

Interferencia

Laboratorio 2C - 1er cuat. 2023 - Bilbao

Sean dos fuentes S_1 y S_2 que emiten ondas esféricas de igual longitud de onda. Los campos producidos por dichas fuentes en un punto P ubicado a distancia r_1 de S_1 y a r_2 de S_2 serán:

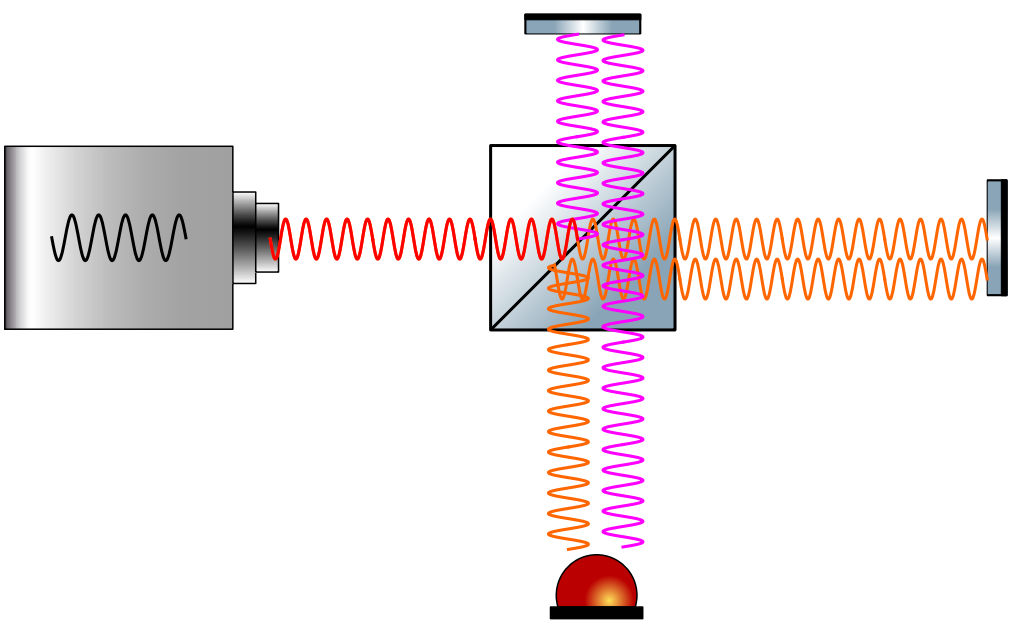
$$E_1 = E_{01}(r_1) \exp[i(k r_1 - \omega t + \varepsilon_1)]$$

$$E_2 = E_{02}(r_2) \exp[i(k r_2 - \omega t + \varepsilon_2)]$$

$$I = \langle E \cdot E^* \rangle$$

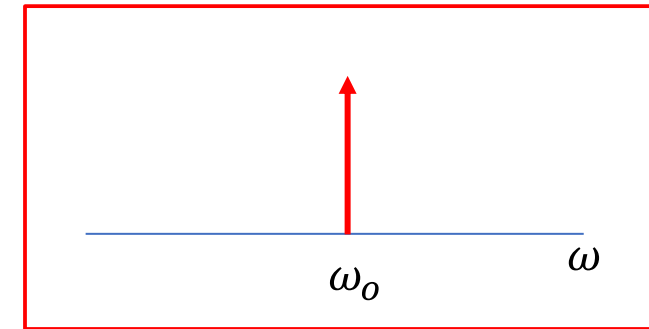
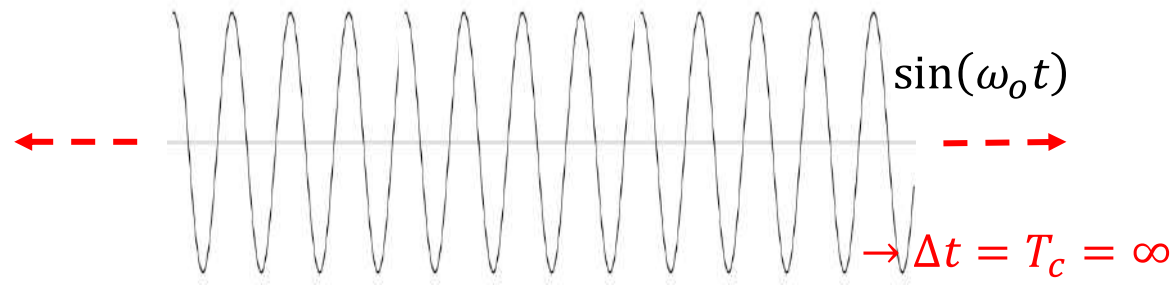
$$\begin{aligned} I &= E_{01}^2 + E_{02}^2 + E_{01} \cdot E_{02} \left\{ \exp\left\{i\left[k(r_1 - r_2) + (\varepsilon_1 - \varepsilon_2)\right]\right\} + \exp\left\{-i\left[k(r_1 - r_2) + (\varepsilon_1 - \varepsilon_2)\right]\right\} \right\} = \\ &= E_{01}^2 + E_{02}^2 + 2 E_{01} \cdot E_{02} \cos\left[k(r_1 - r_2) + (\varepsilon_1 - \varepsilon_2)\right] \end{aligned}$$

Interferómetro de Michelson

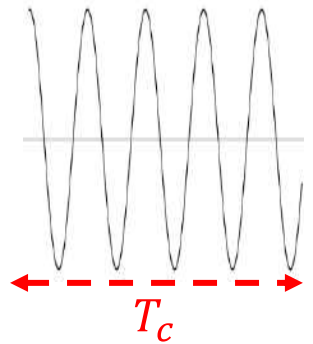


Coherencia temporal

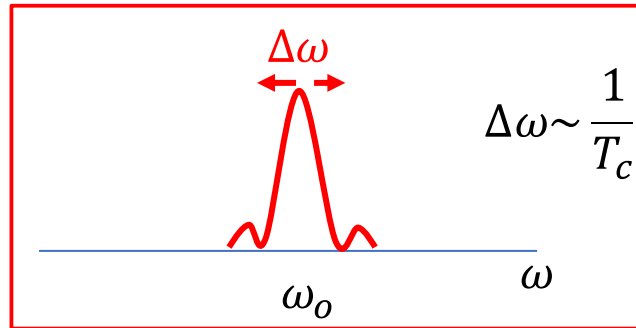
monocromático



no monocromático

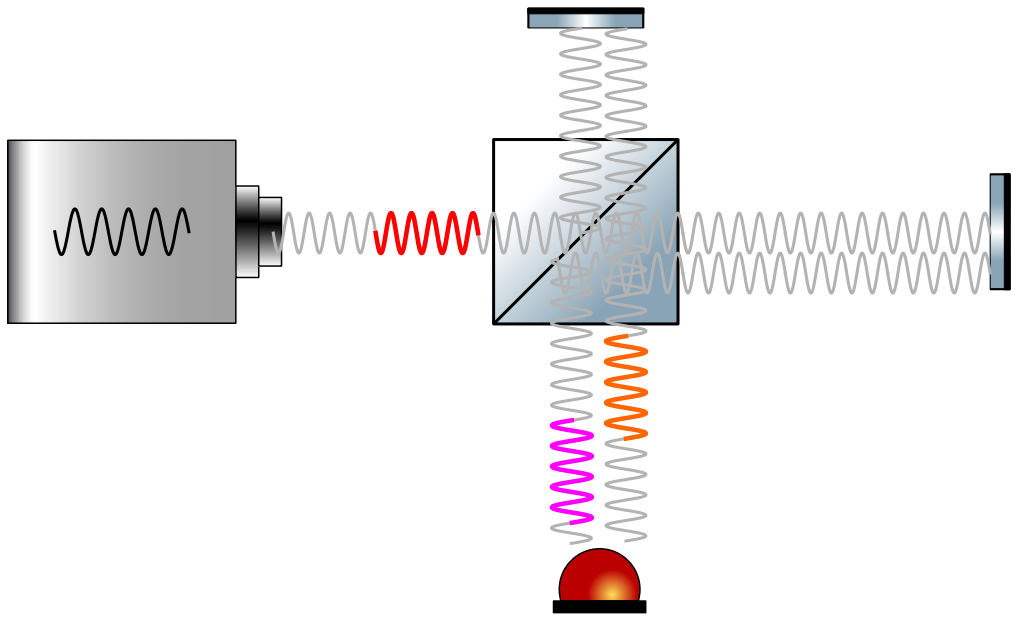


$$\sin(\omega_0 t) \times \text{rect}\left(\frac{t}{T_c}\right)$$



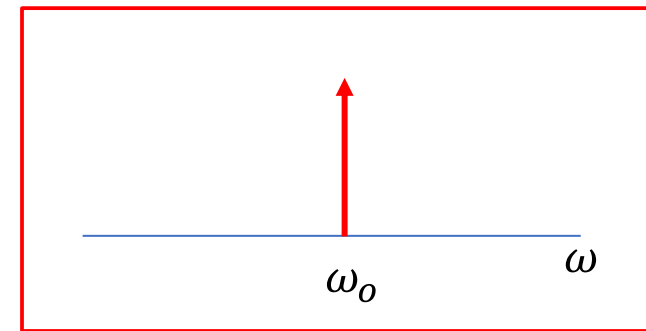
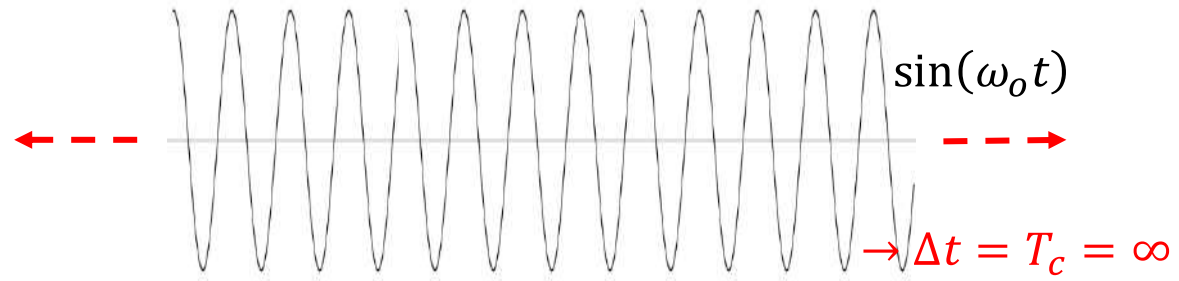
$$L_c = C \cdot T_c = \frac{\lambda^2}{\Delta \lambda}$$

