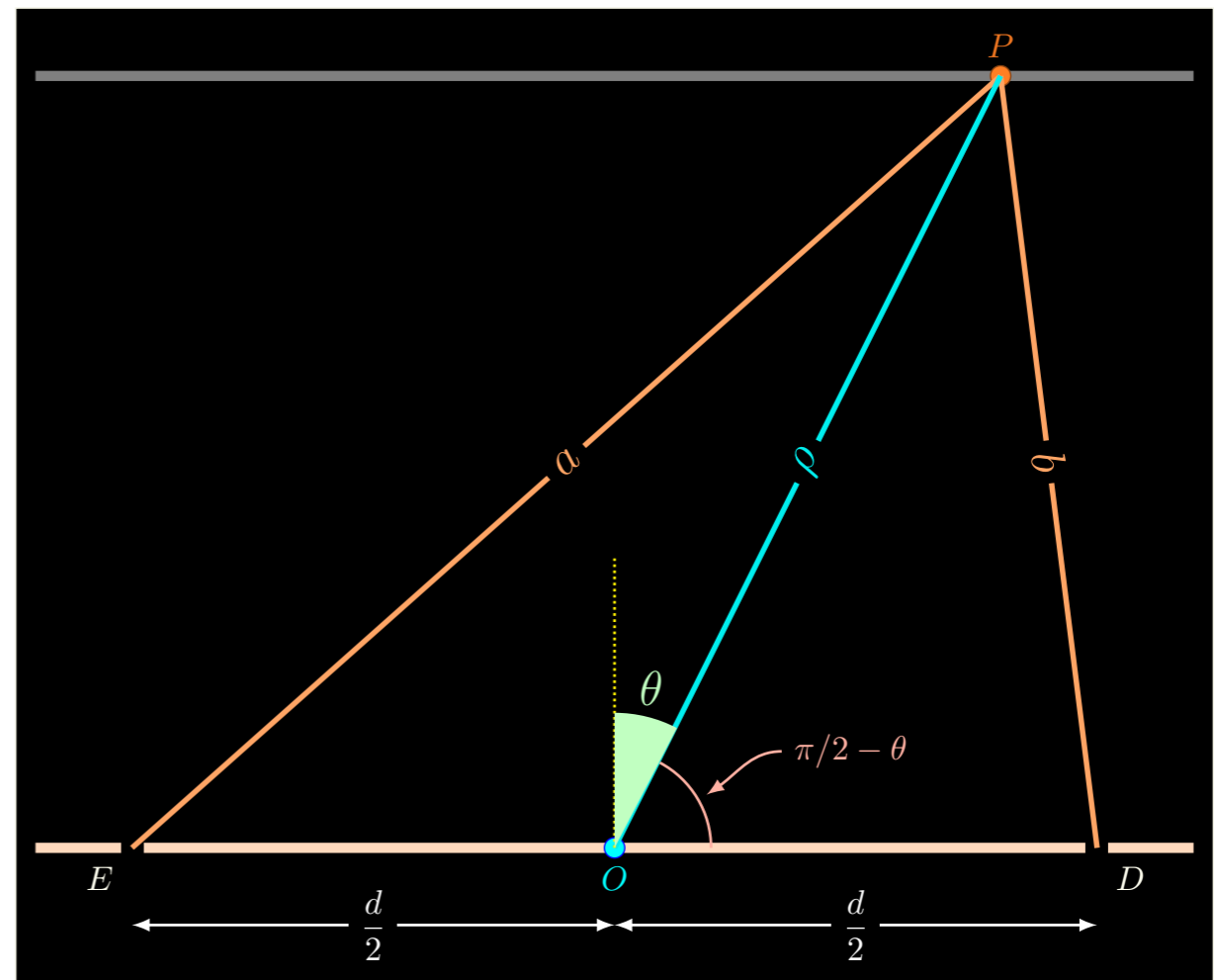
Experiência de



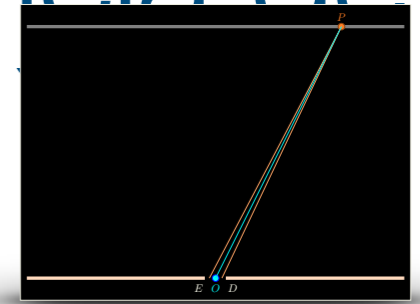
$$a - b = d \sin(\theta)$$

$$E(P) = \frac{2 \cos\left(k \frac{a+b}{2} - \omega t\right) \cos\left(k \frac{a-b}{2}\right)}{\sqrt{k\rho}}$$

$$E(P) = \frac{2 \cos(k\rho - \omega t) \cos\left(\frac{kd \sin(\theta)}{2}\right)}{\sqrt{k\rho}}$$



