Algunos Conceptos para intender Interferometria

1. Transforme de Fourier

2. Young's Double Slit Experiment

3. plano de *uv*

Fourier Transform (definicion)

Parejas en frecuencia y tiempo (o espacio)

Necisitamos un basis de funciones `independiente linearmente' (linear independent)

En caso de Fourier transformes: funciones sin y cosine

e.j. simple - `top hat function' : derivacion de S(f)

$$s(t) = \int_{-\infty}^{+\infty} S(f)\, e^{i2\pi ft}\, df$$

$$S(f) = \int_{-\infty}^{+\infty} s(t)\, e^{-i2\pi ft}\, dt.$$

$$e^{i\phi} = \cos\phi + i\sin\phi$$

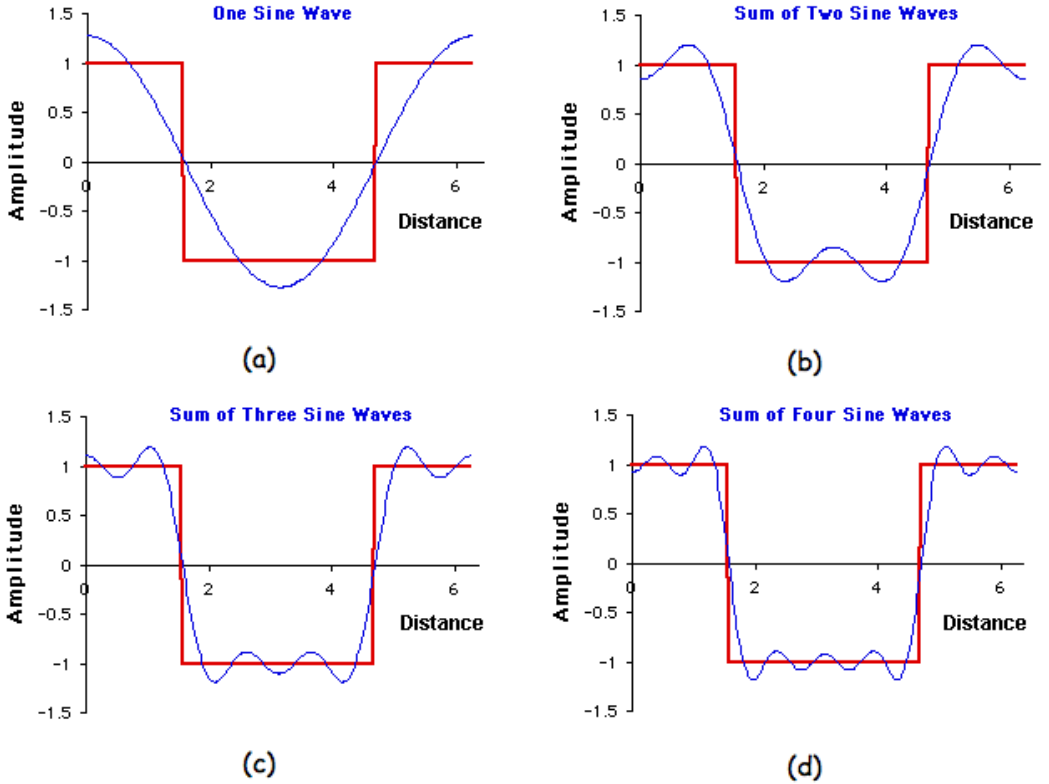
$$e^{i2\pi ft} = \cos 2\pi ft + i\sin 2\pi ft.$$

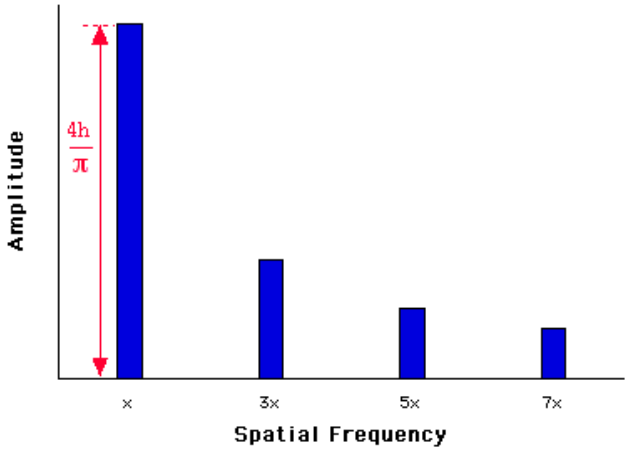
Transforme de Fourier

$$f(x) = \frac{1}{2}a_0 + a_1\cos(x) + a_2\cos(2x) \ldots + a_n\cos(nx) + b_1\sin(x) + b_2\sin(2x) \ldots + b_n\sin(nx)$$