Interferómetro de Michelson

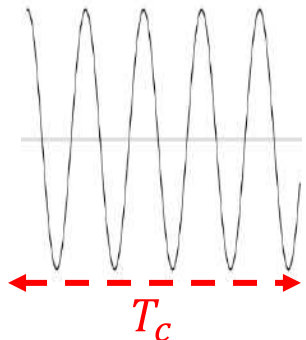


Coherencia temporal

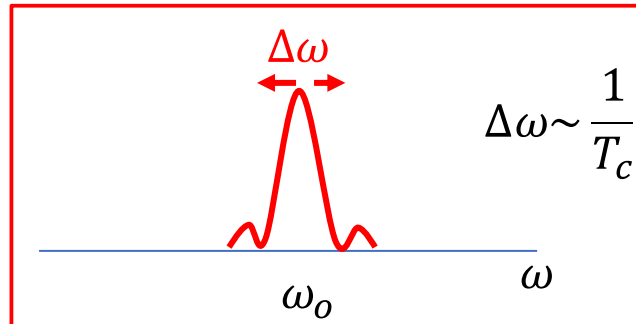
monocromático



no monocromático

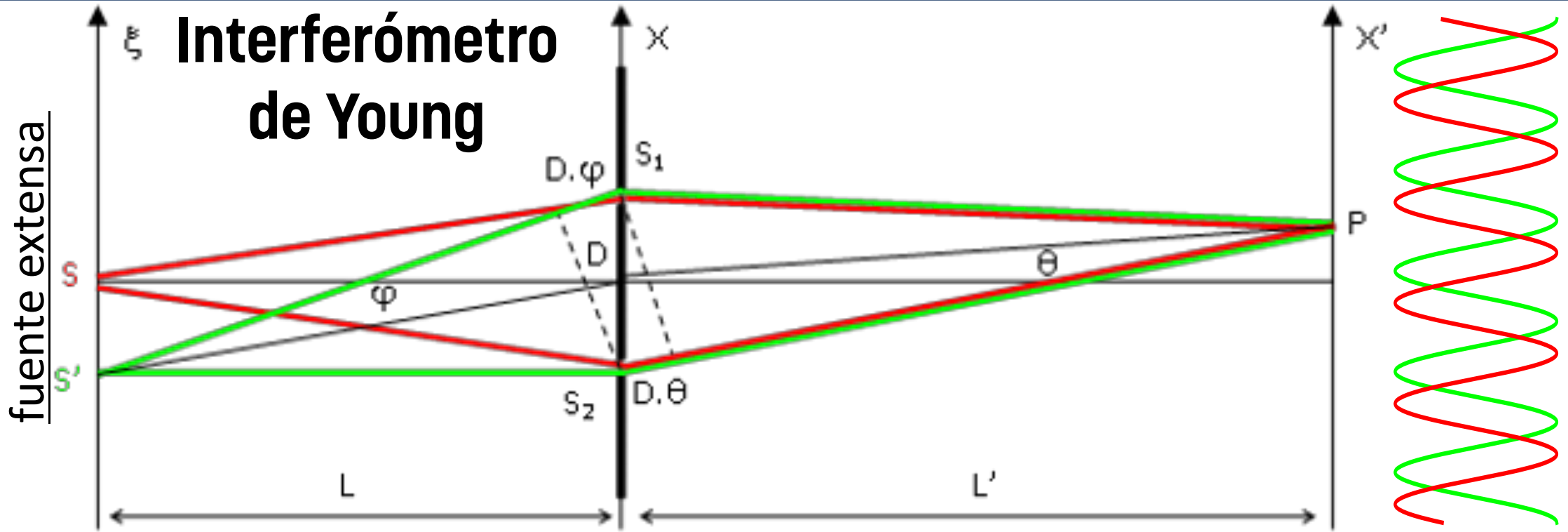


$$\sin(\omega_0 t) \times \text{rect}\left(\frac{t}{T_c}\right)$$



$$L_c = C \cdot T_c = \frac{\lambda^2}{\Delta \lambda}$$

Interferómetro de Young

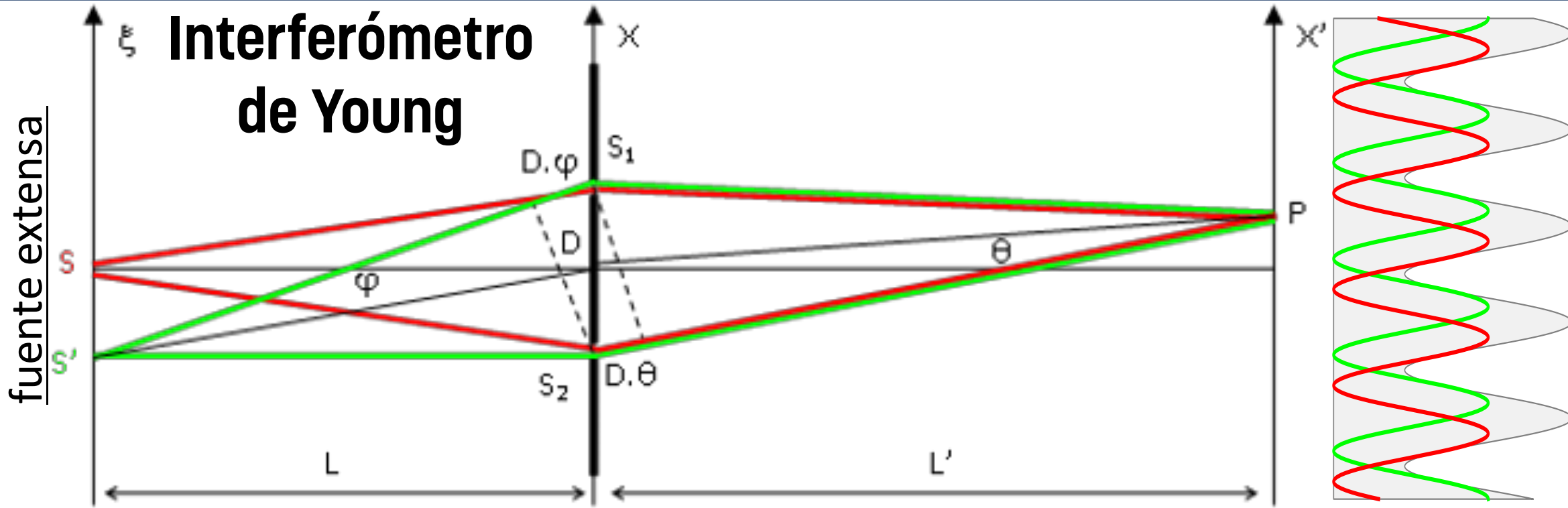


$$I_0 \Rightarrow I = 4I_0 \cos^2 \left(\frac{k}{2} \Delta r' \right) \left[k(r_1 - r_2) + (\epsilon_1 - \epsilon_2) \right] \quad L, L' \gg D \Rightarrow \sin \varphi \cong \varphi ; \sin \theta \cong \theta$$

$$\Delta r = (\overline{SS_2} + \overline{S_2P}) - (\overline{SS_1} + \overline{S_1P}) = \overline{S_2P} - \overline{S_1P} \cong D \cdot \theta$$

$$\Delta r' = (\overline{S'S_2} + \overline{S_2P}) - (\overline{S'S_1} + \overline{S_1P}) \cong D \cdot \theta - D \cdot \varphi \quad \Rightarrow \quad I = 4I_0 \left[\cos^2 \left(\frac{k}{2} D \cdot \theta \right) + \cos^2 \left(\frac{k}{2} D \cdot (\theta - \varphi) \right) \right]$$

Interferómetro de Young

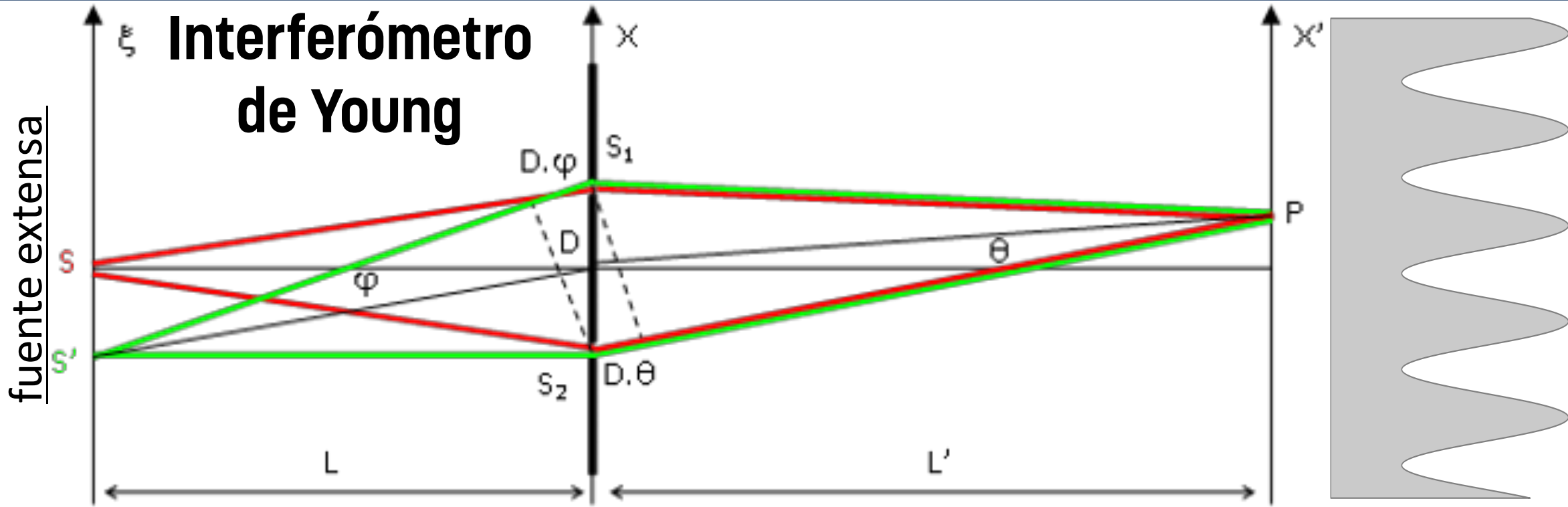


$$I_0 \Rightarrow I = 4I_0 \cos^2 \left(\frac{k}{2} \Delta r' \right) \left[k(r_1 - r_2) + (\varepsilon_1 - \varepsilon_2) \right] \quad L, L' \gg D \Rightarrow \sin \varphi \cong \varphi ; \sin \theta \cong \theta$$

$$\Delta r = (\overline{SS_2} + \overline{S_2P}) - (\overline{SS_1} + \overline{S_1P}) = \overline{S_2P} - \overline{S_1P} \cong D \cdot \theta$$

$$\Delta r' = (\overline{S'S_2} + \overline{S_2P}) - (\overline{S'S_1} + \overline{S_1P}) \cong D \cdot \theta - D \cdot \varphi \quad \Rightarrow \quad I = 4I_0 \left[\cos^2 \left(\frac{k}{2} D \cdot \theta \right) + \cos^2 \left(\frac{k}{2} D \cdot (\theta - \varphi) \right) \right]$$

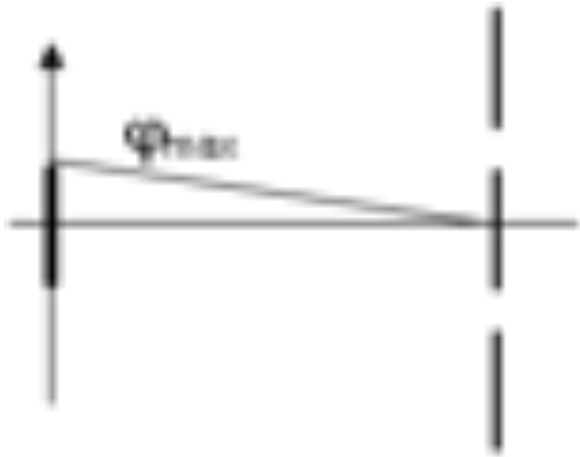
Interferómetro de Young



$$I_0 \Rightarrow I = 4I_0 \cos^2 \left(\frac{k}{2} \Delta r' \right) \left[k(r_1 - r_2) + (\epsilon_1 - \epsilon_2) \right] \quad L, L' \gg D \Rightarrow \sin \varphi \cong \varphi ; \sin \theta \cong \theta$$

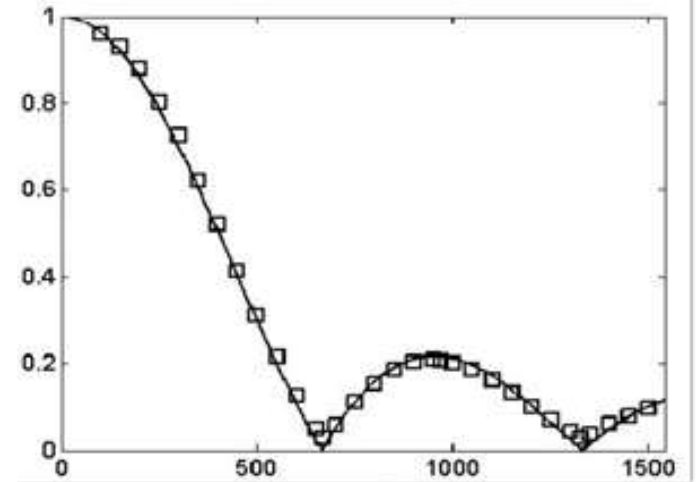
$$\Delta r = (\overline{SS_2} + \overline{S_2P}) - (\overline{SS_1} + \overline{S_1P}) = \overline{S_2P} - \overline{S_1P} \cong D \cdot \theta$$

$$\Delta r' = (\overline{S'S_2} + \overline{S_2P}) - (\overline{S'S_1} + \overline{S_1P}) \cong D \cdot \theta - D \cdot \varphi \quad \Rightarrow \quad I = 4I_0 \left[\cos^2 \left(\frac{k}{2} D \cdot \theta \right) + \cos^2 \left(\frac{k}{2} D \cdot (\theta - \varphi) \right) \right]$$

