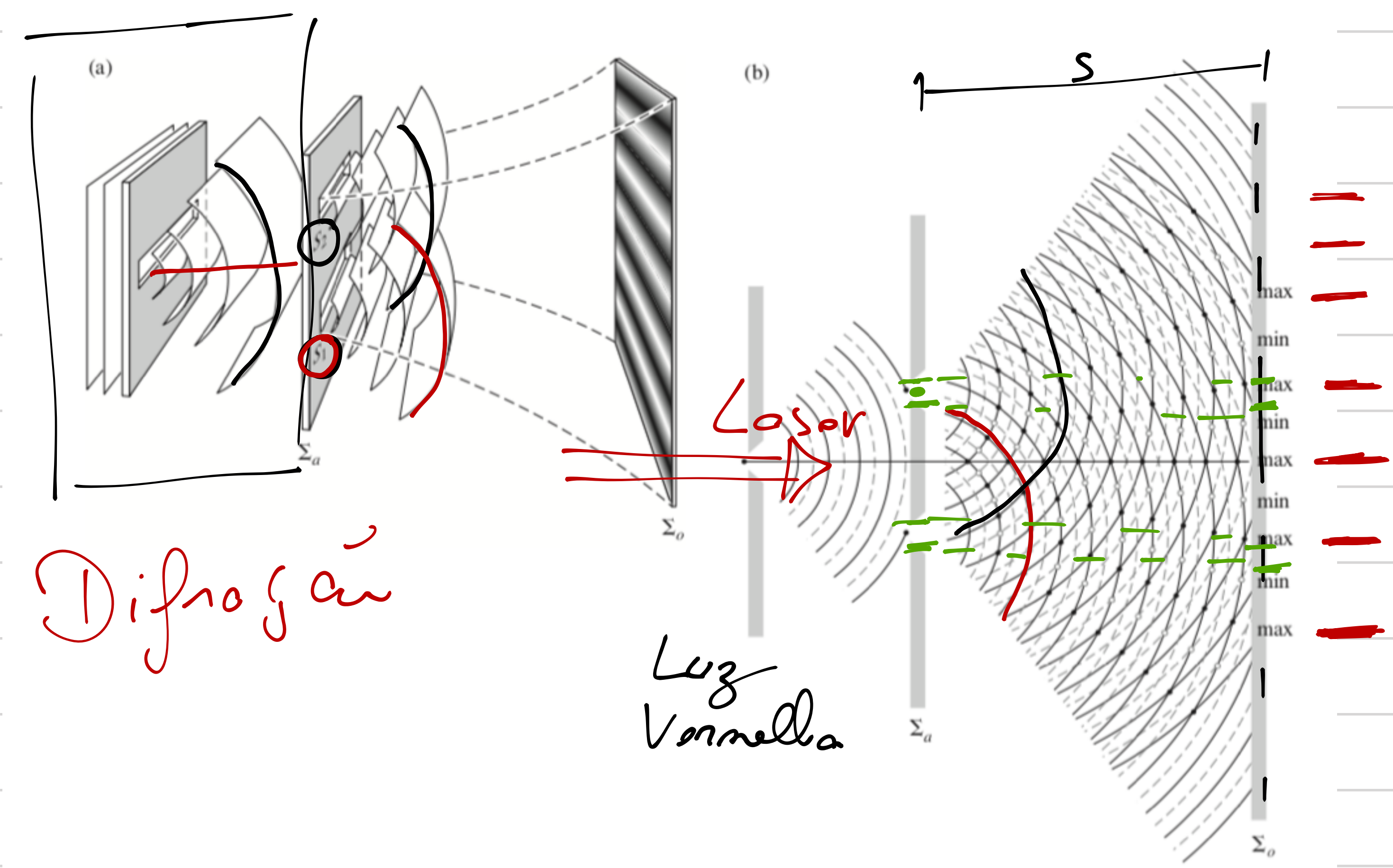
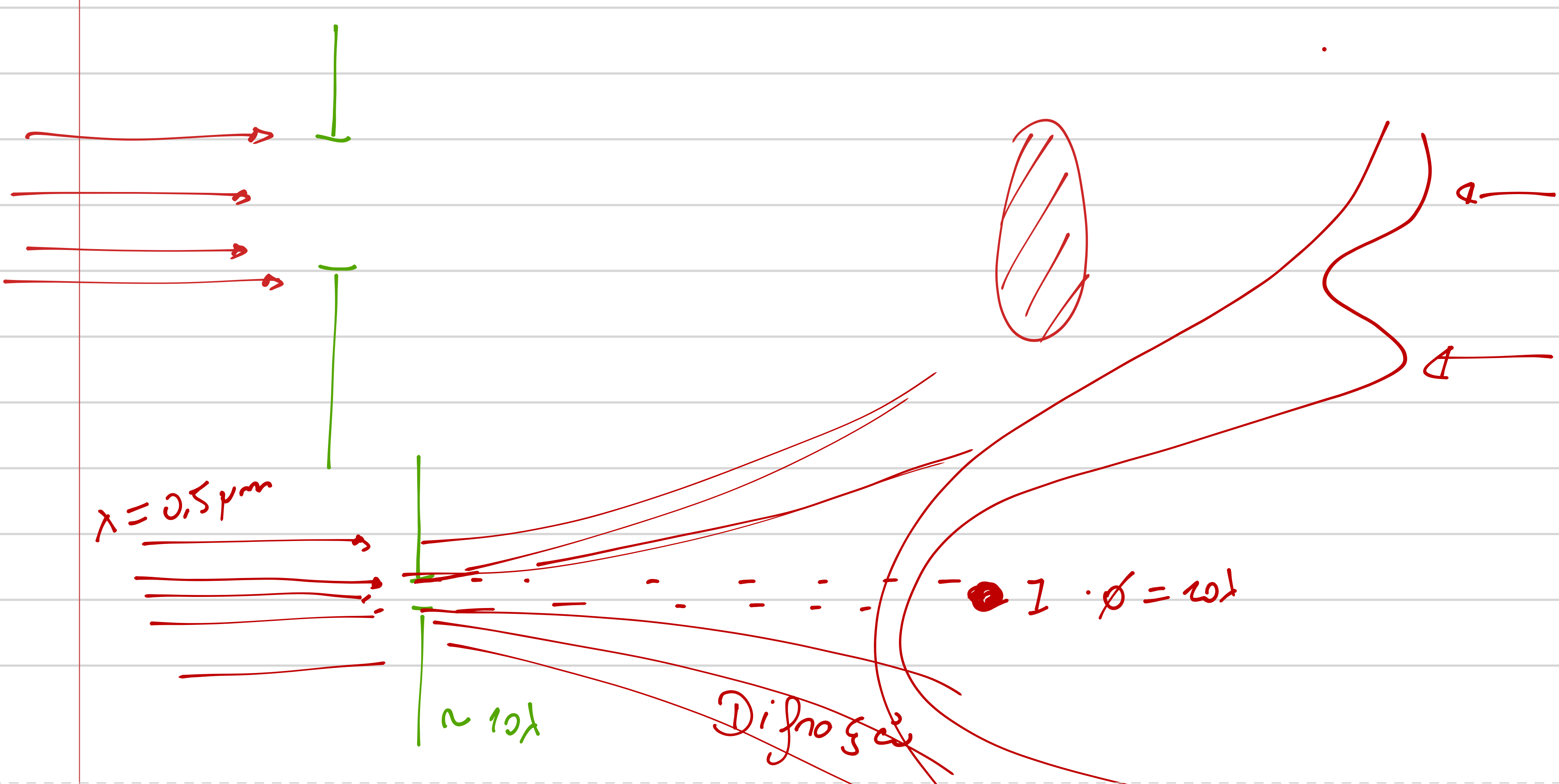
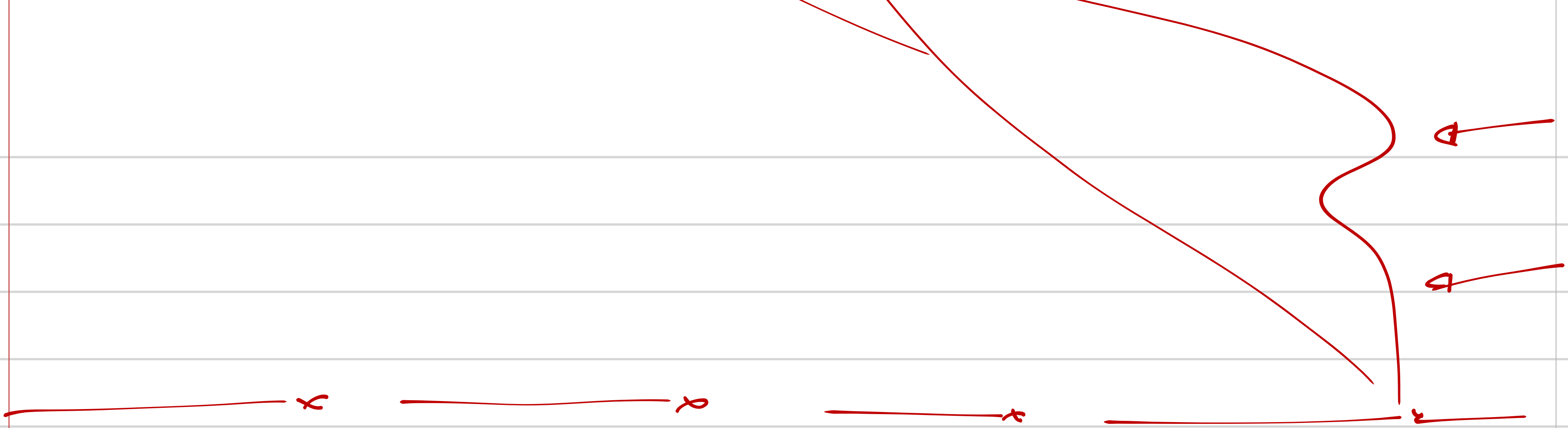
Interferência → Divisão da frente de onda
Ex: Fenda Dupla
→ Divisão de amplitude
Ex: filmes finos