Transform para un 'Square Wave'

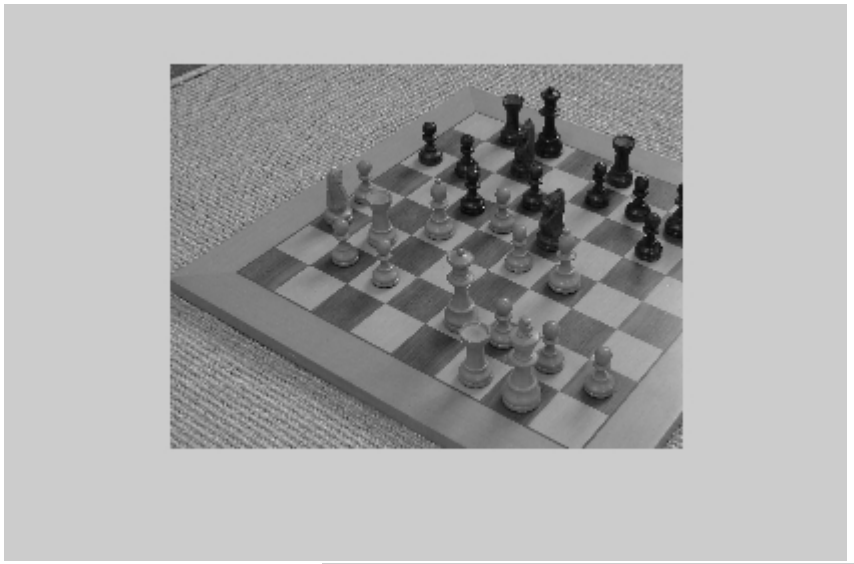
$$f(x) = \frac{4h}{\pi}\left(\sin(x) + \frac{1}{3}\sin(3x) + \frac{1}{5}\sin(5x) + \frac{1}{7}\sin(7x) + \ldots\right)$$