Experiência de

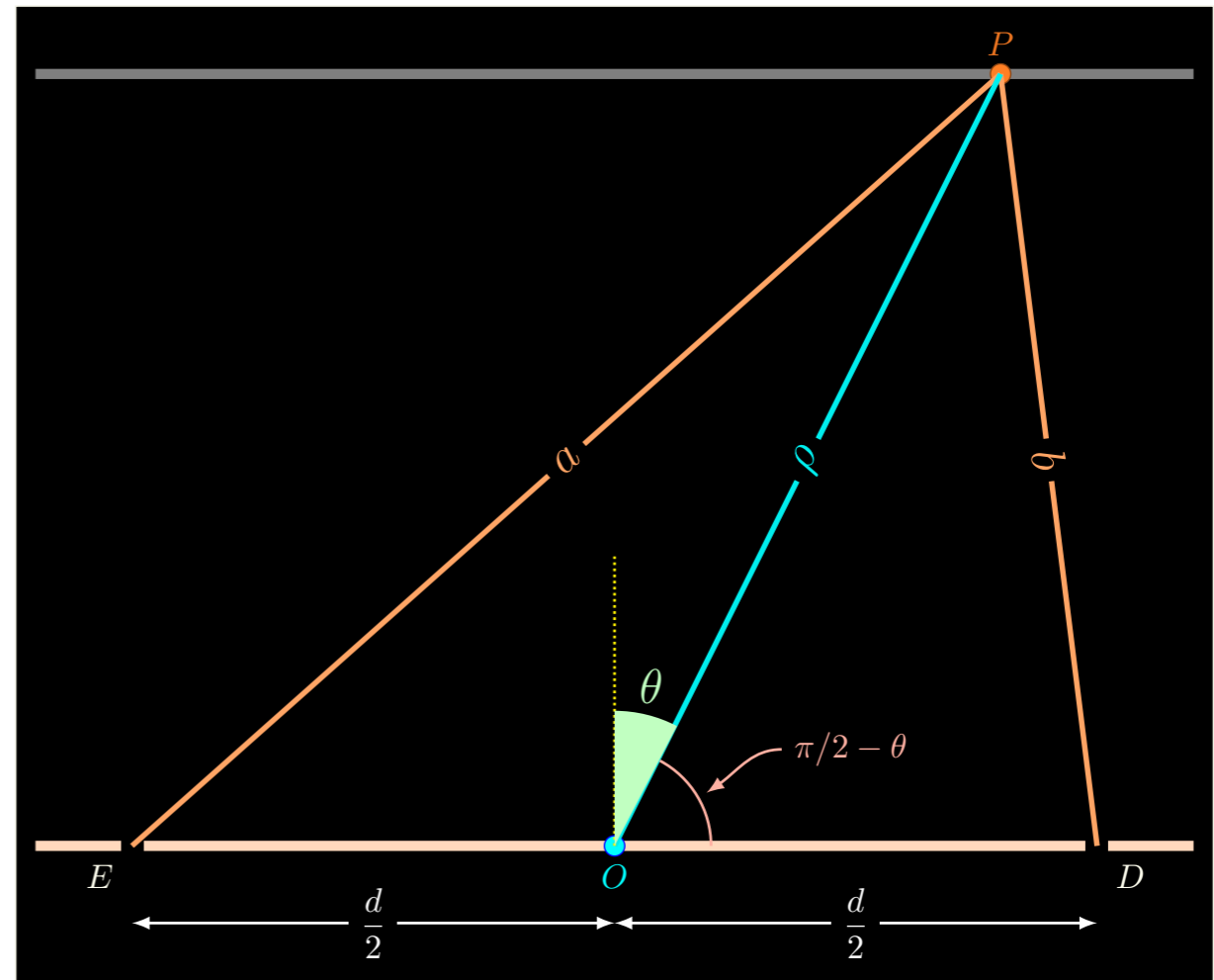


$$a - b = d \sin(\theta)$$

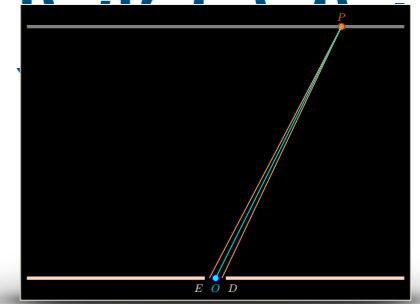
$$E(P) = \frac{2 \cos\left(k \frac{a+b}{2} - \omega t\right) \cos\left(k \frac{a-b}{2}\right)}{\sqrt{k\rho}}$$

$$E(P) = \frac{2 \cos(k\rho - \omega t) \cos\left(\frac{kd \sin(\theta)}{2}\right)}{\sqrt{k\rho}}$$

$$\langle S \rangle = \frac{2}{\mu_0 c k \rho} \cos^2\left(\frac{\pi d \sin(\theta)}{\lambda}\right)$$