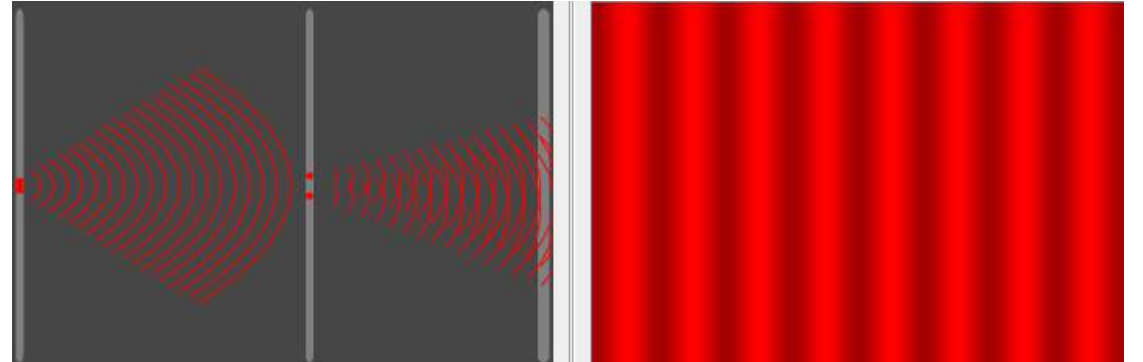
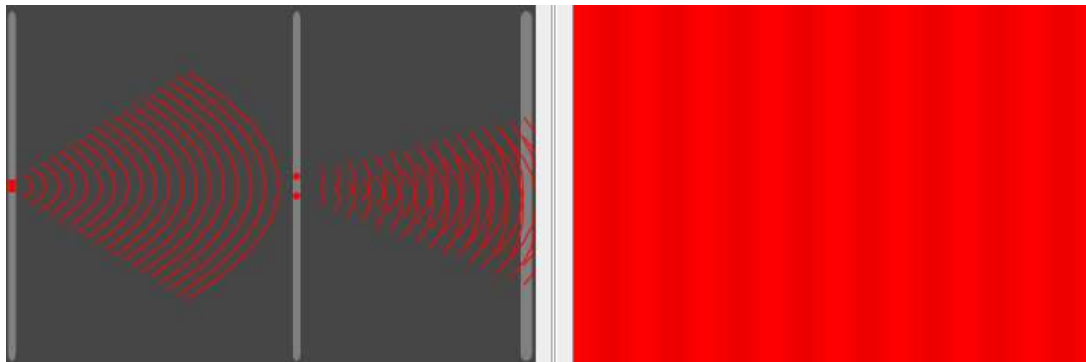
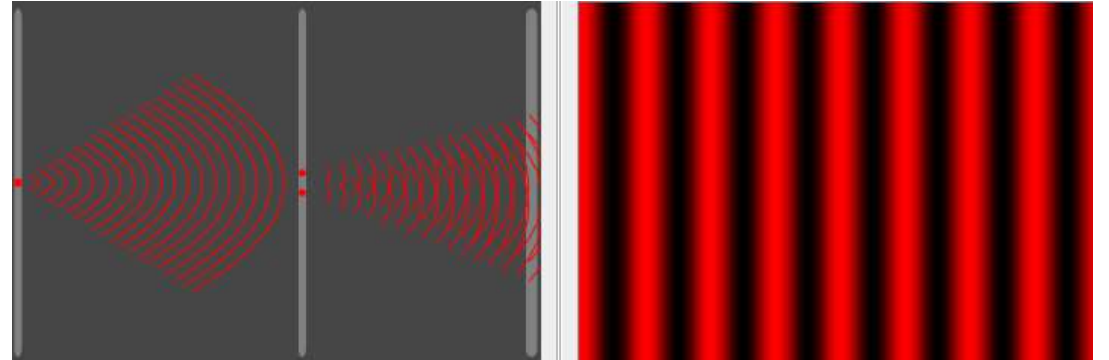


El contraste de las franjas viene dado por:

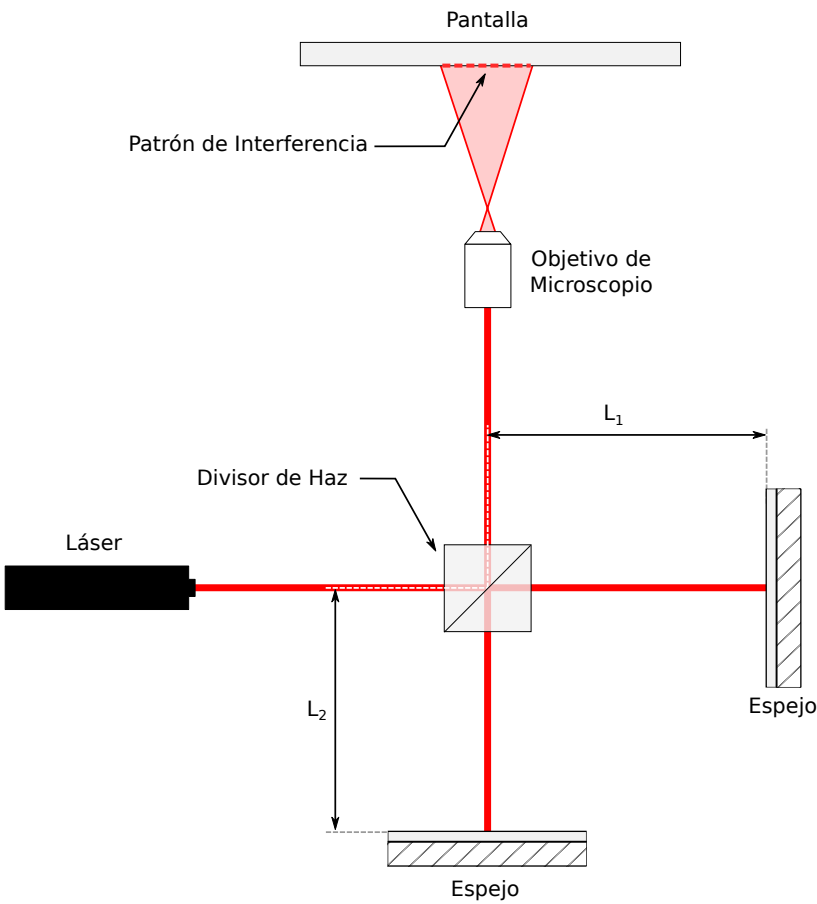
$$C = \frac{I_{\max} - I_{\min}}{I_{\max} + I_{\min}} \quad C = \left| \frac{\sin(k D \varphi_{\max})}{(k D \varphi_{\max})} \right|$$



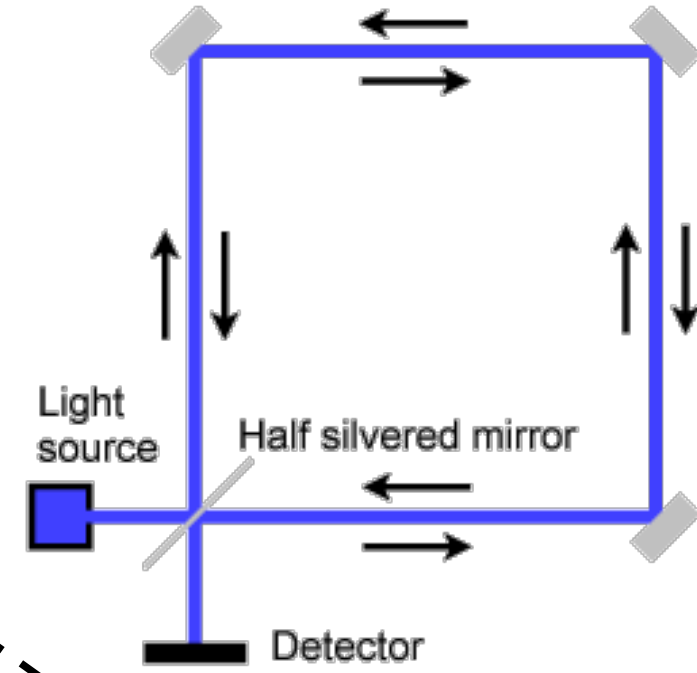
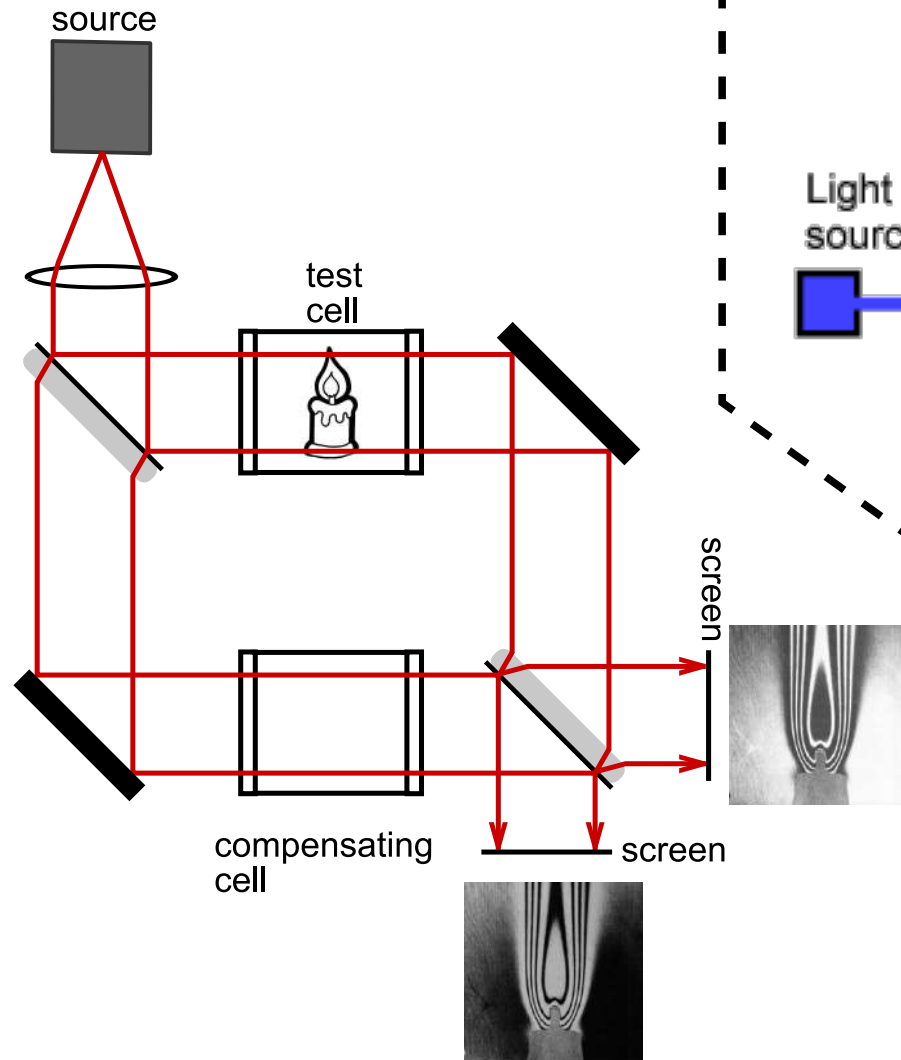
Apunte "Optica de Fourier",
Claudio Lemmi