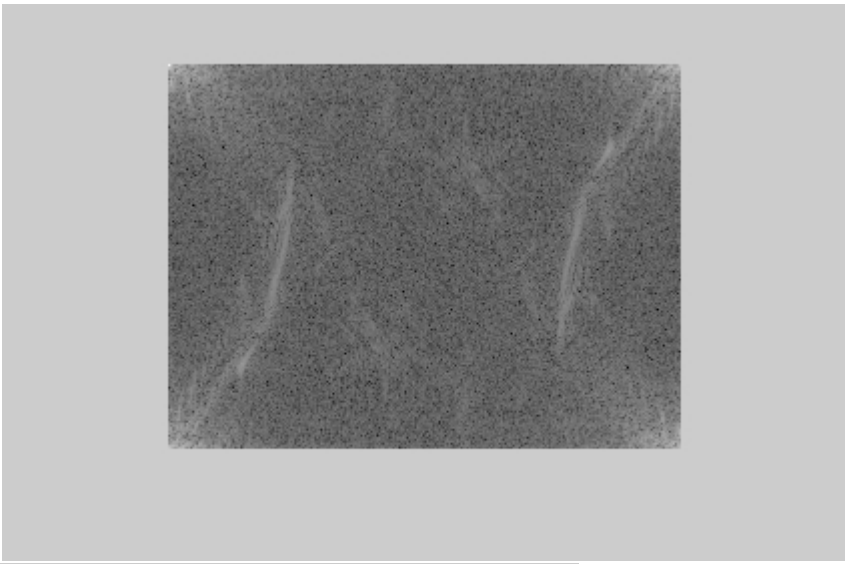




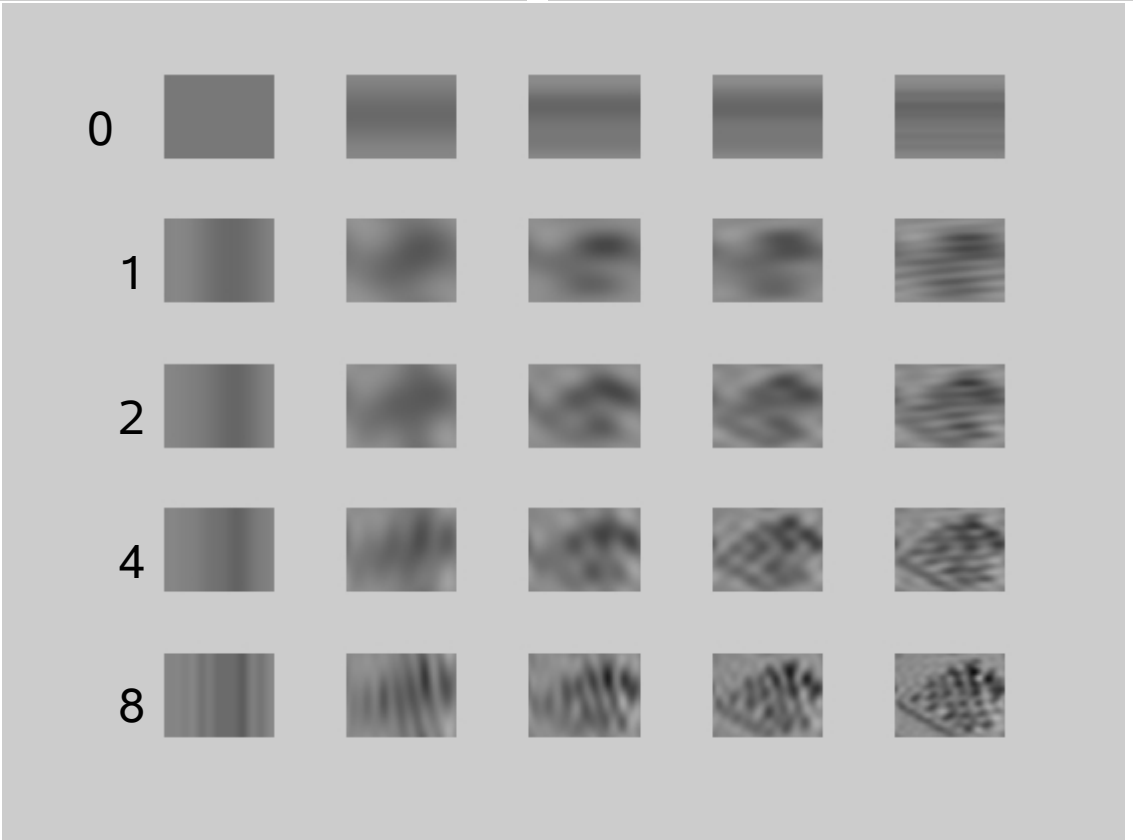
Figures from Wiki-books (author ?)