Experiência de

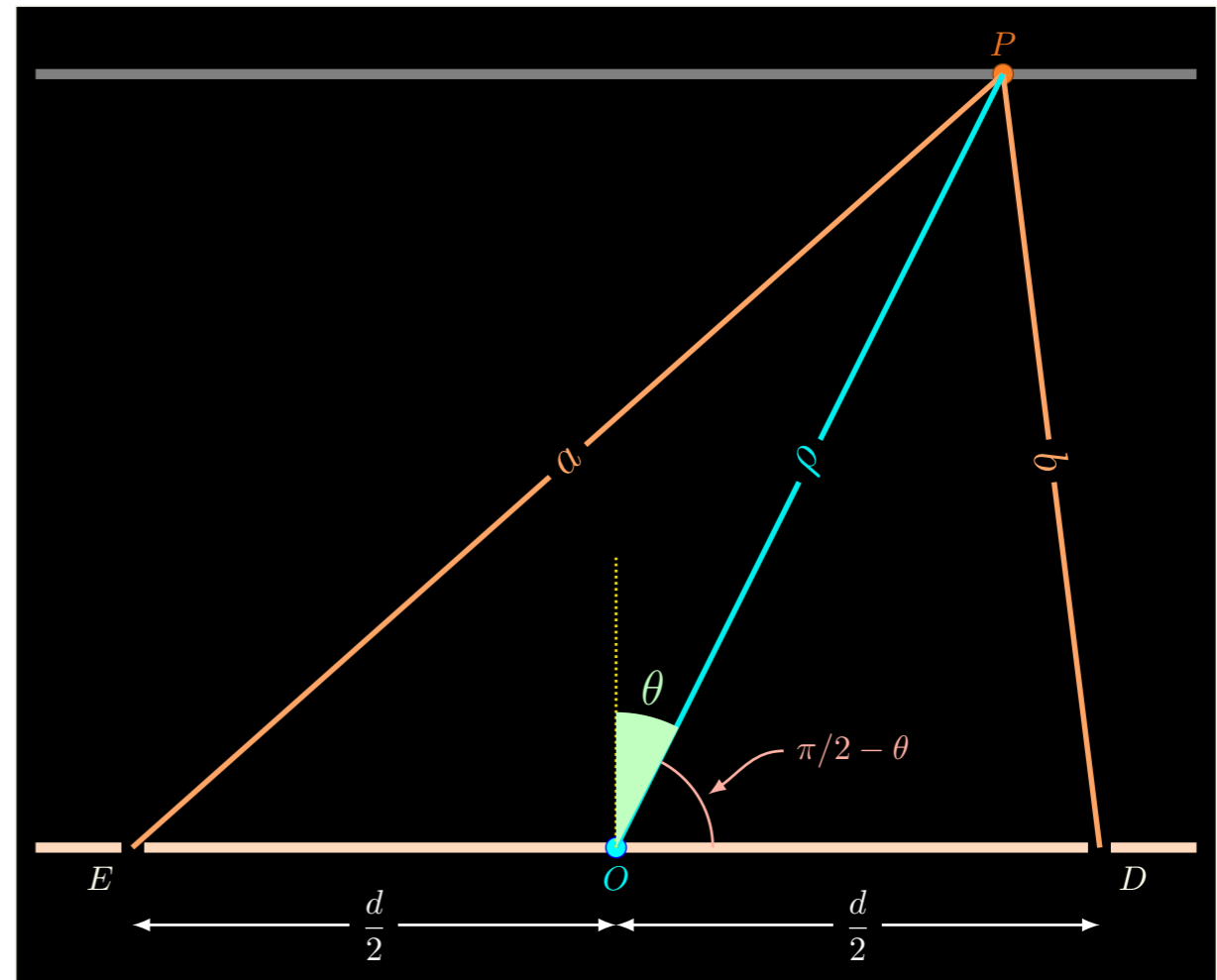


$$a - b = d \sin(\theta)$$

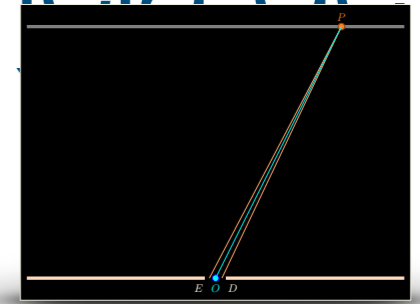
$$E(P) = \frac{2 \cos\left(k \frac{a+b}{2} - \omega t\right) \cos\left(k \frac{a-b}{2}\right)}{\sqrt{k\rho}}$$

$$E(P) = \frac{2 \cos(k\rho - \omega t) \cos\left(\frac{kd \sin(\theta)}{2}\right)}{\sqrt{k\rho}}$$