Michelson

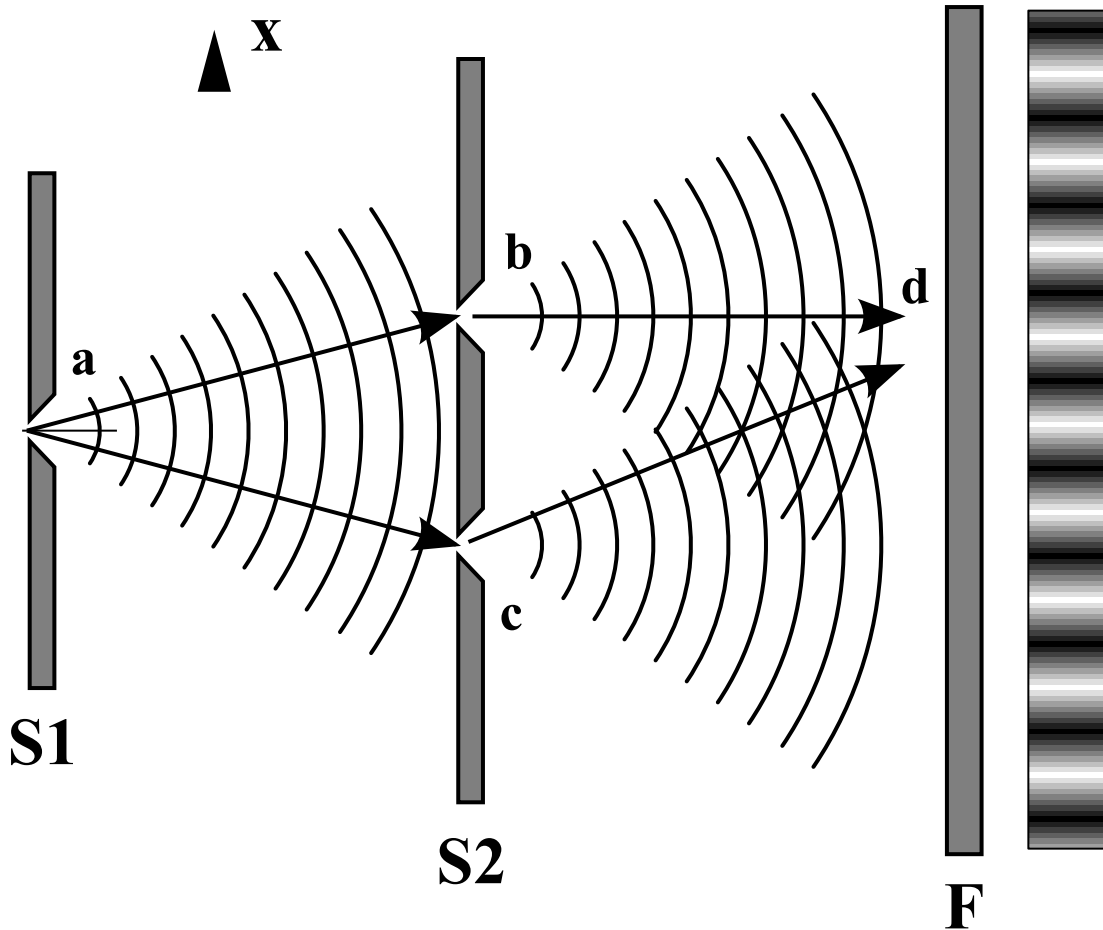


Mach-Zehnder

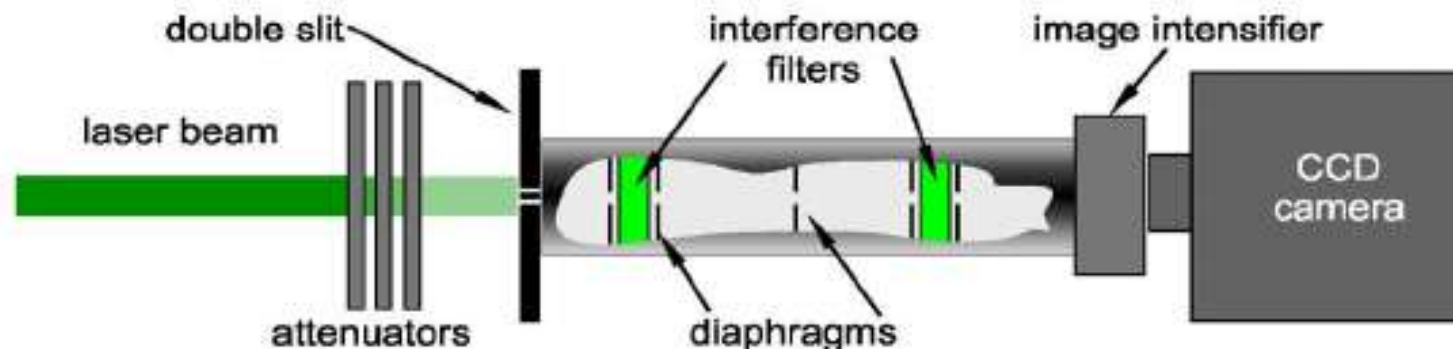
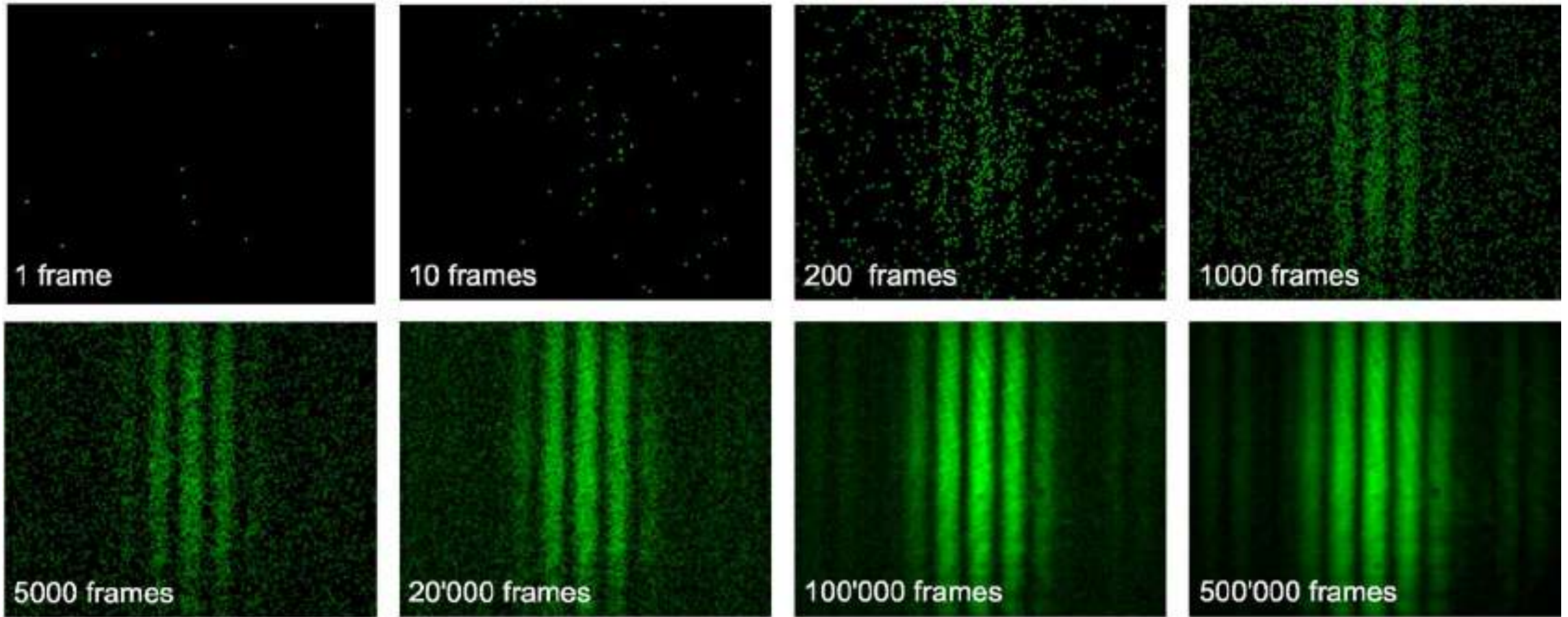


Sagnac

Young



Biprisma
de
Fresnell

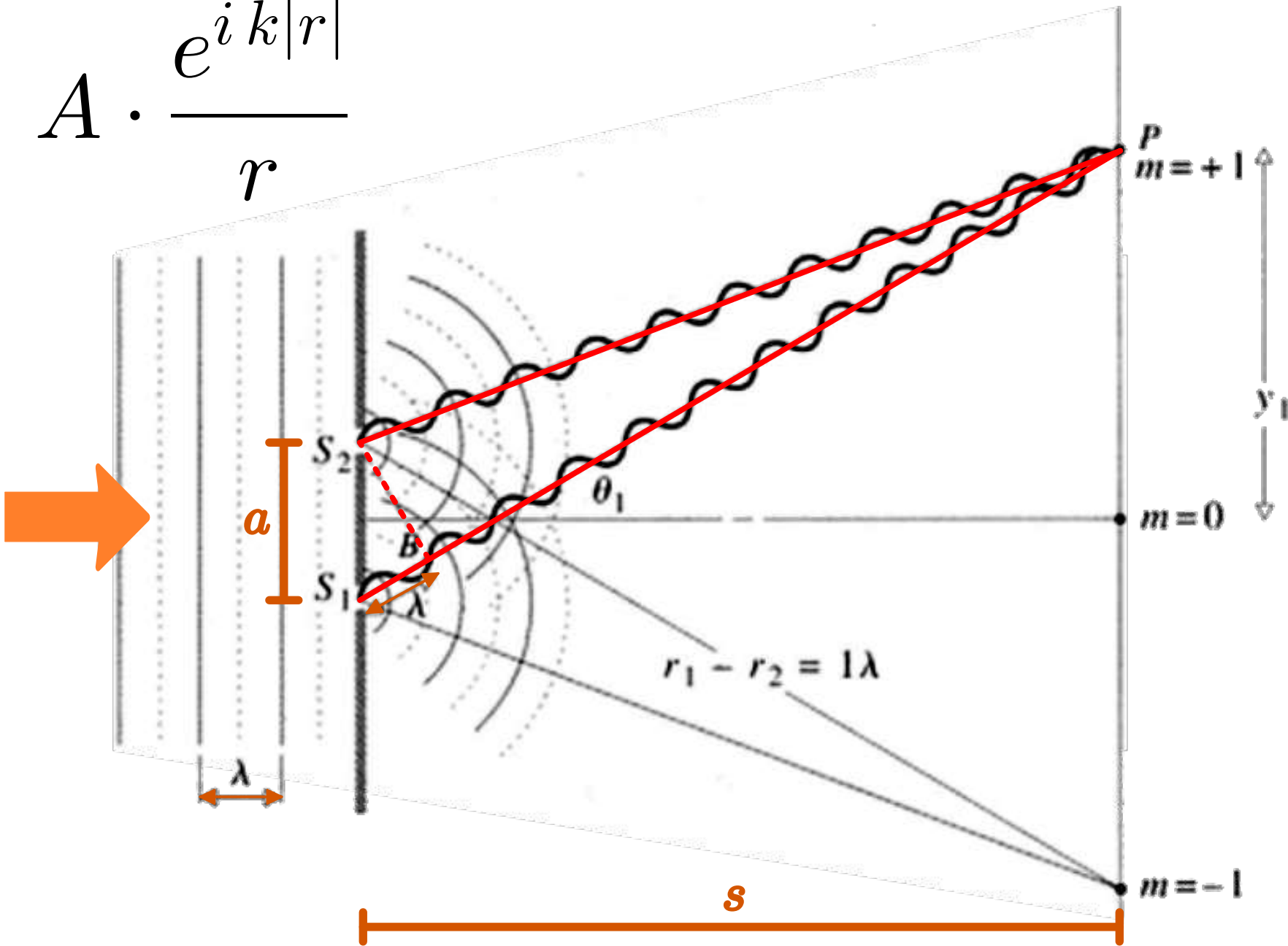


ACTIVIDAD:

Biprisma de Fresnel
Interferómetro
de Young

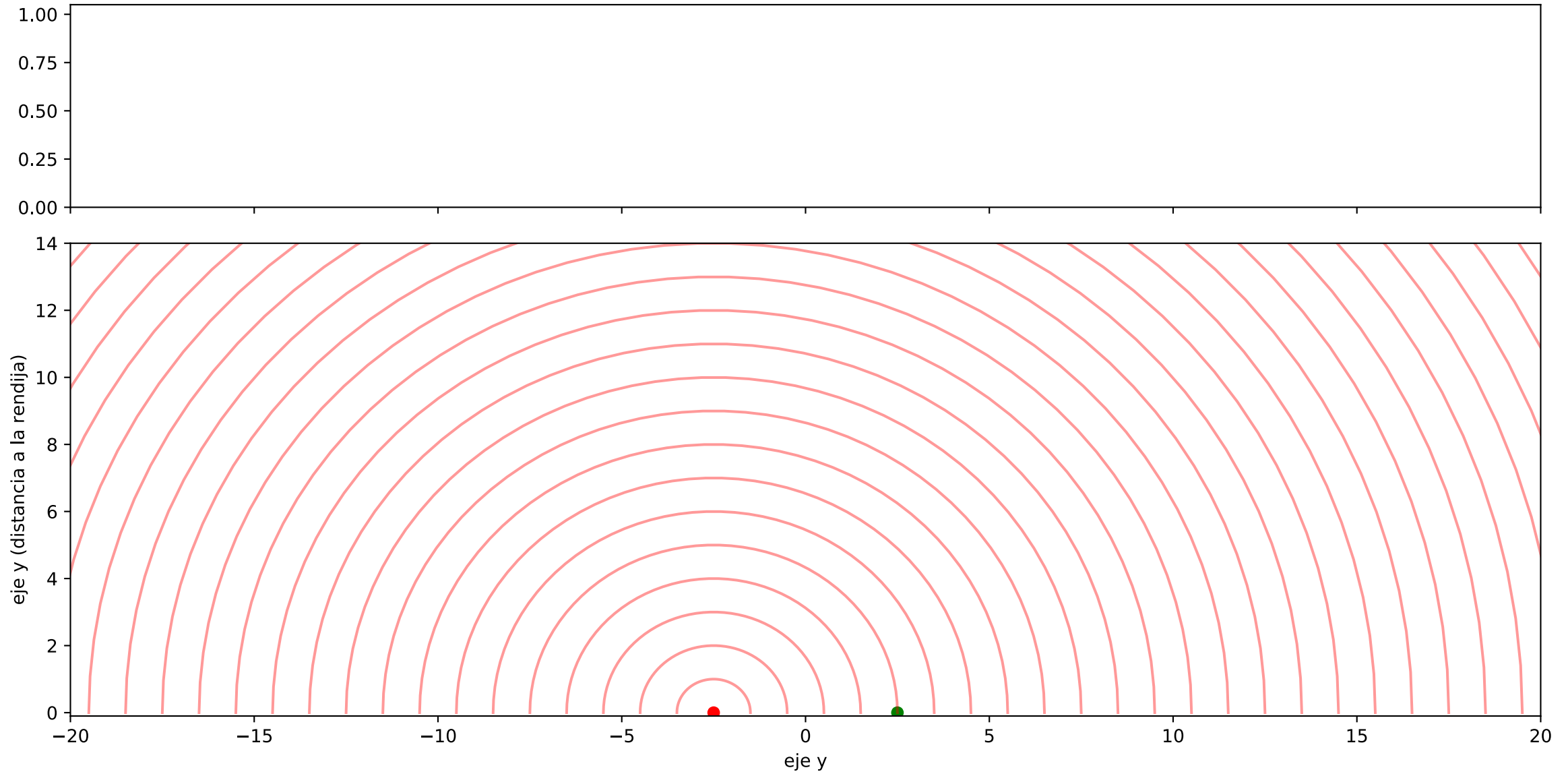
Interferómetro de Young

$$A \cdot \frac{e^{i k |r|}}{r}$$

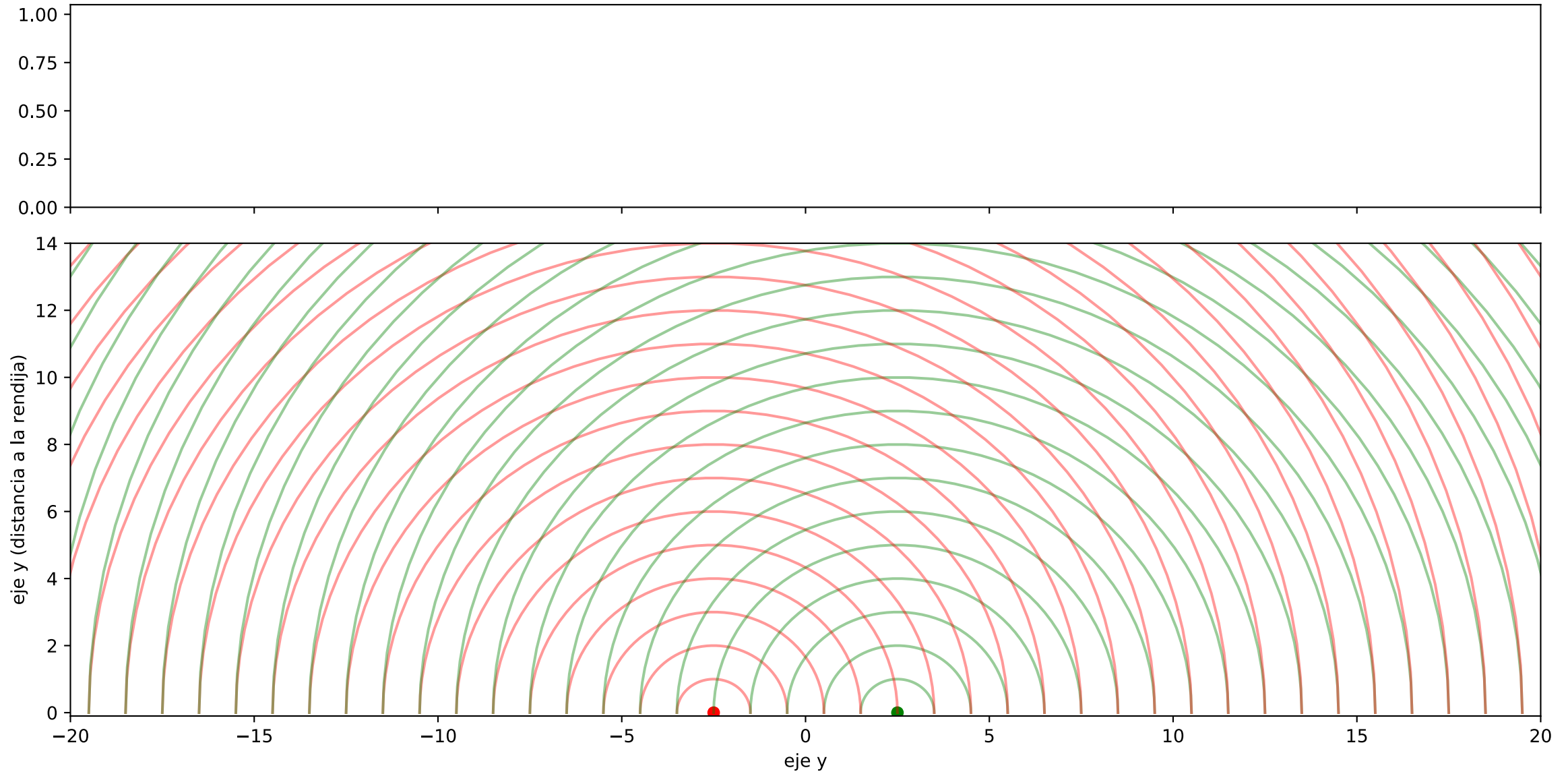


$$y_m \approx \frac{s}{a} m \lambda$$