Int. Divisão de Frente de Onda



Difração





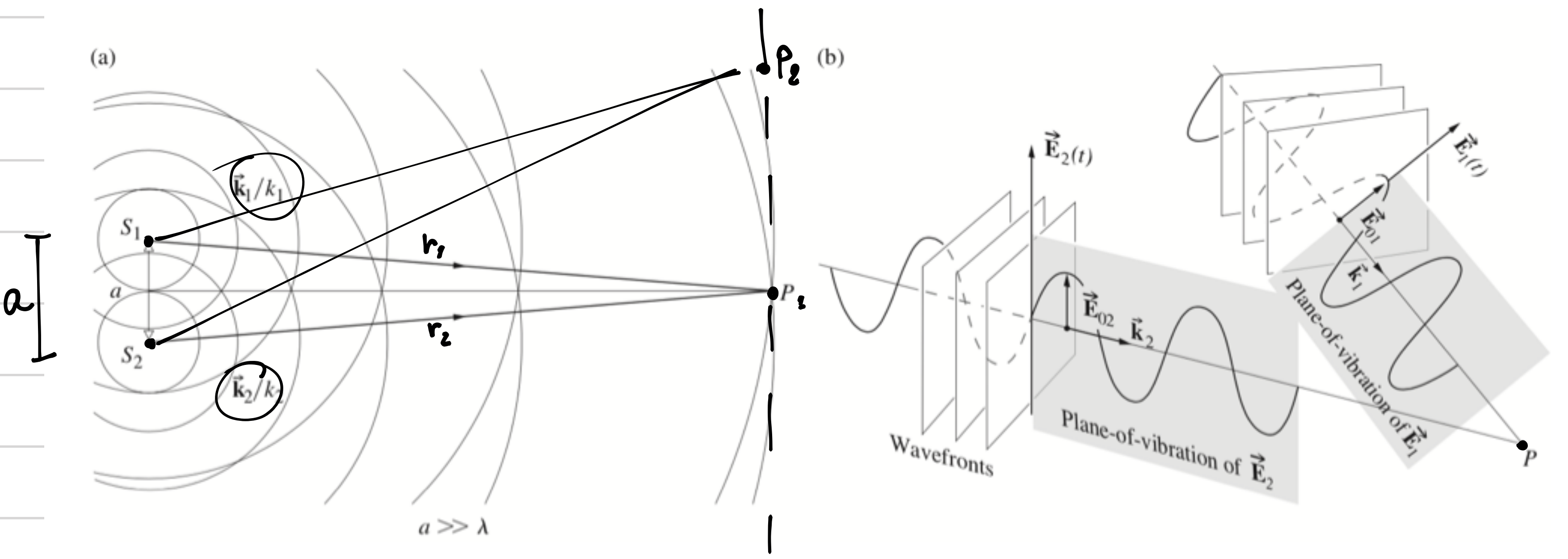


Figure 9.2 Waves from two point sources overlapping in space.

Considere: onda polarizada linearmente

Somente Interferência
Sem Difração

No Ponto P ⇒ Somar os campos
Para este caso $\vec{E}_1$ e $\vec{E}_2$

$$\vec{E} = \vec{E}_1 + \vec{E}_2$$

$$\vec{E}_1 = \vec{E}_{01} \cos(\vec{K}_1 \cdot \vec{r} - \omega t + \varepsilon_1)$$

$$\vec{E}_2 = \vec{E}_{02} \cos(\vec{K}_2 \cdot \vec{r} - \omega t + \varepsilon_2)$$

$\varepsilon_1, \varepsilon_2 =$ constante
ω ⇒ é o mesmo p/ as duas fontes

⇒ No anteparo ⇒ Detector fotodiodo
olho

Intensidade

$$I = \varepsilon v \langle \vec{E}^2 \rangle_T$$

$$\boxed{I = \langle \vec{E}^2 \rangle_T}$$

Expressão q correlaciona o I com:

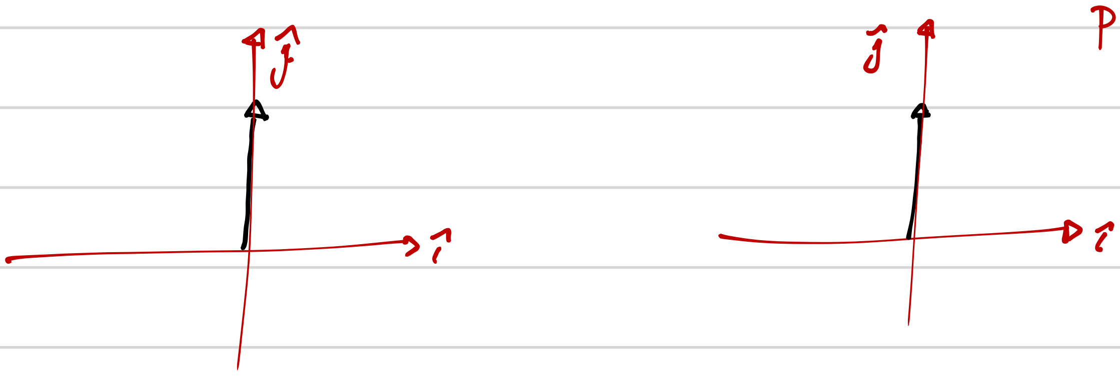
$I \longrightarrow \lambda, \underline{\underline{\varepsilon_1}}, \underline{\underline{\varepsilon_2}}, a, s, E_{01}, E_{02}$, etc.

$$I = \langle \vec{E} \cdot \vec{E} \rangle_T \qquad \vec{E} = \vec{E}_1^2 + E_2^2$$

$$\langle (\vec{E}_1 + \vec{E}_2) \cdot (\vec{E}_1 + \vec{E}_2) \rangle_T = \boxed{\langle \vec{E}_1^2 \rangle} + 2 \langle \vec{E}_1 \cdot \vec{E}_2 \rangle + \boxed{\langle \vec{E}_2^2 \rangle}$$

$$\vec{E}_1 = \hat{j} E_{01} \cos(\vec{K}_1 \cdot \vec{r} - \omega t + \varepsilon_1)$$
$$\vec{E}_2 = \hat{j} E_{02} \cos(\vec{K}_2 \cdot \vec{r} - \omega t + \varepsilon_1)$$

Considere q o campo está, por exemplo, em $\hat{j}$



$$I_1 = \langle \vec{E}_1^2 \rangle_T = \frac{1}{2} E_{01}^2$$

$$I_2 = \langle \vec{E}_2 \rangle_T = \frac{1}{2} E_{02}^2$$

$I_{12} = 2 \langle \vec{E}_1 \cdot \vec{E}_2 \rangle_T \Longrightarrow$ termo de interferência

$$\boxed{I = I_1 + I_2 + I_{12}}$$

$$\boxed{\vec{E}_1 \cdot \vec{E}_2} = \hat{j} E_{01} \cos(\vec{K}_1 \vec{r} - \omega t + \varepsilon_1) \cdot \hat{j} E_{02} \cos(\vec{K}_2 \vec{r} - \omega t + \varepsilon_2)$$

$$= E_{01} E_{02} \left[\cos(\overbrace{\vec{K}_1 \cdot \vec{r} + \varepsilon_1}^{a} - \overbrace{\omega t}^{b}) \cdot \cos(\overbrace{\vec{K}_2 \cdot \vec{r} + \varepsilon_2}^{a} - \overbrace{\omega t}^{b}) \right]$$

$$\boxed{\cos(a - b) = \cos a \cos b + \operatorname{sen} a \operatorname{sen} b}$$

$\longrightarrow$ Separar o argumento (espacial + fase) do (temporal)

$$\langle \cos^2 \omega t \rangle_T = \frac{1}{2}$$

$$\langle \operatorname{Sen}^2 \omega t \rangle_T = \frac{1}{2}$$

$$\langle \cos \omega t \cdot \operatorname{Sen} \omega t \rangle_T = 0$$

$$\vec{E}_1 \cdot \vec{E}_2 = \frac{E_{01}E_{02}}{2}\left[\cos(\vec{K}_1 \cdot \vec{r} + \mathcal{E}_1) \cdot \cos(\vec{K}_2 \cdot \vec{r} + \mathcal{E}_2) + \operatorname{Sen}(\vec{K}_1 \cdot \vec{r} + \mathcal{E}_1) \cdot \operatorname{Sen}(\vec{K}_2 \cdot \vec{r} + \mathcal{E}_2) \right]$$