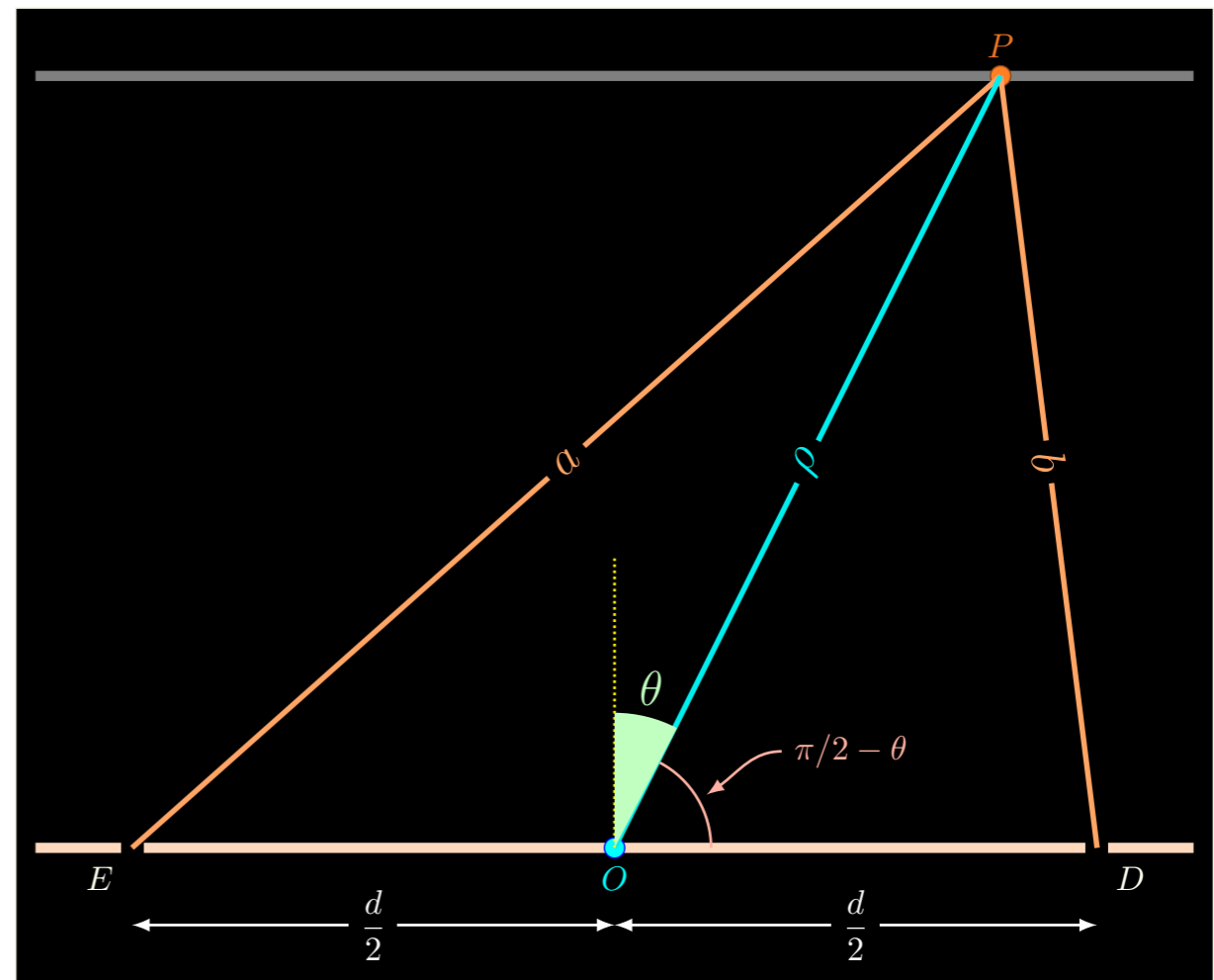
$$\langle S \rangle = \frac{2}{\mu_0 c k \rho} \cos^2\left(\frac{\pi d \sin(\theta)}{\lambda}\right)$$