Fourier en dos dimensiones: imagenes

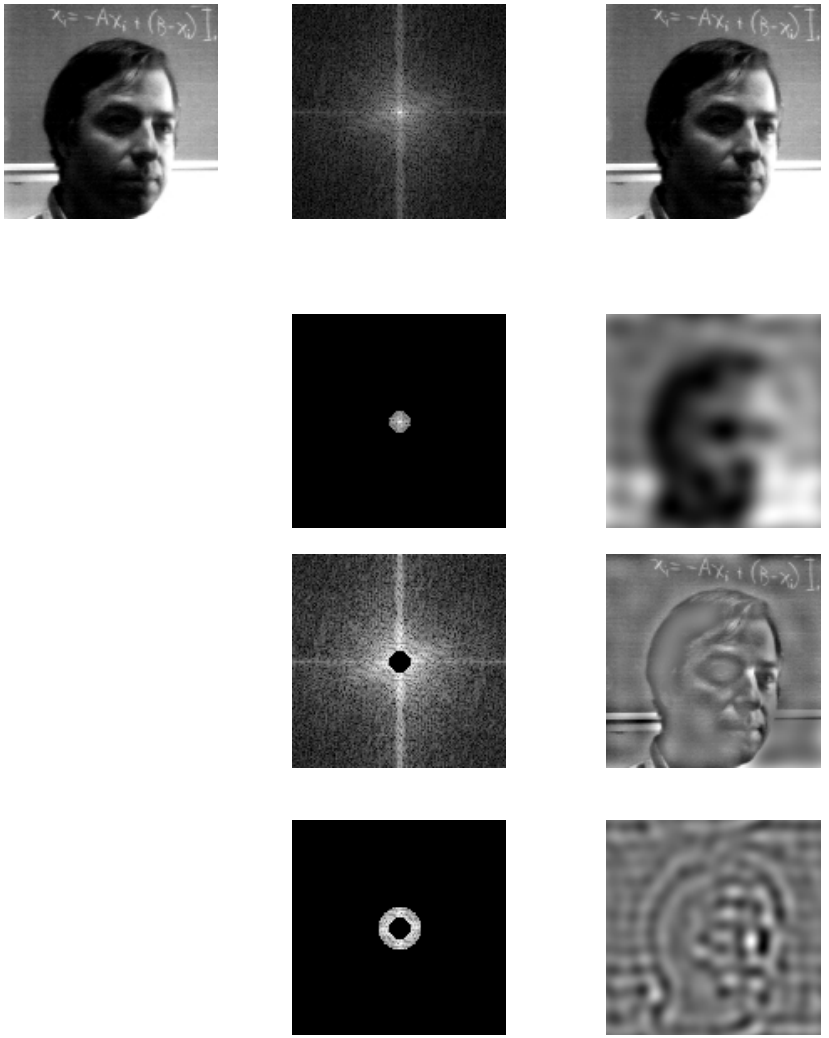




amplitude
y
fase



Sussex
Univ.
webpage

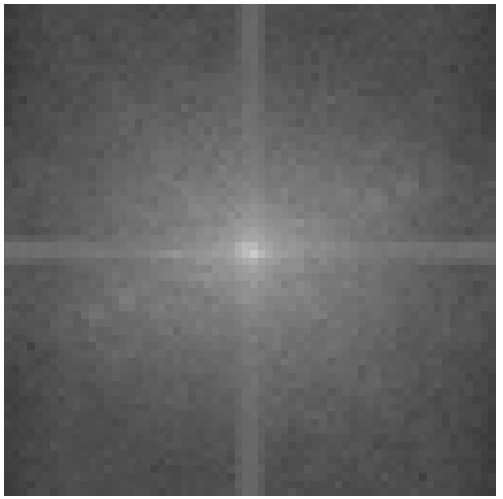


From Steven Lehar's Fourier tutorial webpage

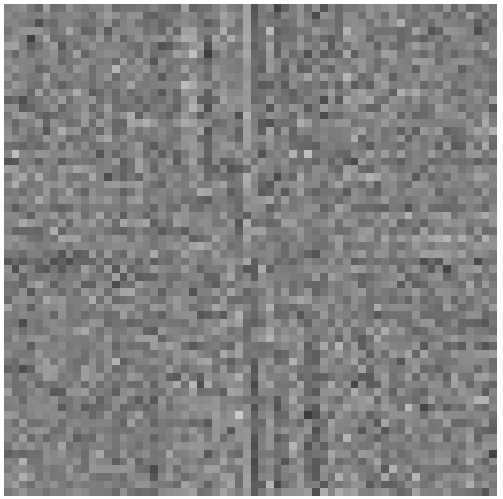
Importancia del fase

Imagen original

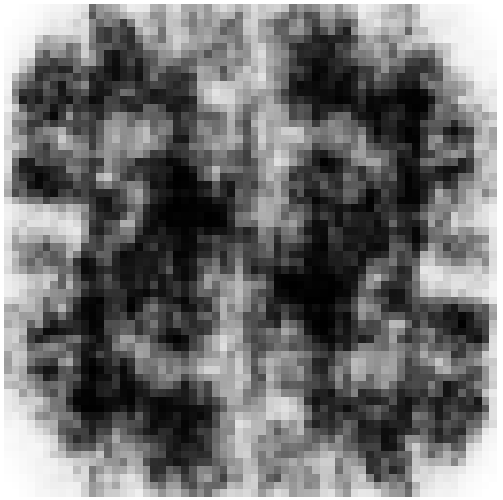
Fourier: log Amplitud



Fourier: fase



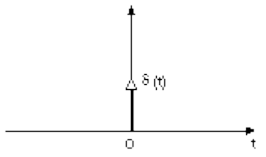
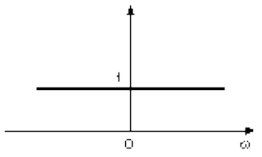
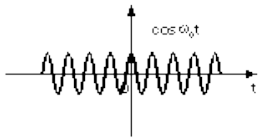
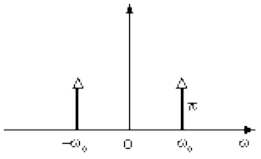
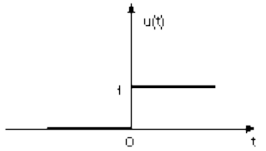
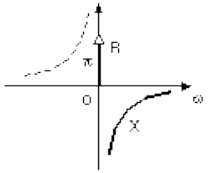
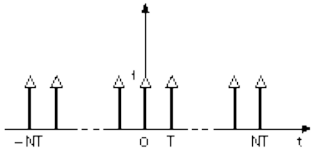
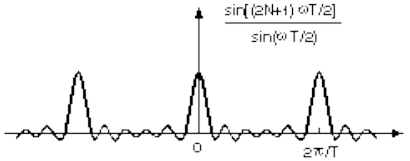
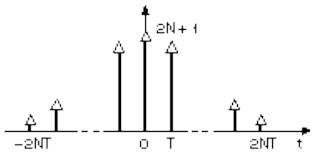
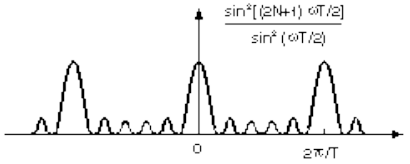
from tutorial on
Bob Fisher's homepage
Univ. of Edinburgh