$$\cos(a-b) = \cos a \cos b + \operatorname{Sen} a \operatorname{Sen} b$$

$$\vec{E}_1 \cdot \vec{E}_2 = \frac{E_{01}E_{02}}{2} \cos\left[(\vec{K}_1 \cdot \vec{r} + \mathcal{E}_1) - (\vec{K}_2 \cdot \vec{r} + \mathcal{E}_2) \right]$$

$$I_{12} = 2 \cdot \vec{E}_1 \cdot \vec{E}_2 = \cancel{2}\left[\frac{\overset{\sqrt{I_1}}{E_{01}}\overset{\sqrt{I_2}}{E_{02}}}{\cancel{2}} \cos\left[(\vec{K}_1 \cdot \vec{r} + \mathcal{E}_1) - (\vec{K}_2 \cdot \vec{r} + \mathcal{E}_2) \right] \right]$$

$$I = \underset{\frac{1}{2}E_{01}^2}{\underset{\downarrow}{I_1}} + \underset{\frac{1}{2}E_{02}^2}{\underset{\downarrow}{I_2}} + \underset{2\sqrt{I_1 I_2} \cos \delta}{\underset{\downarrow}{I_{12}}}$$

$$\delta = \left[(\vec{K}_1 \cdot \vec{r} - \vec{K}_2 \cdot \vec{r}) + (\mathcal{E}_1 - \mathcal{E}_2) \right]$$