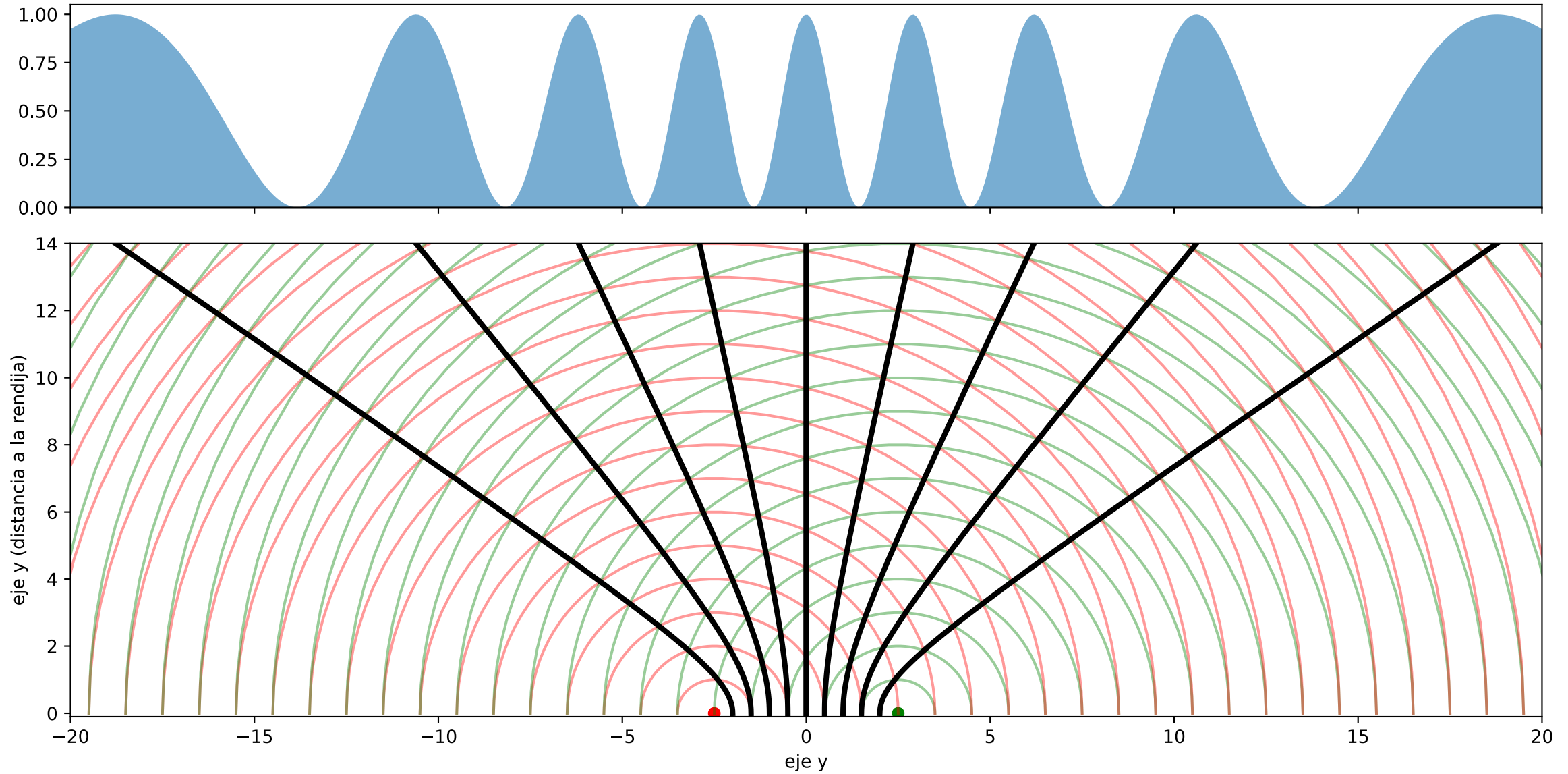
Interferómetro de Young



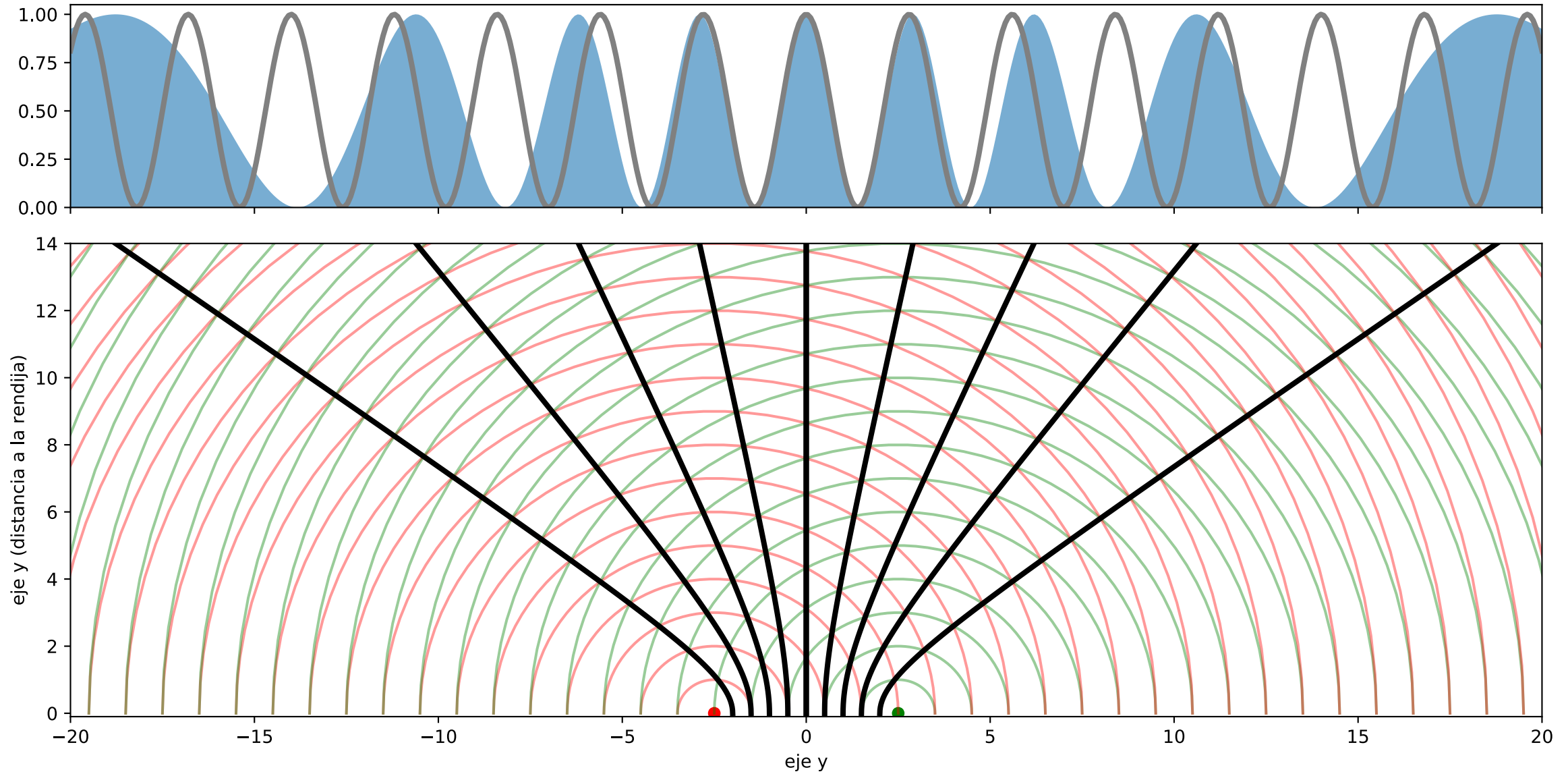
Interferómetro de Young



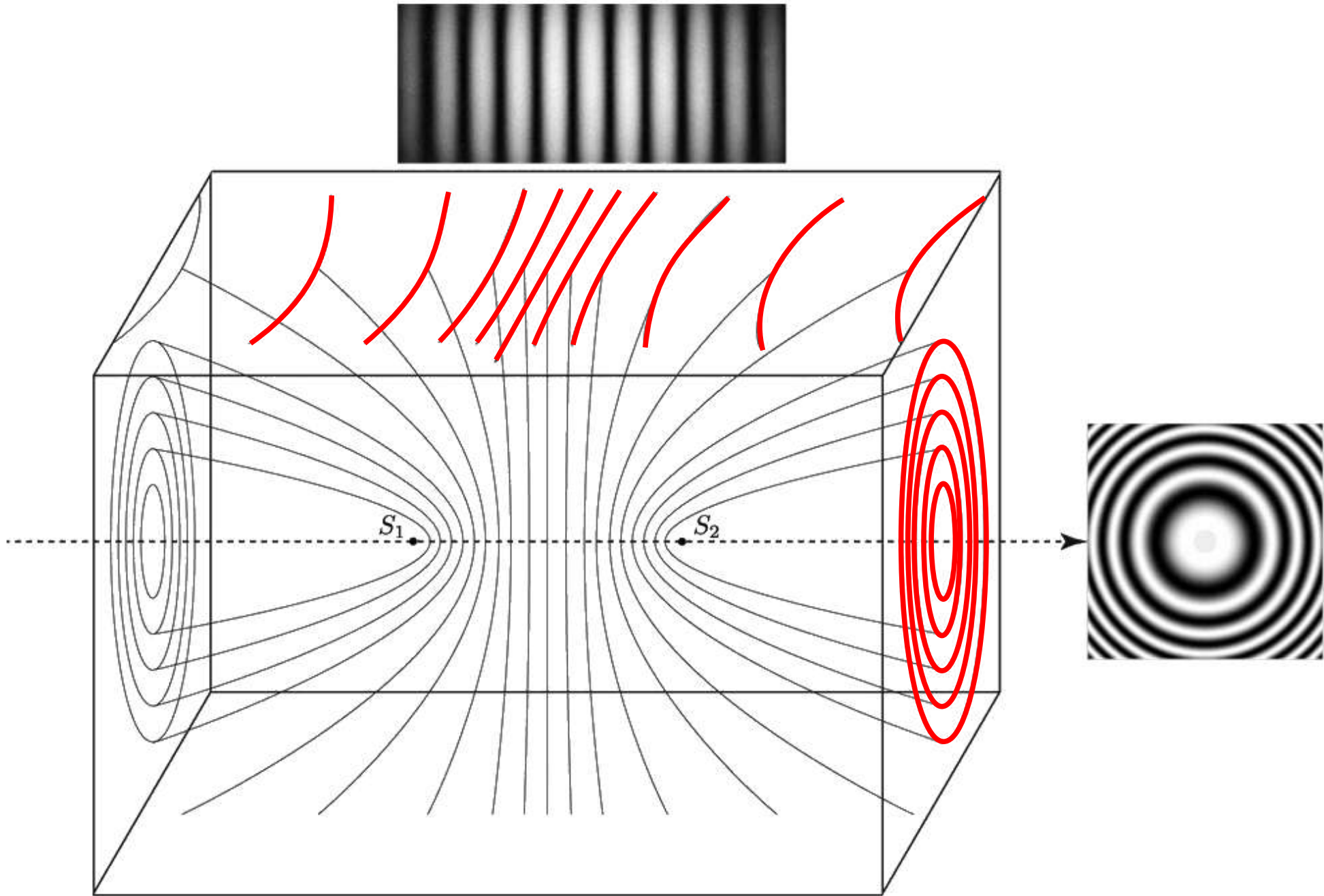
Interferómetro de Young

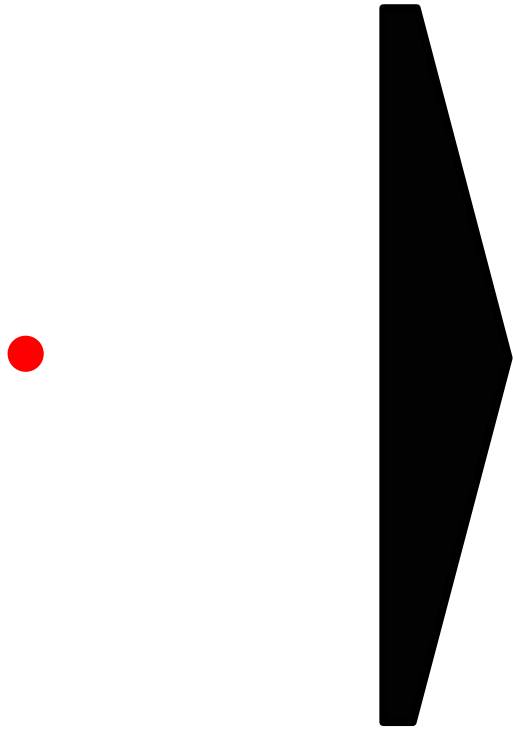


Interferómetro de Young