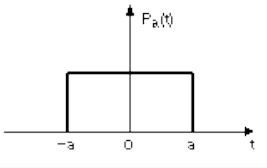
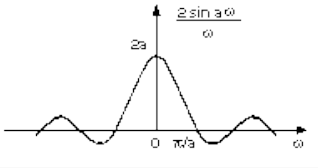
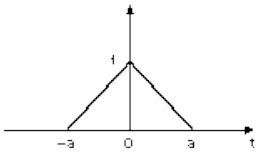
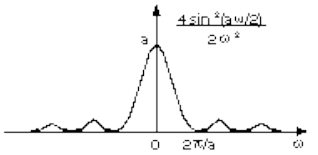
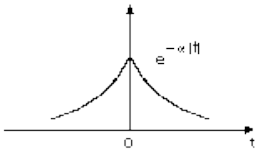
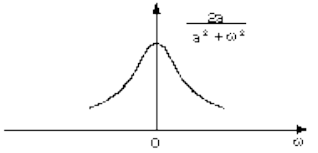
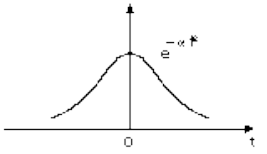
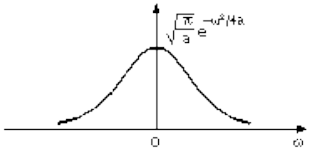
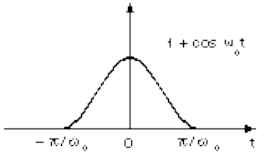
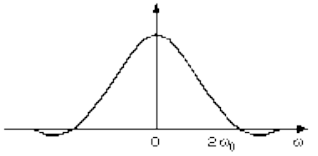
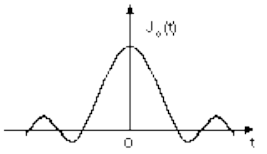
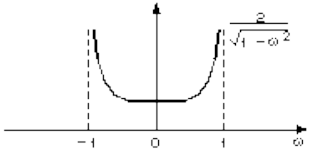
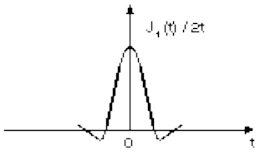
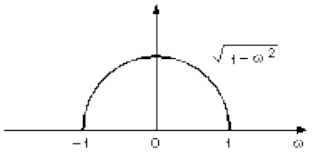
Inverse Fourier
sin fase
informacion

Ejemplos

Transforms of singularity functions

$f(t) \longleftrightarrow F(\omega)$	
	
	
	
	
	
$\delta(x)\delta(y) \Leftrightarrow 1$	$\delta(x) \Leftrightarrow 2\pi\delta(v)$
$\varphi(x) \Leftrightarrow 2\pi\Phi(u)\delta(v)$	$\varphi(x)\delta(y) \Leftrightarrow \Phi(u)$

Examples of Fourier transforms

$f(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} F(\omega)e^{j\omega t}d\omega$	$F(t) = \int_{-\infty}^{\infty} f(t)e^{-j\omega t}dt$
	
	
	
	
	
	
	