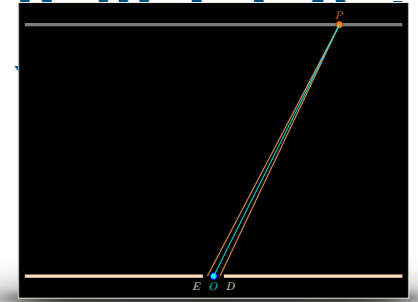
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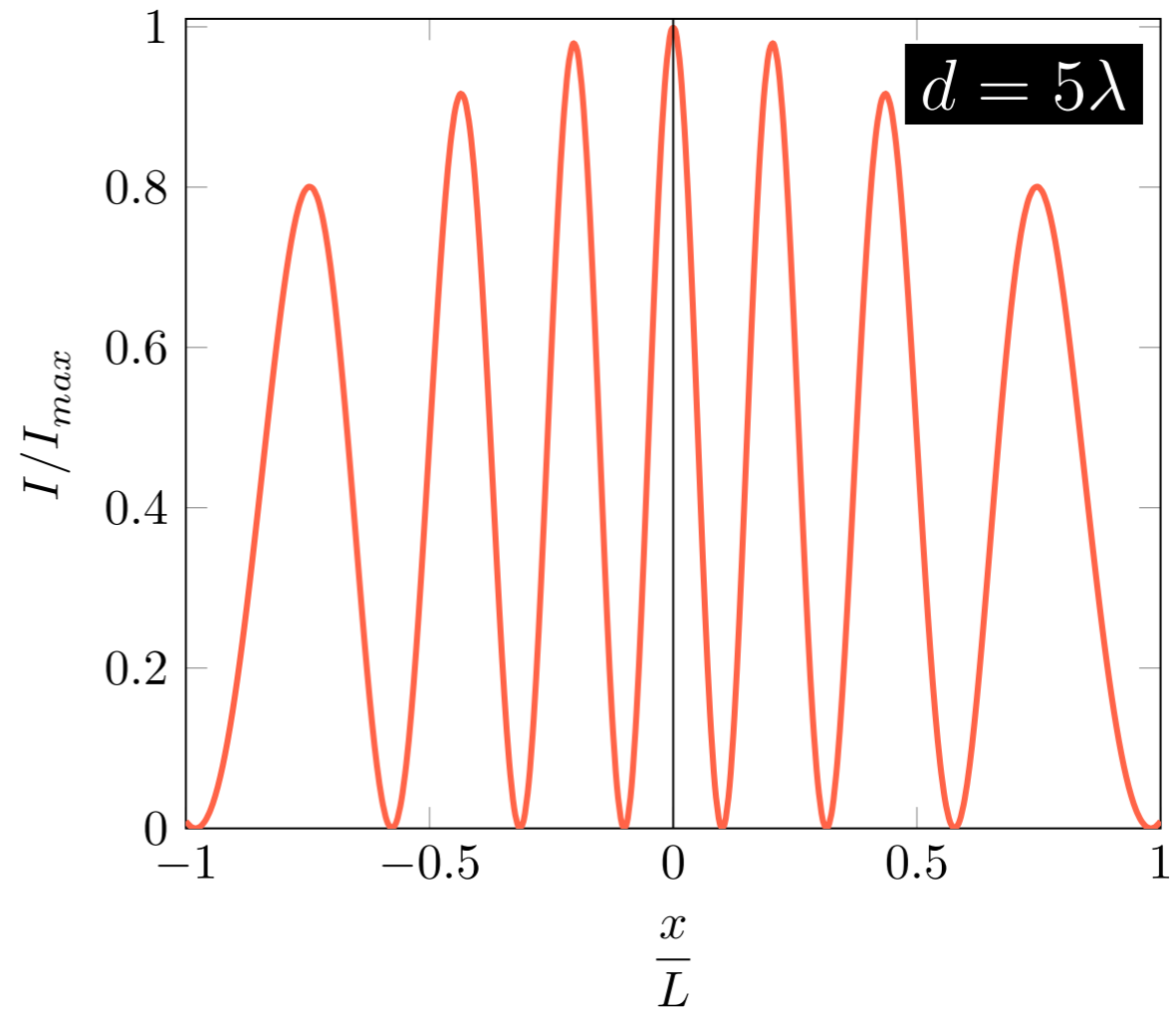
$$\langle S \rangle = \frac{2}{\mu_0 c k \rho} \cos^2 \left(\frac{\pi d \sin(\theta)}{\lambda} \right)$$



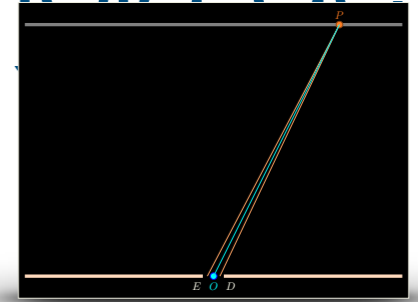
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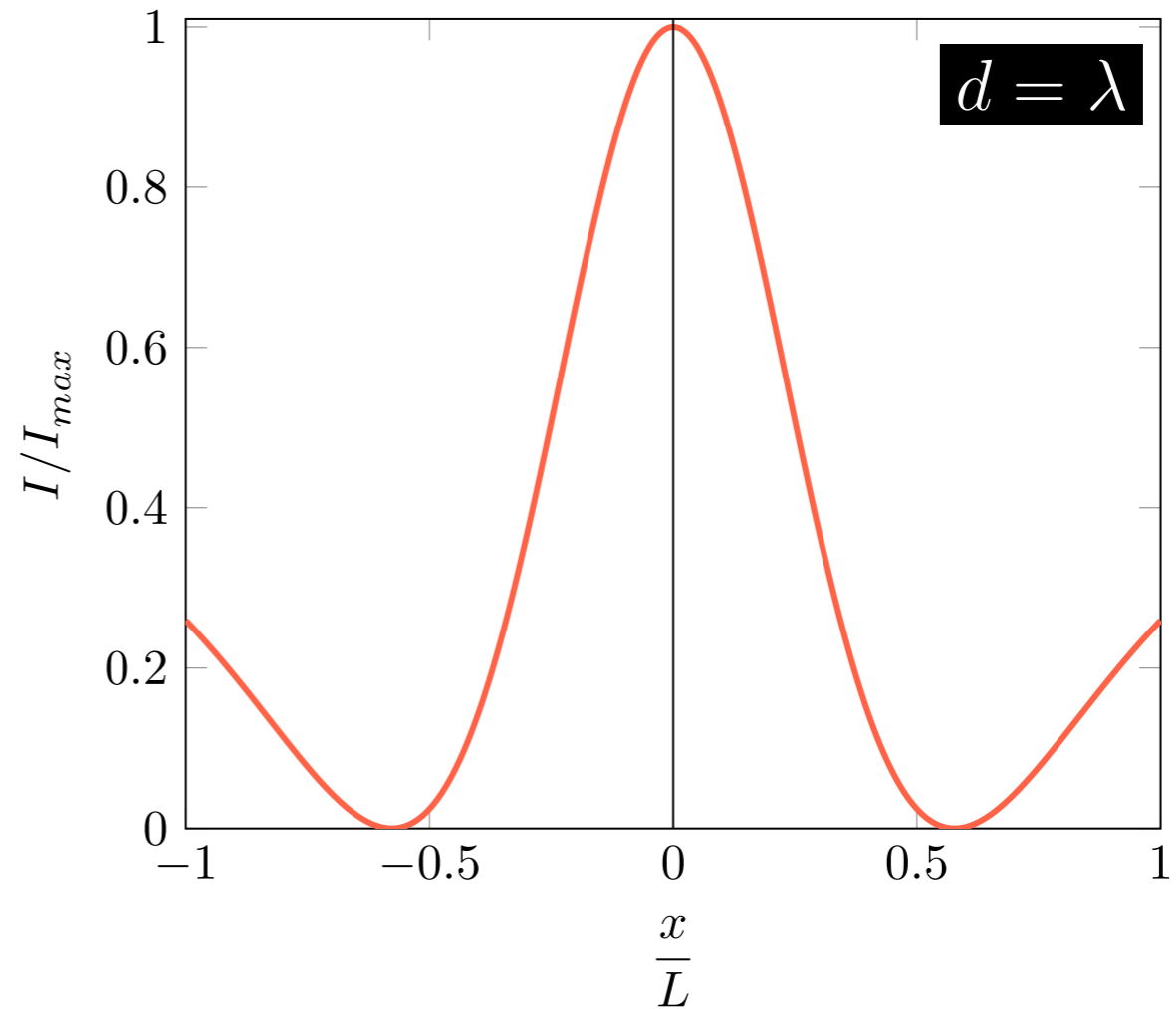
$$\langle S \rangle = \frac{2}{\mu_0 c k \rho} \cos^2\left(\frac{\pi d \sin(\theta)}{\lambda}\right)$$