$$\boxed{I = I_1 + I_2 + 2\sqrt{I_1 I_2} \cdot \cos \delta}$$

$\delta \rightarrow$ Definir se há Interferência entre as fontes 1 e 2

Se $\delta = 0, \pm 2\pi, \pm 4\pi$

$\cos\delta = 1$

$I = I_1 + I_2 + 2\sqrt{I_1 I_2}$

p/ caso particular

$E_{01} = E_{02}$

$I_1 = I_2 = I_0$

$I = 2I_0 + 2\sqrt{I_0^2}$

$\boxed{I = 4I_0} \rightarrow I_{max}!$ Construtiva

Se $\delta = \pm\pi, \pm 3\pi, \ldots$

$\cos\delta = -1$

$I = I_1 + I_2 - 2\sqrt{I_1 I_2}$

p/ $I_1 = I_2 = 0$

$\boxed{I = 0} \rightarrow$ Interferência Destrutiva

p/ qualquer δ, mas com $E_{01} = E_{02}$

$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cdot\cos\delta$

$= 2I_0 + 2I_0\cos\delta = 2I_0(1+\cos\delta)$

$(1+\cos\delta) = 2\cos^2\left(\frac{\delta}{2}\right)$

$$\boxed{I = 4I_0\cos^2\left(\frac{\delta}{2}\right)}$$

$\cos^2\left(\frac{\delta}{2}\right)$

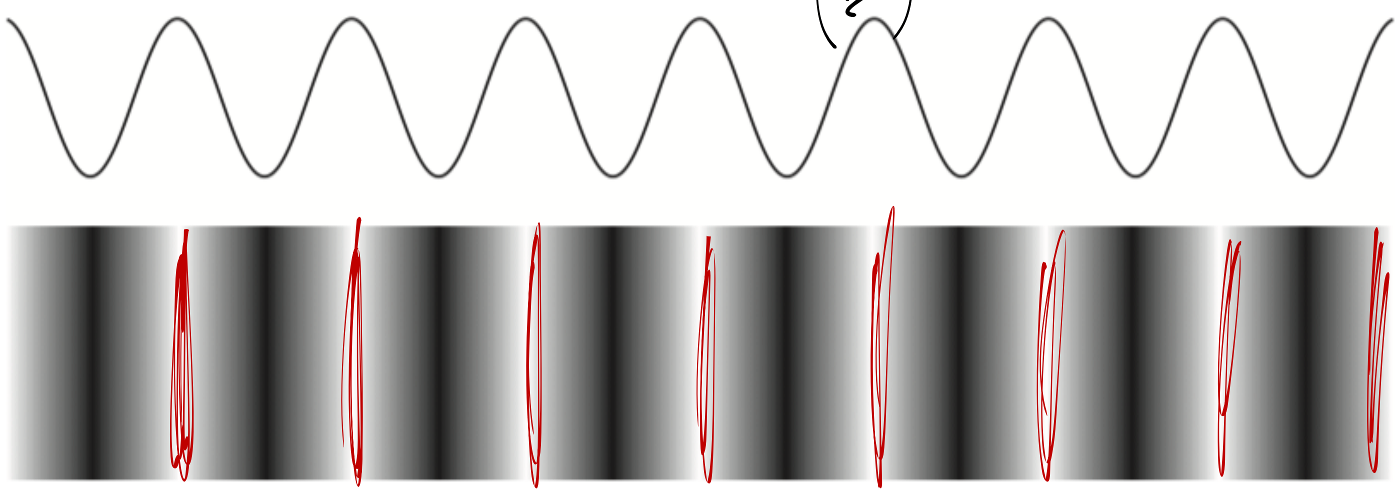
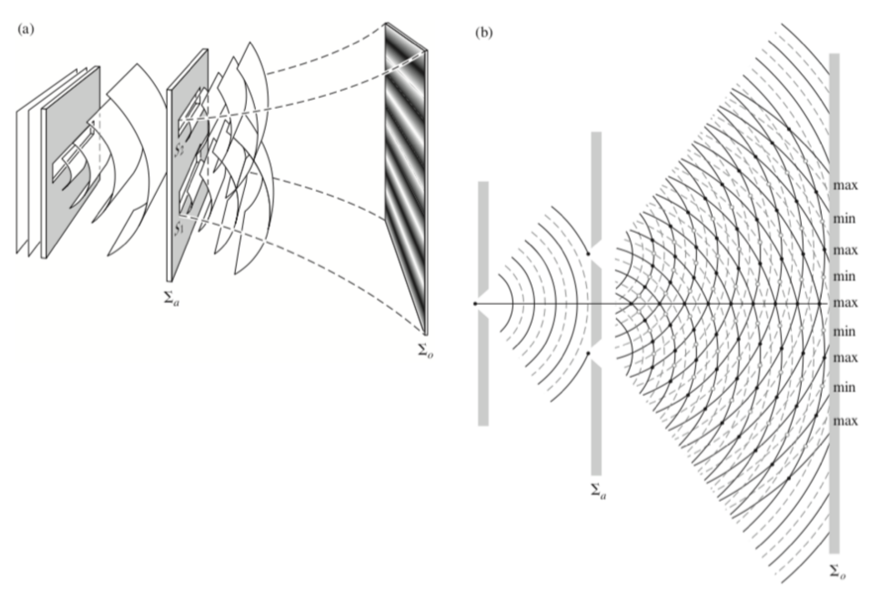


Figure 9.4 Cosine-squared fringes associated with far-field double-beam interference. The oscillating curve is a bit of an idealization, since the fringes actually lose contrast at both right and left extremes.

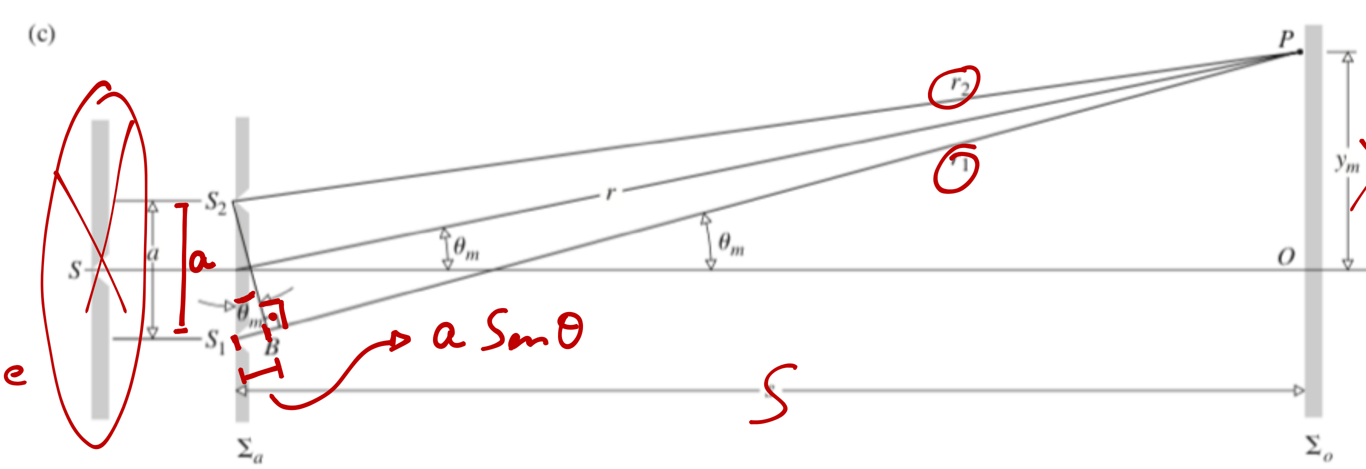


Exp de fenda Duplo

→ Interferência

$I = 4I_0 \cos^2\left(\frac{\delta}{2}\right)$

$\boxed{\text{→ Difração}}$ p/ depois



λ

Laser

$\mathcal{E}$ = cte

a

a Sen θ

S

max

$\hat{j}$

Figure 9.11 Young's Experiment. (a) Cylindrical waves superimposed in the region beyond the aperture screen. (b) Overlapping waves showing peaks and troughs. The maxima and minima lie along nearly straight hyperbolas. (c) The geometry of Young's Experiment. (d) A path length difference of one wavelength corresponds to $m = \pm 1$ and the first-order maximum. (e) (M. Cagnet, M. Francon, and J. C. Thierr: *Atlas optischer*