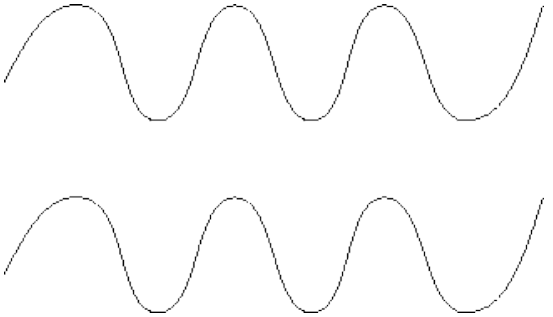
Fourier transform theorems

$f(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} F(\omega)e^{j\omega t}d\omega$	$F(t) = \int_{-\infty}^{\infty} f(t)e^{-j\omega t}dt$
$f(at)$	$\frac{1}{\lvert a\rvert}F\left(\frac{\omega}{a}\right)$
$f^*(t)$	$F^*(-\omega)$
$F(t)$	$2\pi f(-\omega)$
$f(t-t_0)$	$F(\omega)e^{-jt_0\omega}$
$f(t)e^{j\omega_0 t}$	$F(\omega-\omega_0)$
$f(t)\cos\omega_0 t$	$\frac{1}{2}[F(\omega+\omega_0)+F(\omega-\omega_0)]$
$f(t)\sin\omega_0 t$	$\frac{1}{2}[F(\omega+\omega_0)-F(\omega-\omega_0)]$
$\frac{d^n f(t)}{dt^n}$	$(jw)^n F(\omega)$
$(-jt)^n f(t)$	$\frac{d^n F(\omega)}{d\omega^n}$
$m_n = \int_{-\infty}^{\infty} t^n f(t)dt$	$F(\omega) = \sum_{n=0}^{\infty}\frac{m_n}{n!}(-j\omega)^n$
$\int_{-\infty}^{\infty} f_1(\tau)f_2(t-\tau)d\tau$	$F_1(\omega)F_2(\omega)$
$\int_{-\infty}^{\infty} f(t+\tau)f^*(\tau)d\tau$	$\lvert F(\omega)\rvert^2$
$\int_{-\infty}^{\infty}\lvert f(t)\rvert^2 dt = \frac{1}{2\pi}\int_{-\infty}^{\infty}\lvert F(\omega)\rvert^2 d\omega$	
$f(t)+j\hat{f}(t)$	$2F(\omega)U(\omega)$
$\hat{f}(t)$	$-j\ \operatorname{sgn}\ \omega F(\omega)$
$\sum_{n=-\infty}^{\infty} f(t+nT) = \frac{1}{T}\sum_{n=-\infty}^{\infty} F\left(\frac{2\pi n}{T}\right)e^{j2\pi nt/T}$	

Interferometria y Interferencia

Interferencia constructiva

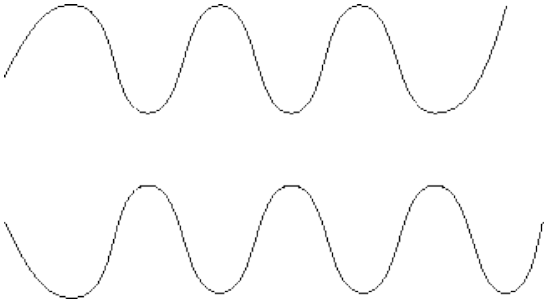
(amplitudo netto = max)



$A = A_0 \cos(\omega t + \phi)$

Interferencia destructiva

(amplitudo netto = 0)