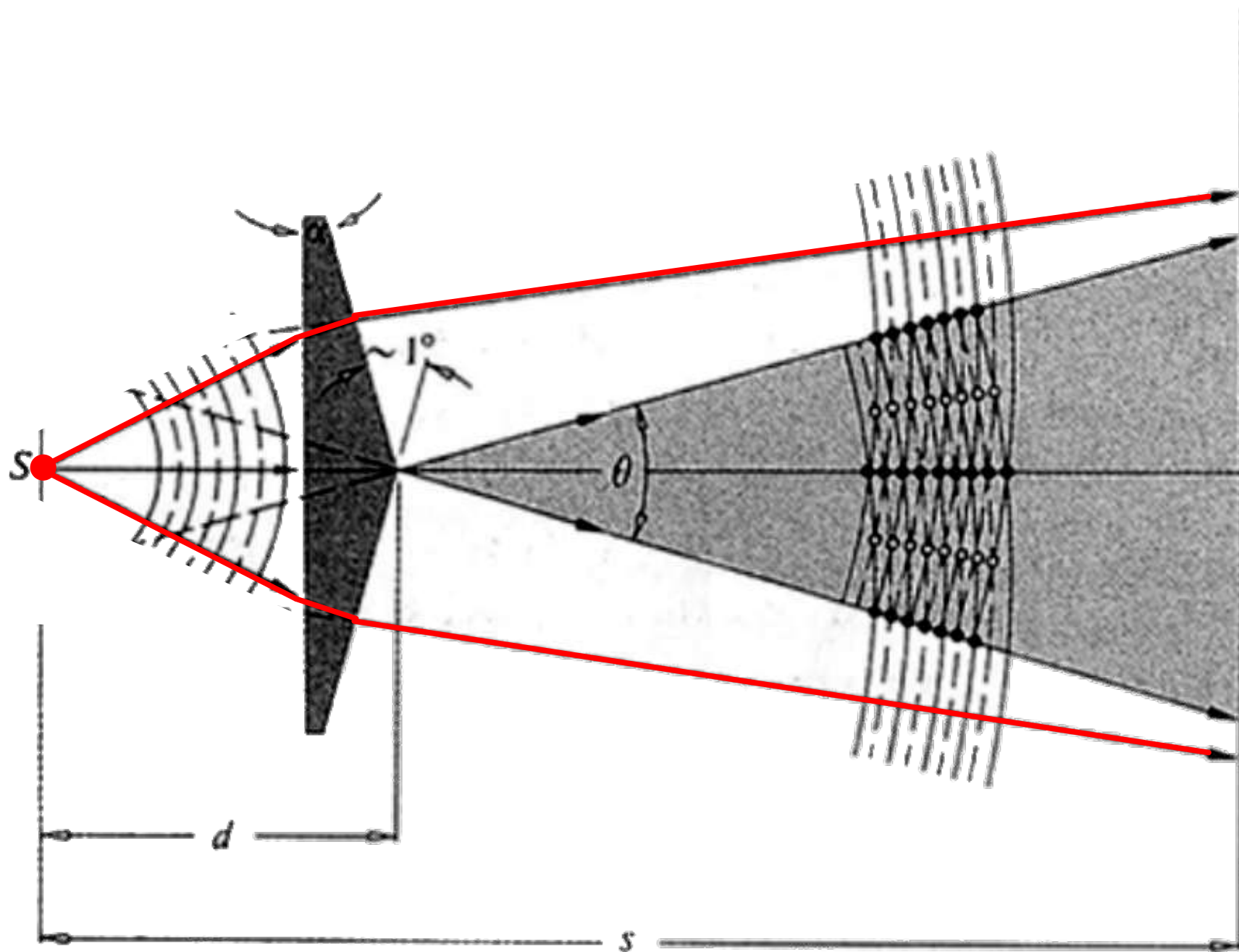


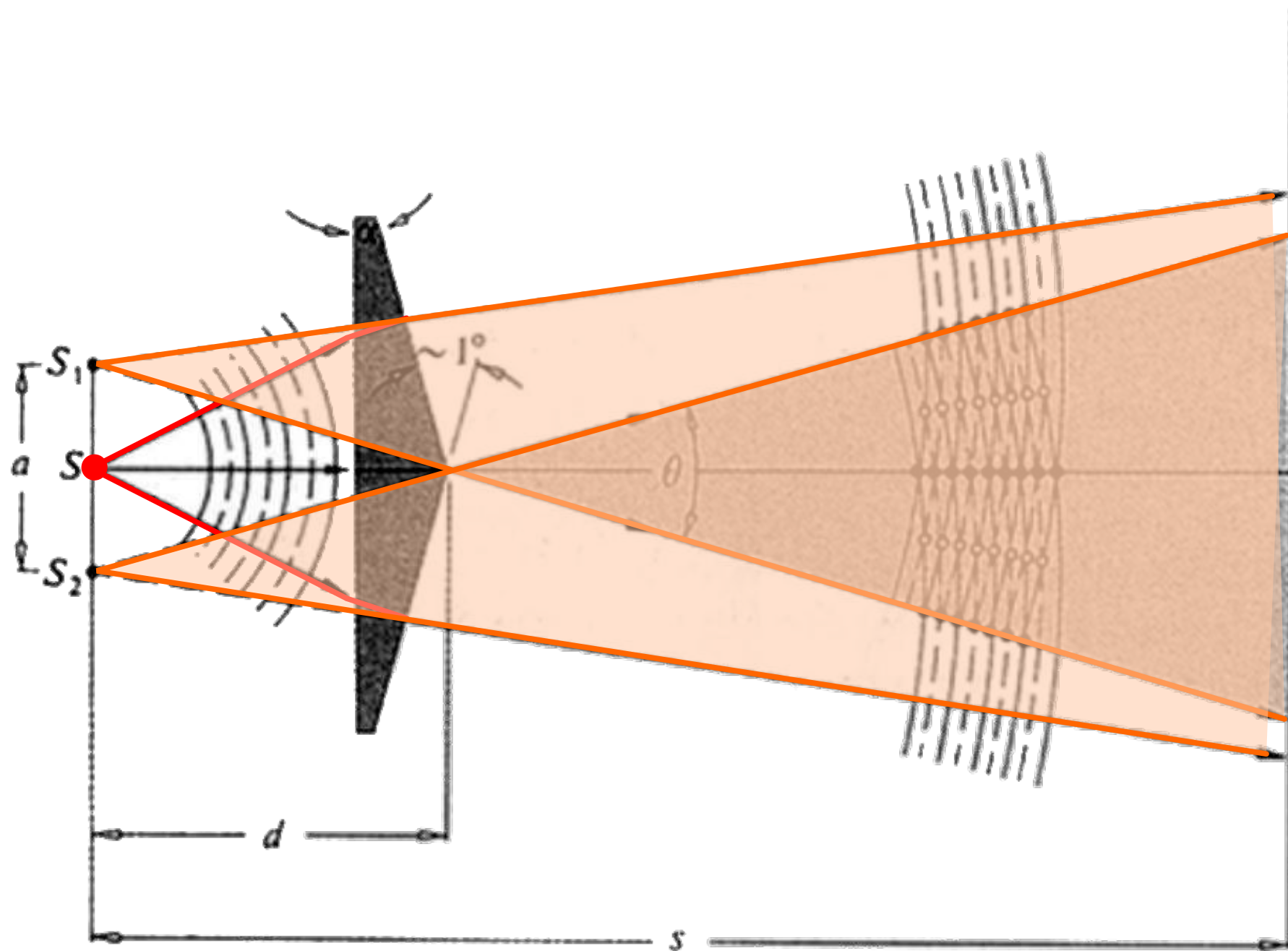
Interferómetro de Young

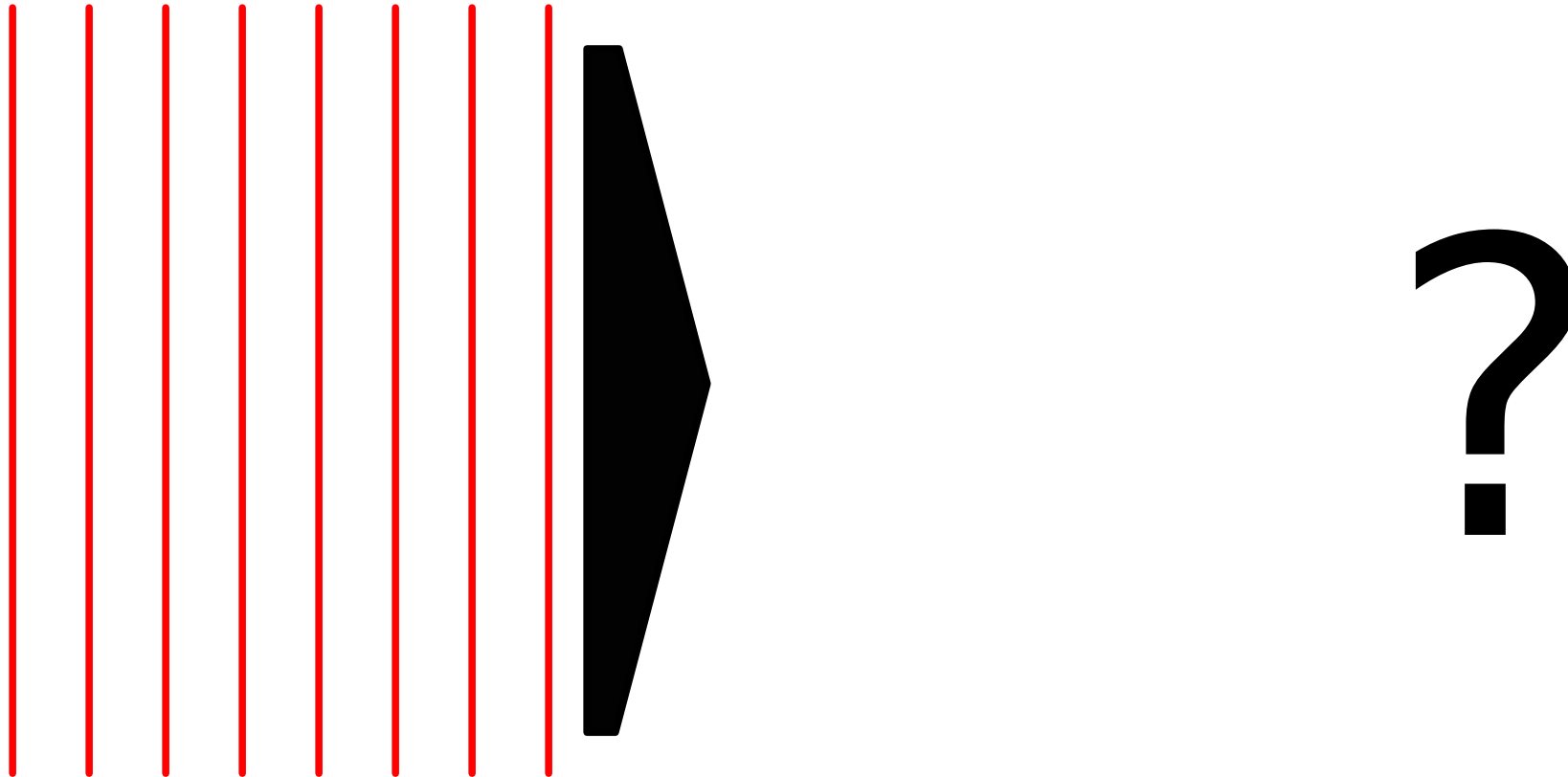


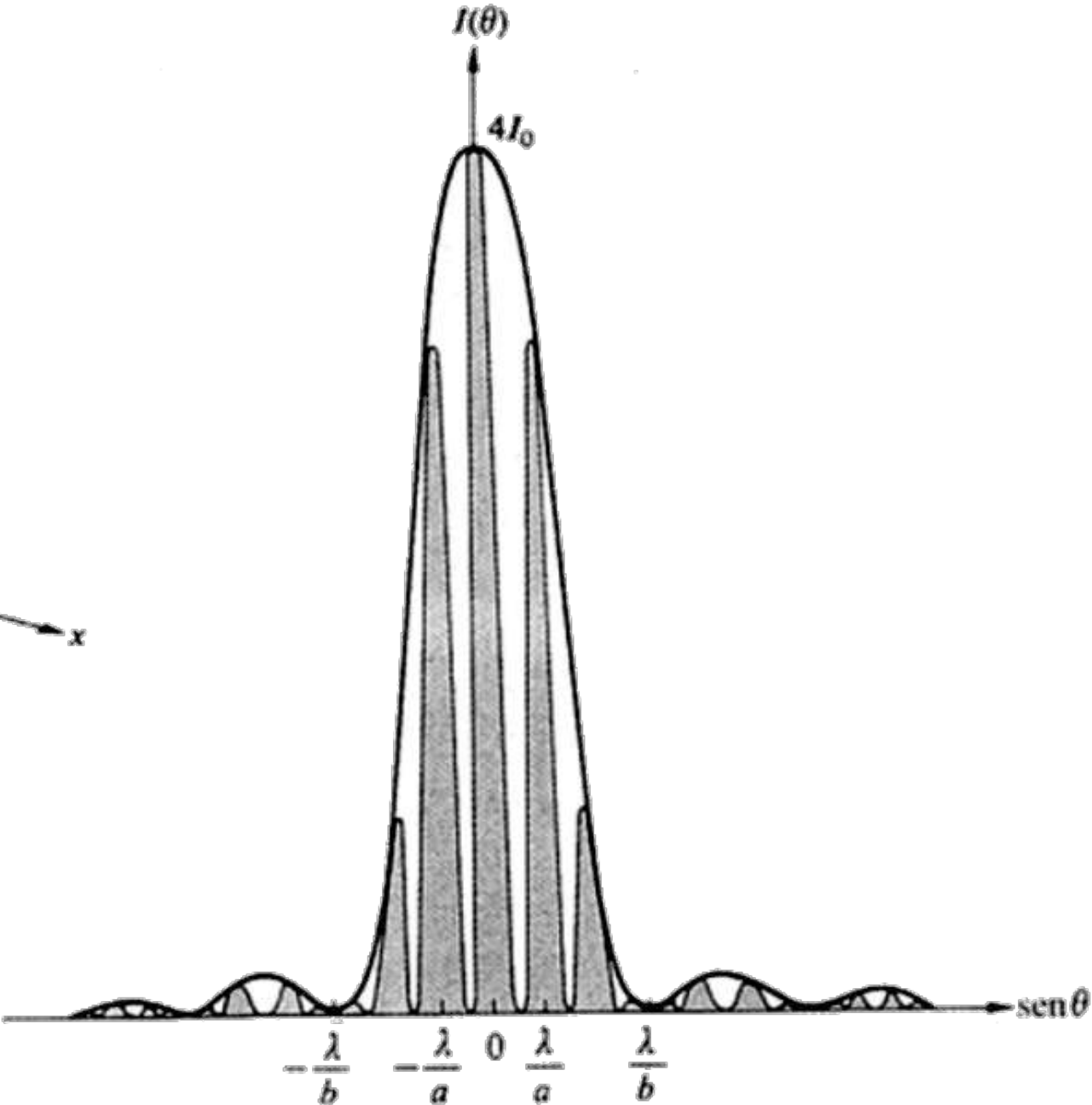
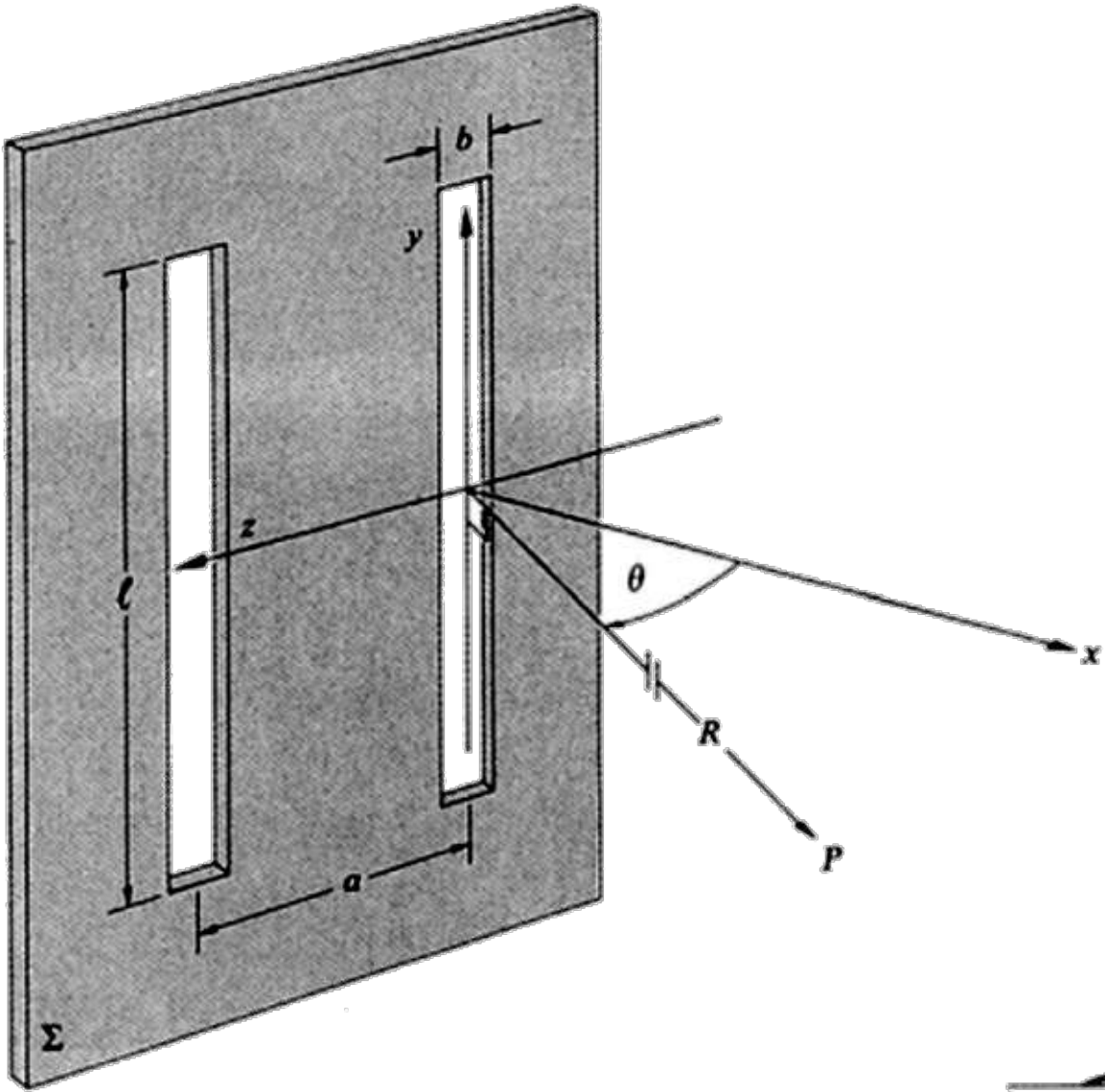