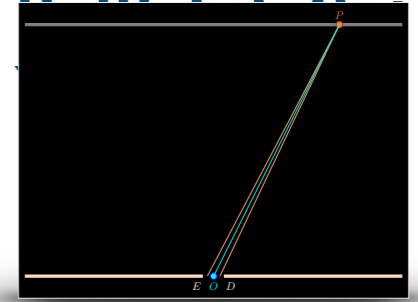
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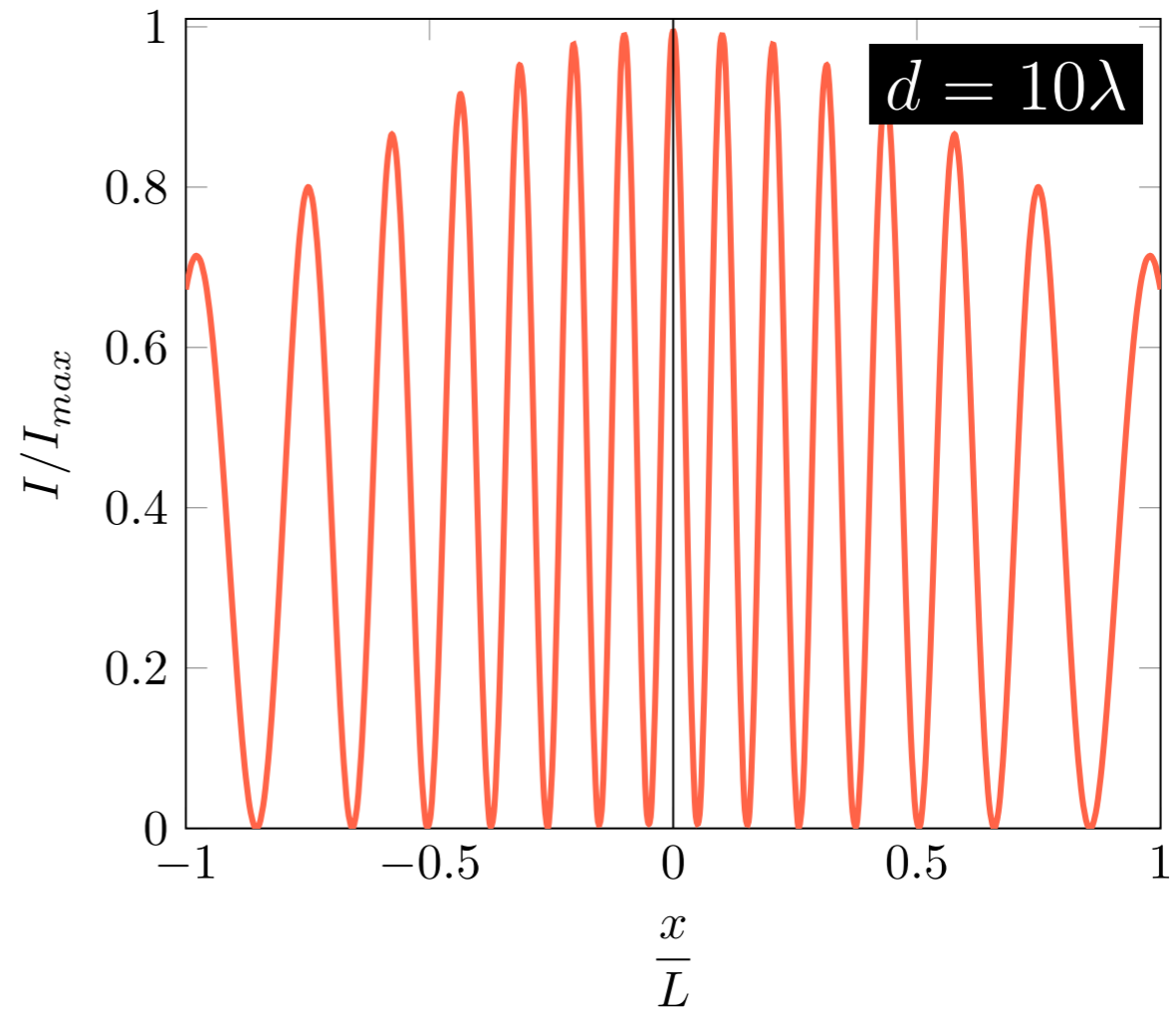
$$\langle S \rangle = \frac{2}{\mu_0 c k \rho} \cos^2\left(\frac{\pi d \sin(\theta)}{\lambda}\right)$$