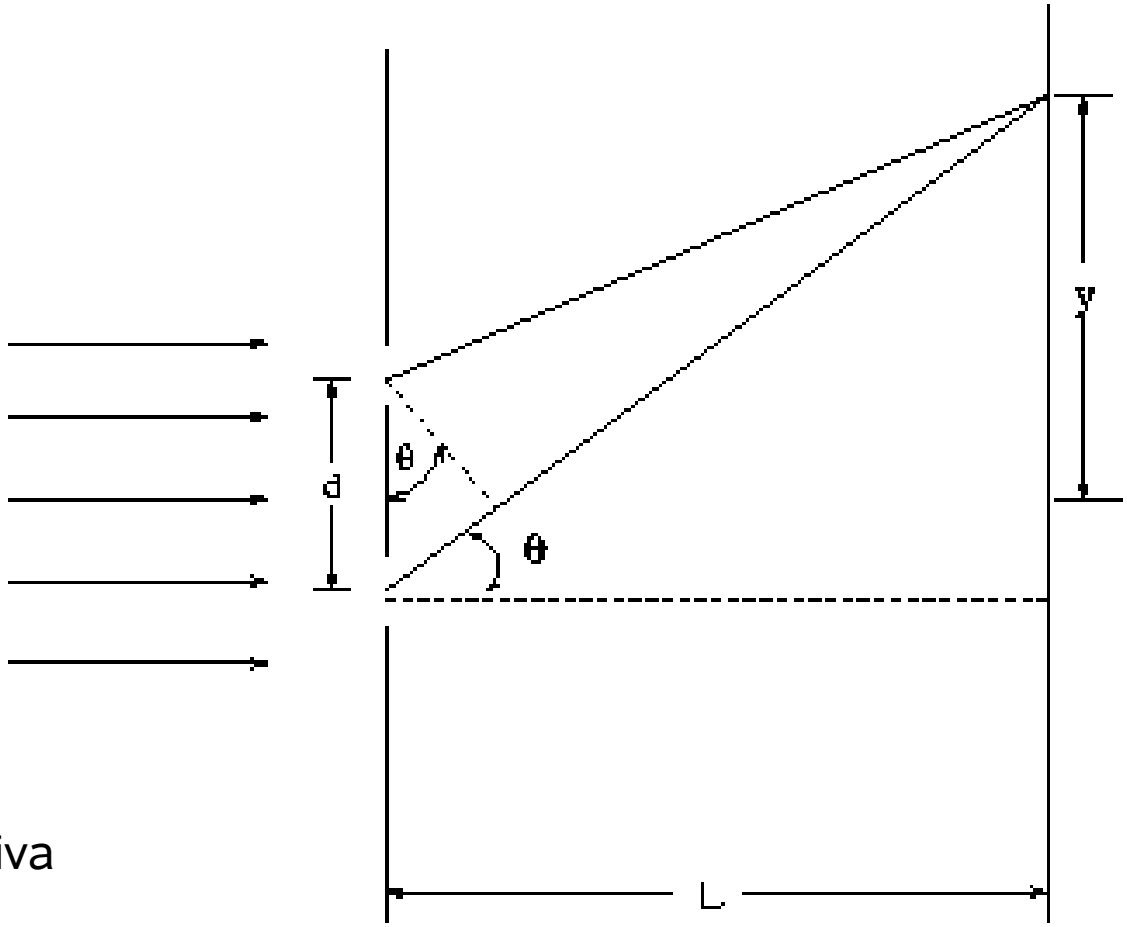
Dos ondas comenzar en fase en el mismo punto y viajan distancia r1 y r2, resp.

$r1 - r1 = m\lambda$ $(m = 1,2,3....)$ --> Interferencia constructiva

$r1 - r2 = (m+½)\lambda$ $(m = 1,2,3...)$ --> Interferencia destructiva

Young's Double Slit Experiment

dos rayos, dos “slits”
(tamano del “slits” < λ del luz)



si d << L, r1 – r2 = d sin Θ

entonces, quando:

d sin Θ = m λ (m= +/- 1,2,3...)
interferencia constructiva

d sin Θ = (m+½) λ (m = +/- 1,2,3...)
interferencia destructiva

La pantalla va a tener bandas brillos y bandas oscuos alternadas:

se llama : Interference fringes (y con un foton?)

si $d << L$, $r1 - r2 = d \sin \Theta$
si $y << L$, $\sin \Theta = y / L$

entonces quando:

$d \sin \Theta = m \lambda$ $(m = \pm 1, \pm 2, \pm 3...)$
interferencia constructiva

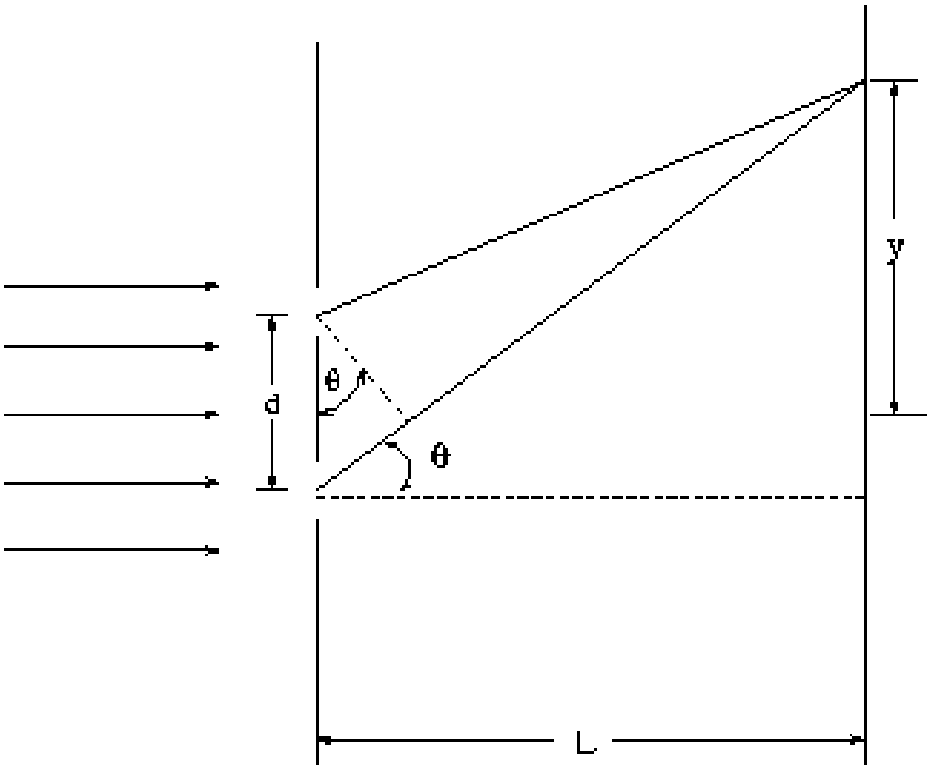
$y = (m \lambda L) / d$ (banda brillo)