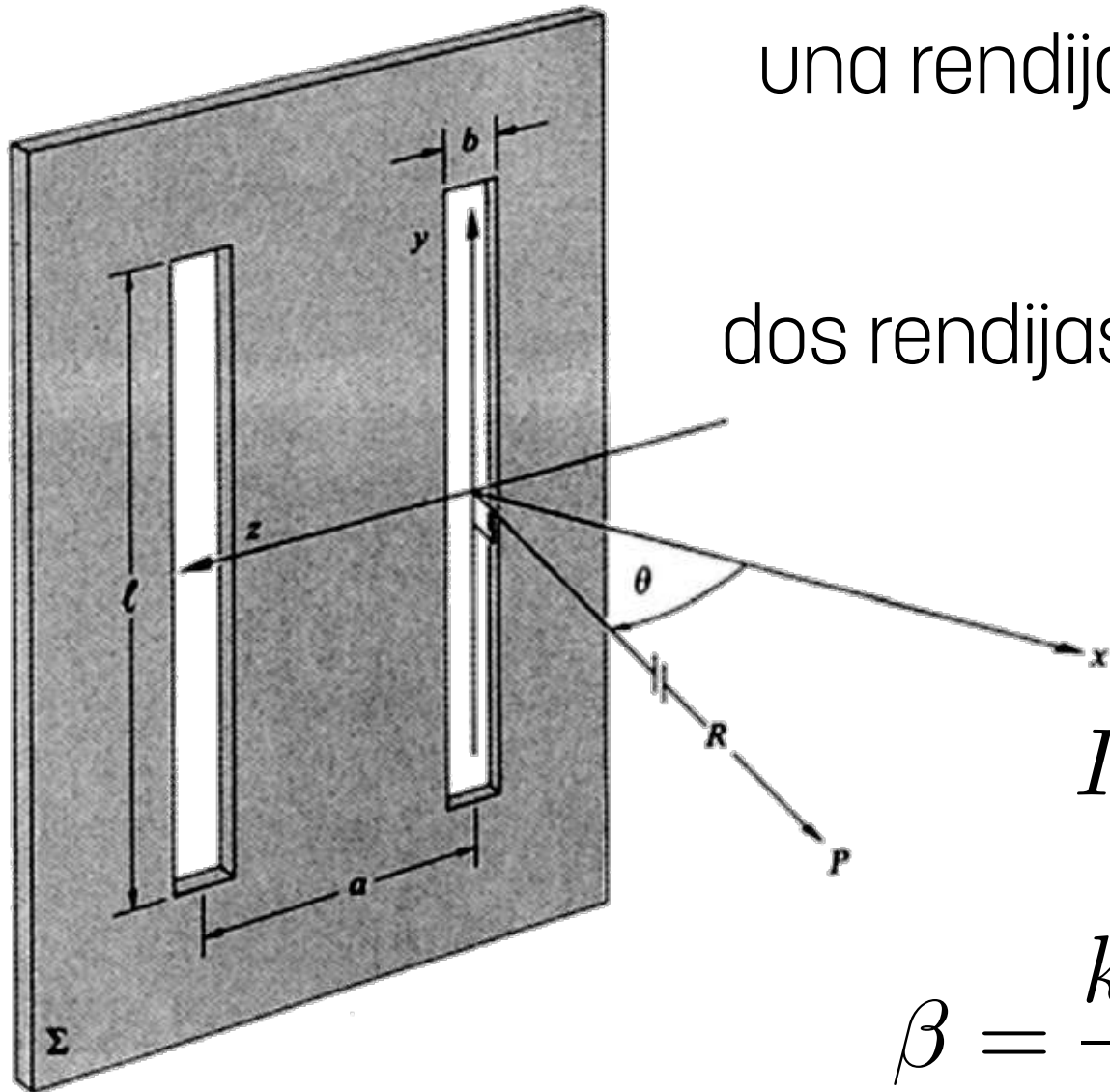
Biprisma de Fresnel



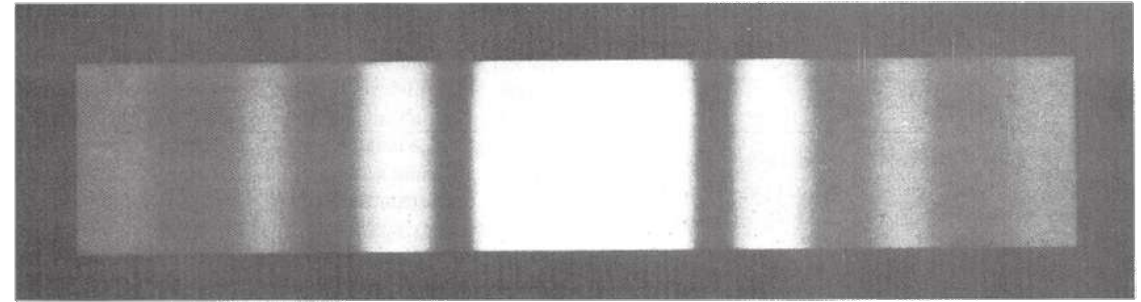




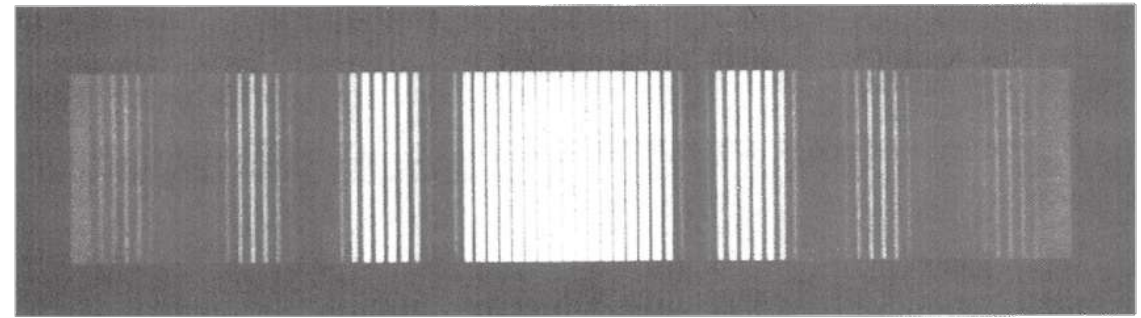




una rendija



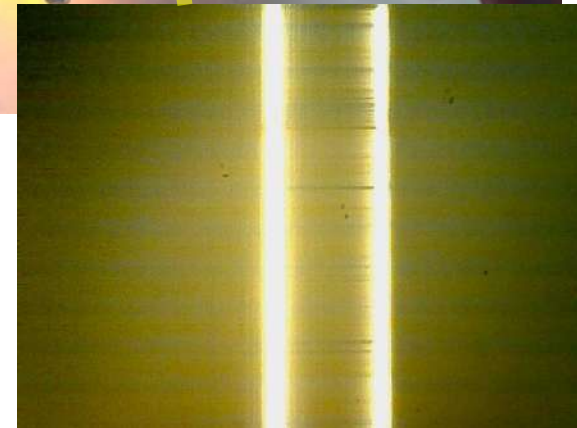
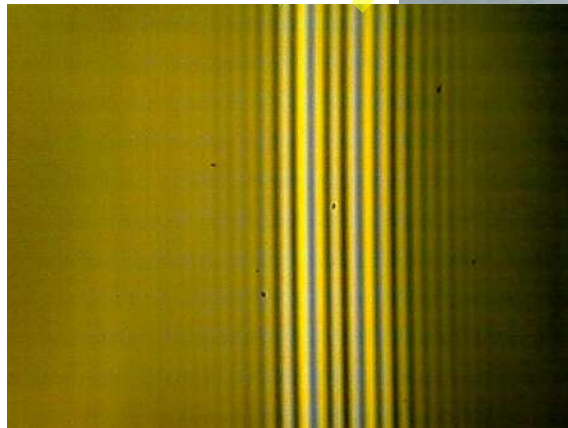
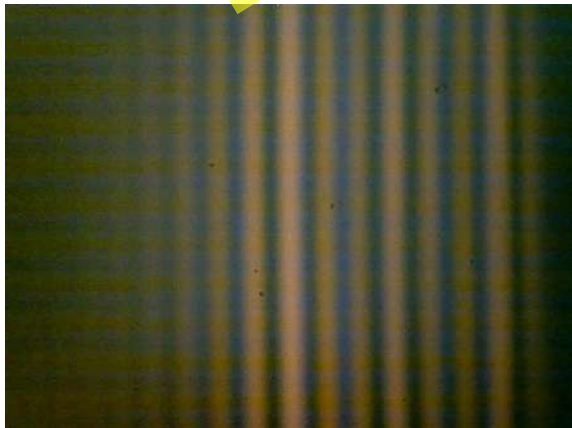
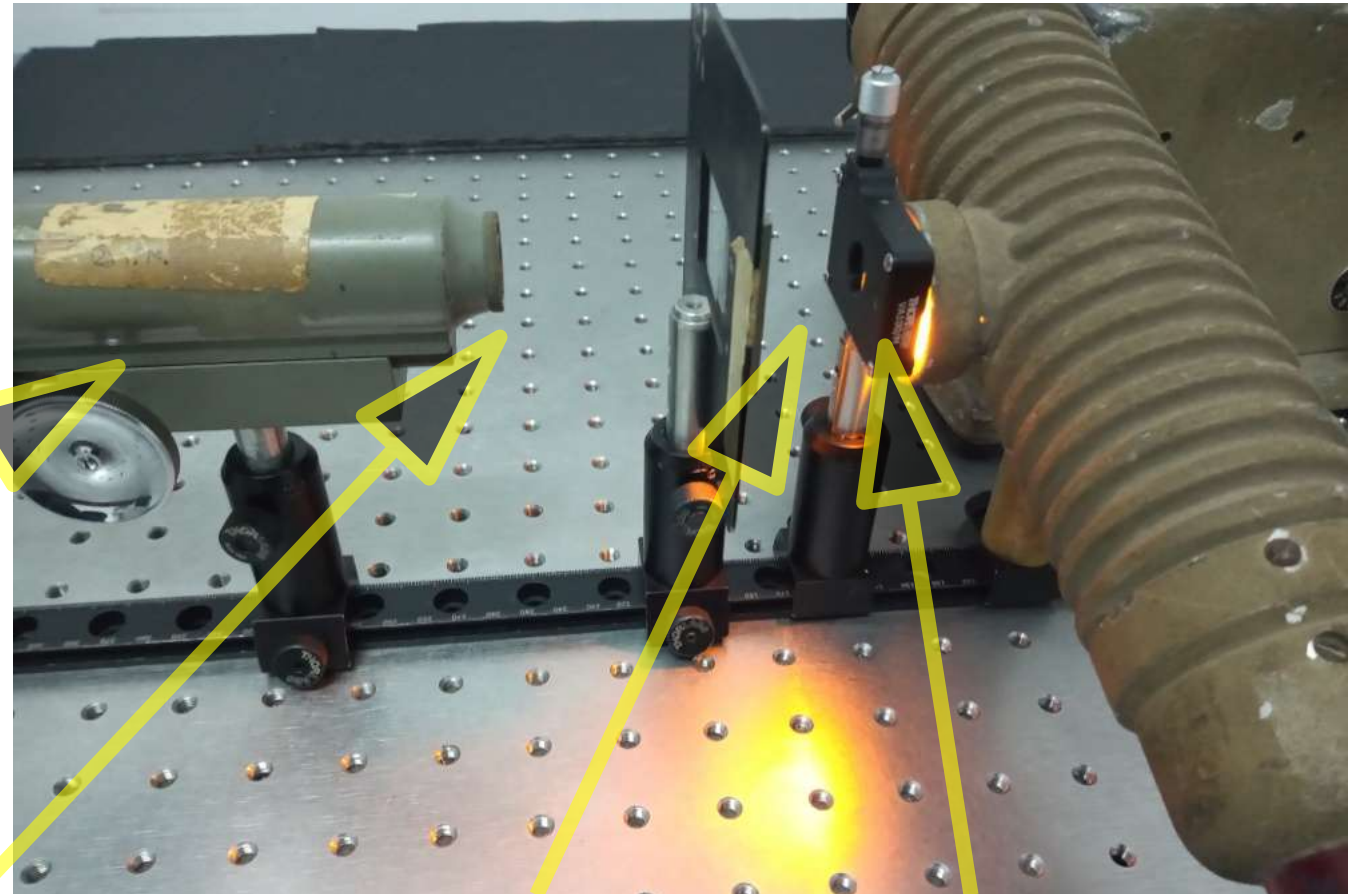
dos rendijas

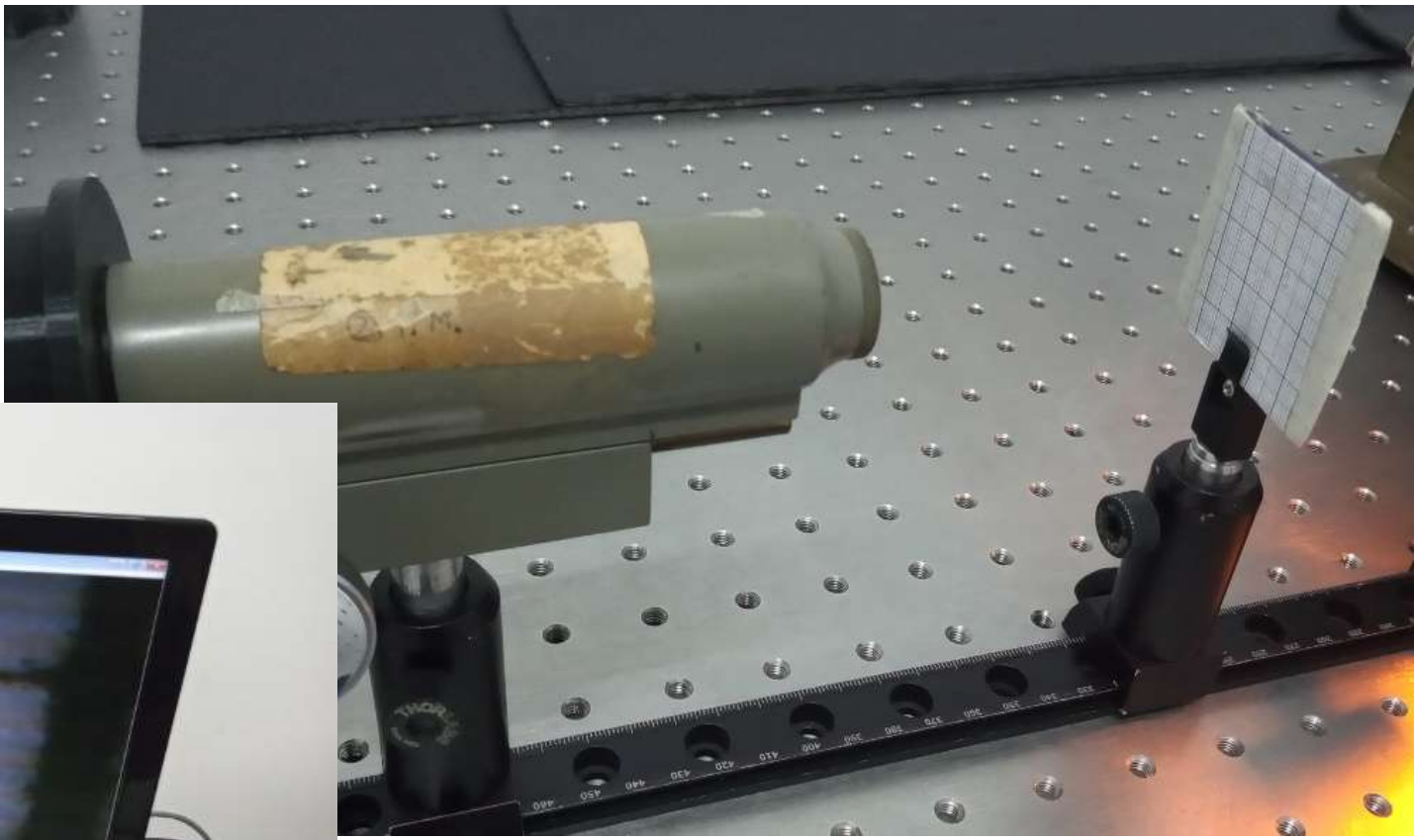


$$I(\theta) = 4I_0 \cdot \frac{\sin(\beta)}{\beta} \cdot \cos(\alpha)$$

$$\beta = \frac{k b}{2} \sin(\theta)$$

$$\alpha = \frac{k a}{2} \sin(\theta)$$





- **Montar biprisma de Fresnel con lámpara de Sodio**
 - **Medir λ del la lámpara de sodio**
 - **Medir interfrenja en función de la distancia a la fuente**
 - **Evaluar coherencia espacial**
- **Montar biprisma de Fresnel con láser**
 - **Medir λ del laser**
 - **Evalaur frente de onda**