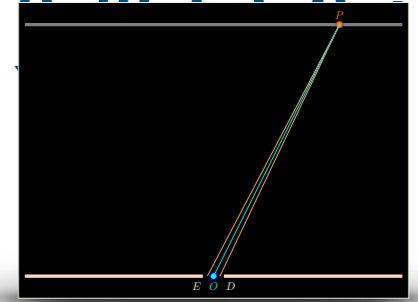
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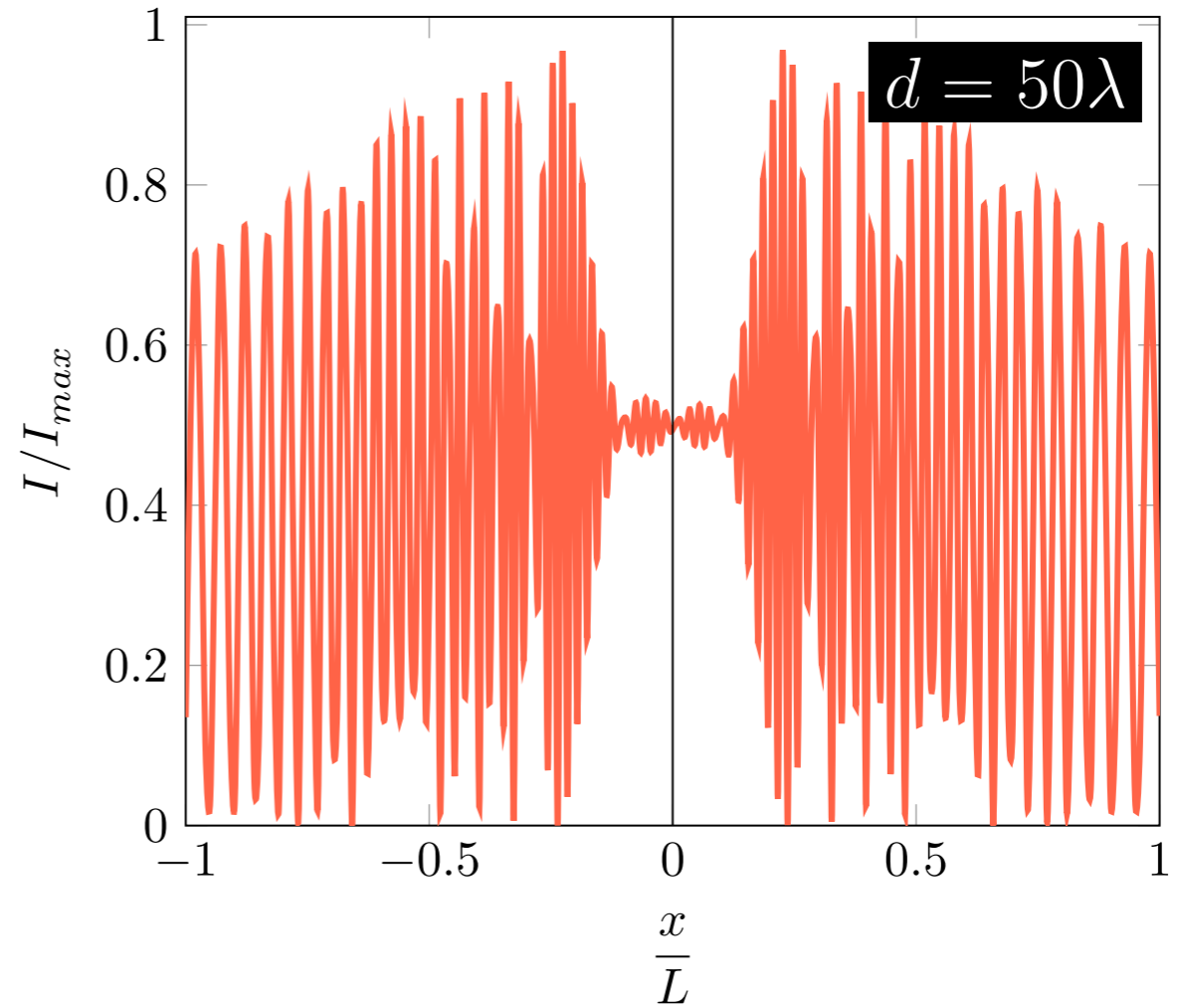
$$\langle S \rangle = \frac{2}{\mu_0 c k \rho} \cos^2\left(\frac{\pi d \sin(\theta)}{\lambda}\right)$$