$d \sin\Theta = (m+½) \lambda$ $(m = \pm 1, \pm 2, \pm 3...)$
interferencia destructiva

$y = (m +½) \lambda L / d$ (bando oscuro)

distancia entre bandos brillos (o oscuros)

$\Delta y = \lambda L / d$

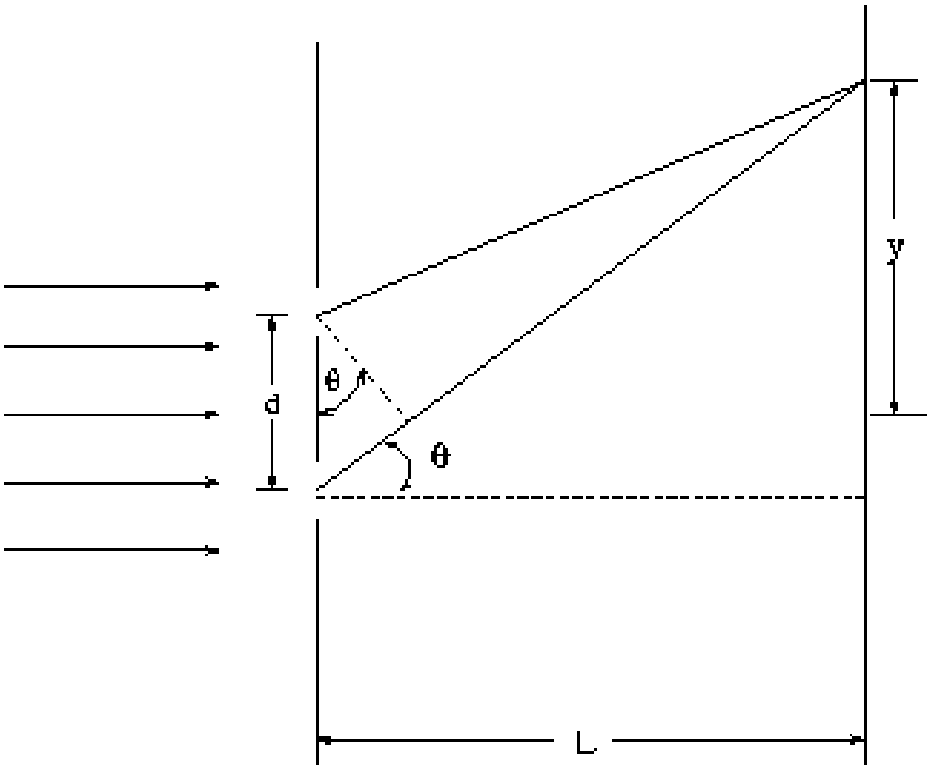


Ver JAVA applet sobre Interferencia.

Imagen en la pantalla es una componente del Transform Fourier del Fuente

slits -> telescopios (radio o optico)

pantalla -> correlador
- optico : light delay (espejos)
  - direct interference
  - fringe image
  - medir
- radio : delay (cables/fibros)
  - correlador
  - medir amplitude y fase



Various ejemplos:
- fuentes puntuales o extendido
- posicion del fuente y fase
- "d" pequena o grande

Necisitamos various "d"'s
--> Earth Rotation Synthesis

recordar: $\Delta y = \lambda L / d$
No ocupamos "L" in radio interferometria
facil si "d" es in unidades de λ
-->> el plano *uv*