$\vec{K}(\vec{r}_2 - \vec{r}_1) = Ka\,\text{Sen}\,\theta$

$\delta = (\vec{K}_1 \cdot \vec{r} - \vec{K}_2 \cdot \vec{r}) + \underbrace{\cancel{(\mathcal{E}_1 - \mathcal{E}_2)}}_{\text{zero}}$

$$\delta = Ka \sin\theta \qquad \sin\theta \simeq tg\,\theta \cong \frac{y_m}{S}$$

p $S \gg a \implies \delta = Ka\theta$

↳ distância entre as fendas e o anteparo

$y_m \rightarrow$ Interferência construtiva.

$$\boxed{(r_2 - r_1) = m\lambda \qquad m = 0, \pm 1, \pm 2, \ldots}$$

Interferência Construtiva

$$\boxed{(r_2 - r_1) = \left(m + \frac{1}{2}\right)\lambda \qquad m = 0, \pm 1, \pm 2}$$

Interferência Destrutiva

$$I = 4 I_0 \cos^2\left(\frac{\delta}{2}\right)$$

$$\delta = K(r_2 - r_1)$$

$$\delta = Ka\theta$$

$$\boxed{\delta = Ka\frac{y_m}{S}}$$

$$\boxed{I = 4 I_0 \cos^2\left[\frac{Ka\, y_m}{2 \cdot S}\right]}$$

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

$$I_0 = E_0^2$$

— x — x —

λi

Sol

não coerente

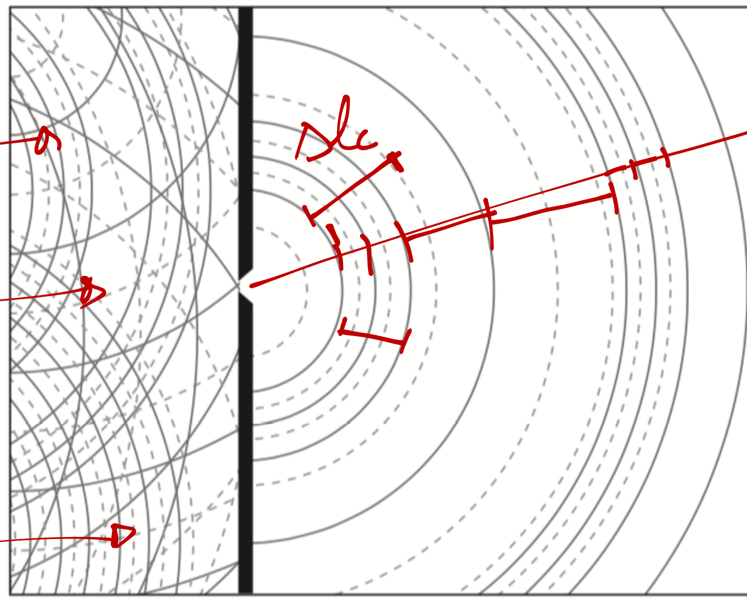
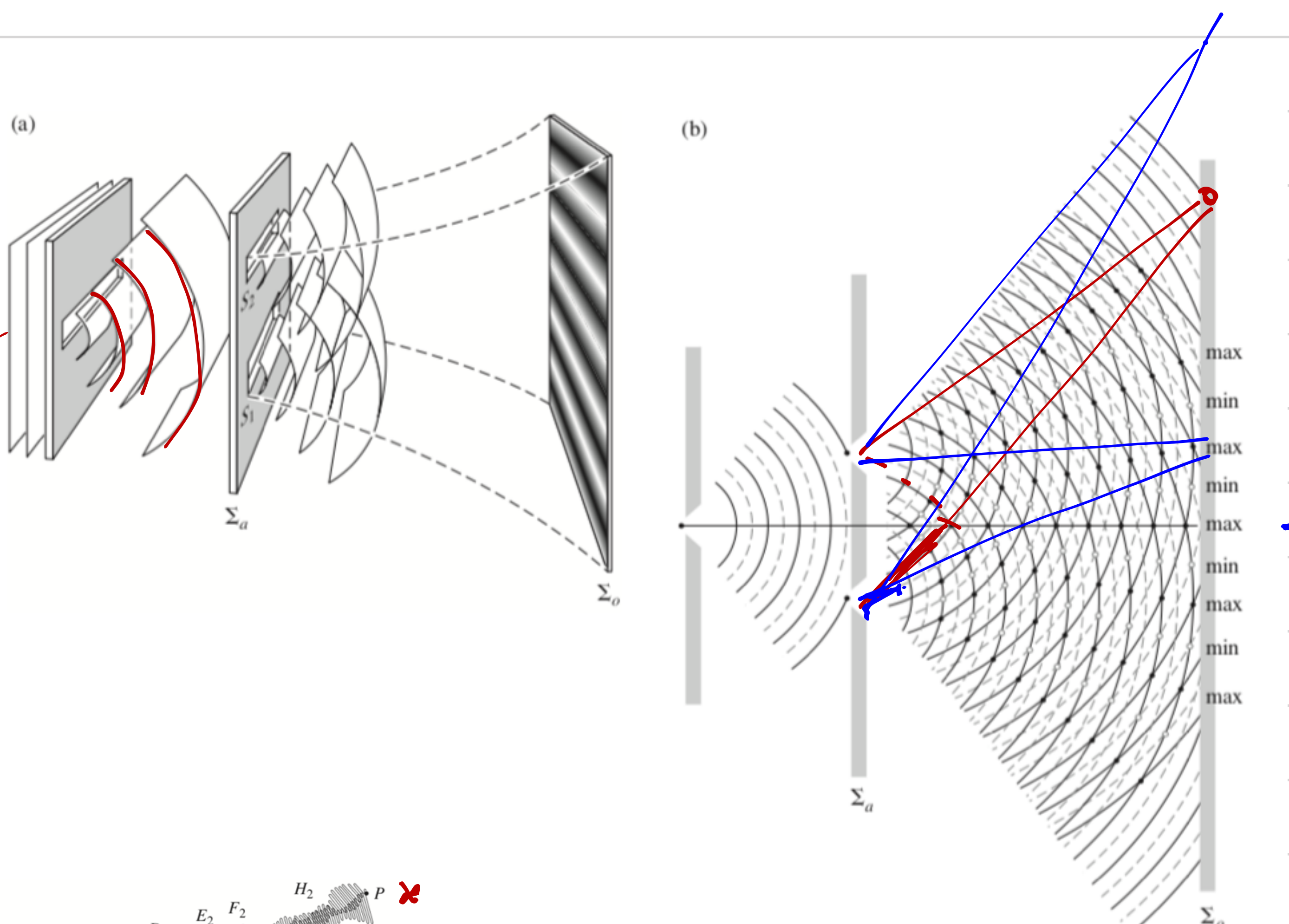


Figure 9.9 The pinhole scatters a wave that is spatially coherent, even though it's not temporally coherent.

Sol



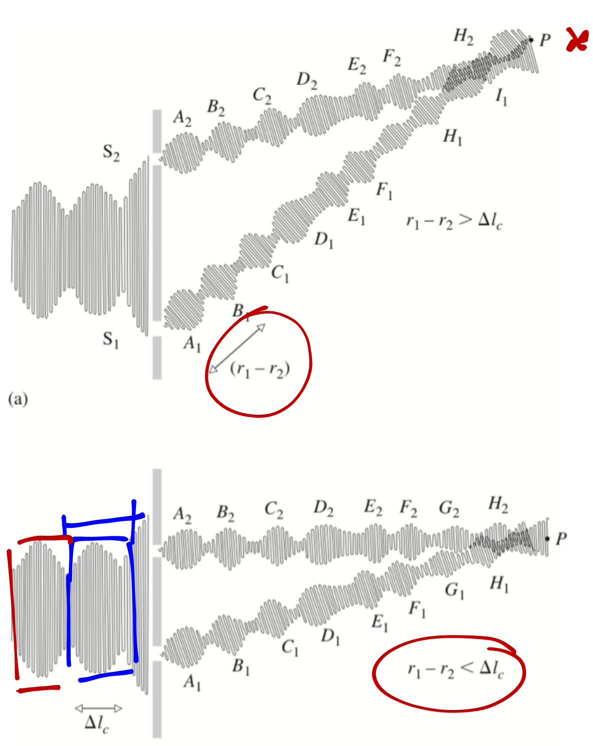


Figure 9.18 A schematic representation of how light, composed of a progression of wavegroups with a coherence length Δl_c, produces interference when (*a*) the path length difference exceeds Δl_c and (*b*) the path length difference is less than Δl_c.