Experiência de



$$\langle S \rangle = \frac{2}{\mu_0 c k \rho} \cos^2\left(\frac{\pi d \sin(\theta)}{\lambda}\right)$$



Índice de refração negativo

$$\nabla^2 \vec{E} = \frac{1}{\mu\epsilon} \frac{\partial^2 E}{\partial t^2}$$

$$v^2 = \frac{1}{\mu\epsilon}$$

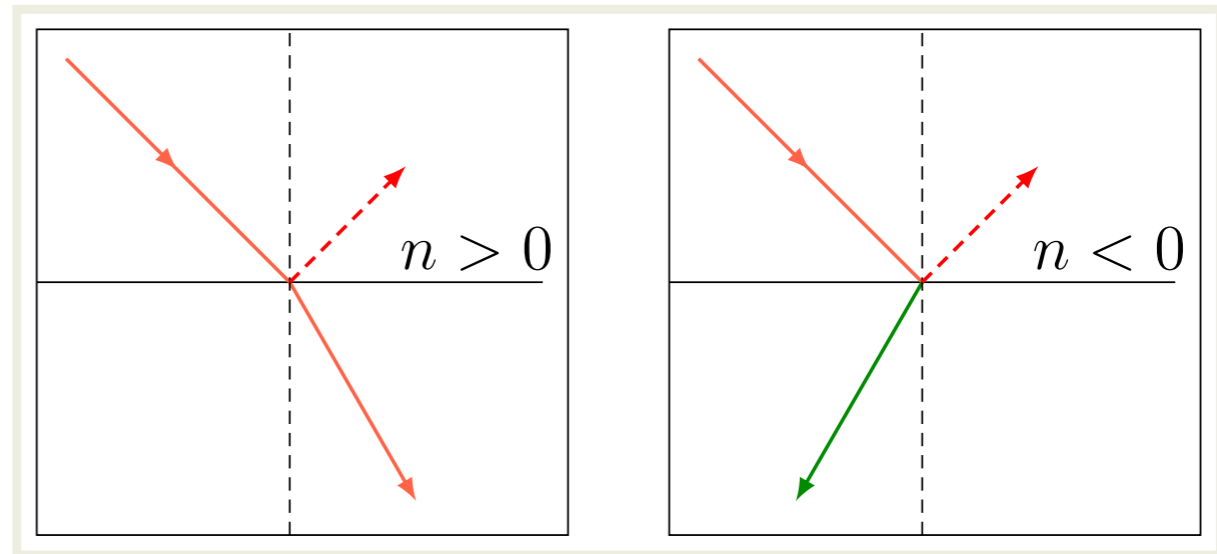
$$v = \frac{\pm 1}{\sqrt{\mu\epsilon}} = \frac{c}{n}$$

Índice de refração negativo

$$\nabla^2 \vec{E} = \frac{1}{\mu\epsilon} \frac{\partial^2 E}{\partial t^2}$$

$$v^2 = \frac{1}{\mu\epsilon}$$

$$v = \frac{\pm 1}{\sqrt{\mu\epsilon}} = \frac{c}{n}$$

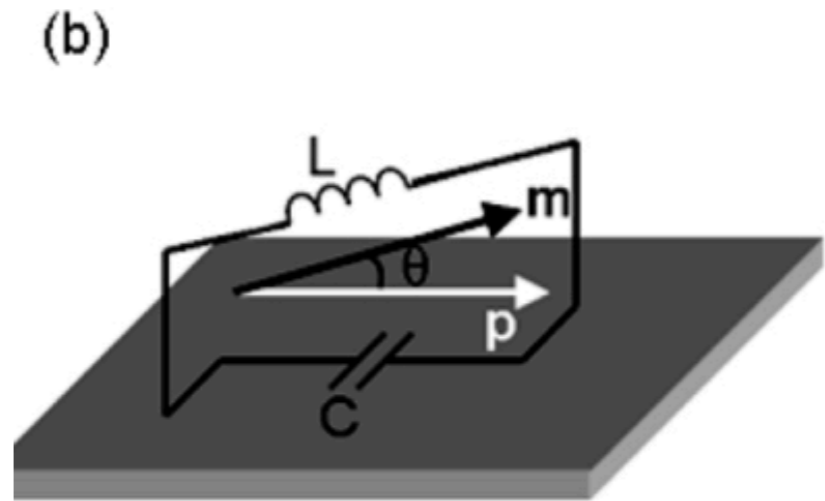


Índice de refração negativo

$$\nabla^2 \vec{E} = \frac{1}{\mu\epsilon} \frac{\partial^2 E}{\partial t^2}$$

$$v^2 = \frac{1}{\mu\epsilon}$$

$$v = \frac{\pm 1}{\sqrt{\mu\epsilon}} = \frac{c}{n}$$



(d)

