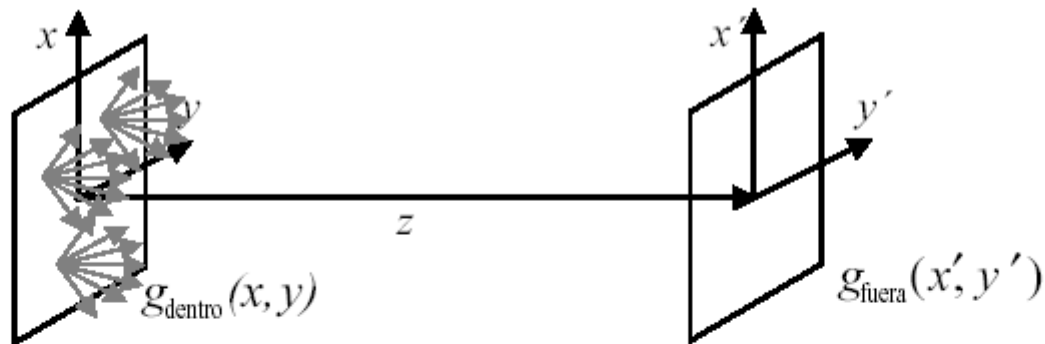
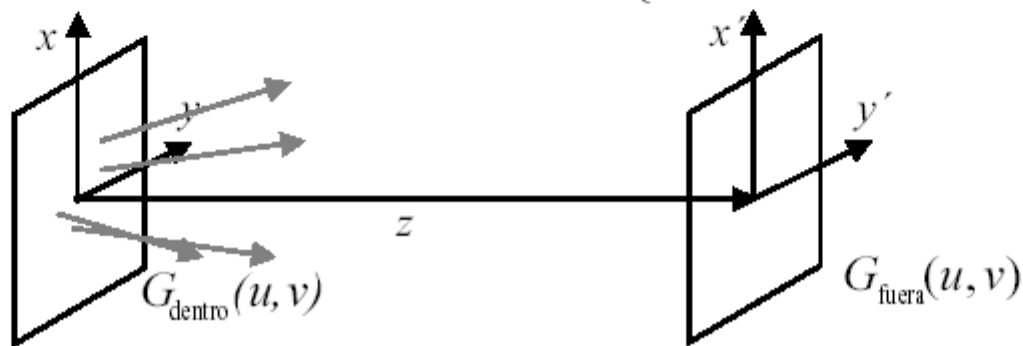


## Fórmulas de la difracción de Fresnel

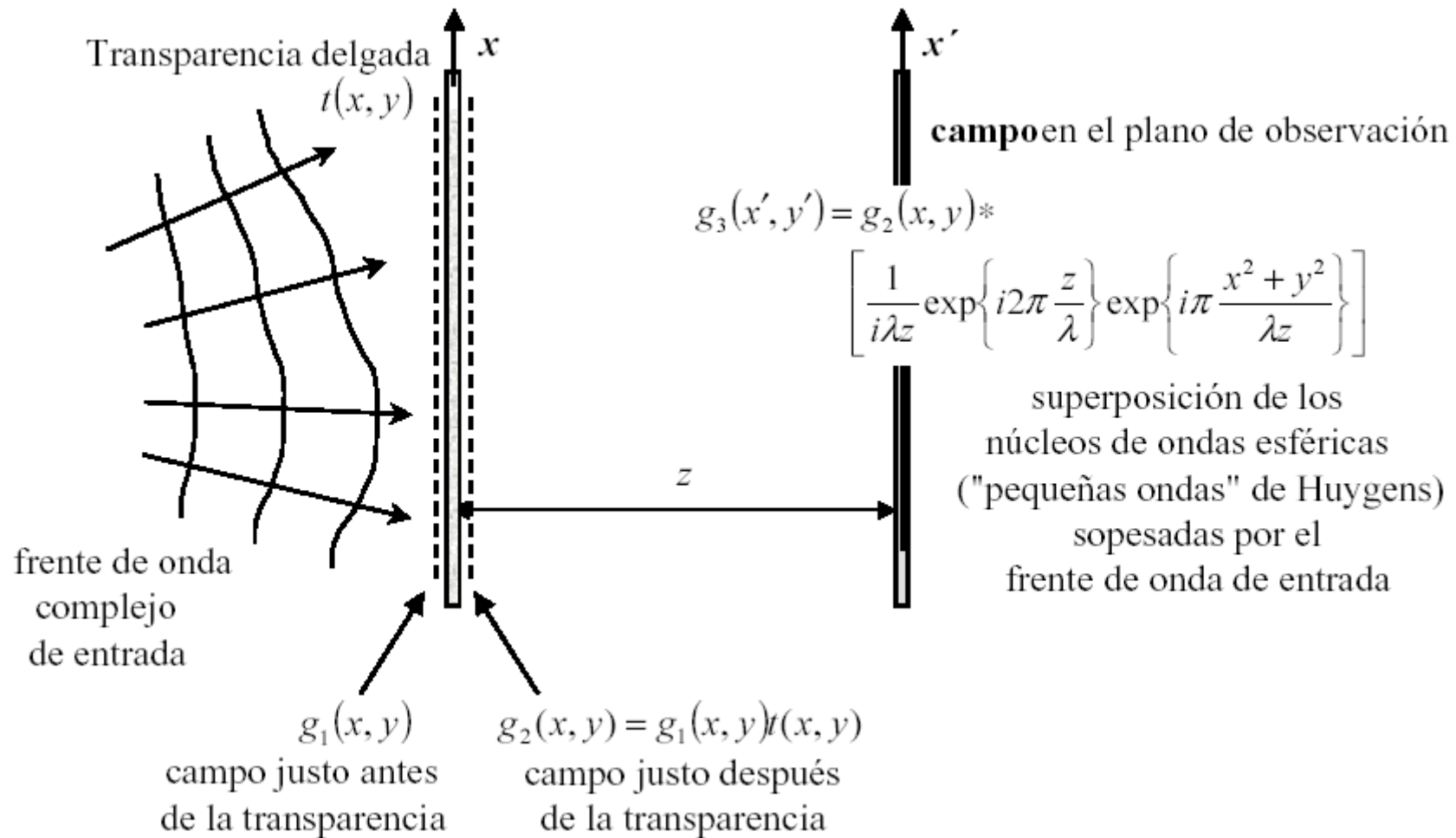


$$g_{\text{fuera}}(x', y'; z) = \frac{1}{i\lambda z} \exp\left\{i2\pi \frac{z}{\lambda}\right\} \int g_{\text{dentro}}(x, y) \exp\left\{i\pi \frac{(x' - x)^2 + (y' - y)^2}{\lambda z}\right\} dx dy$$

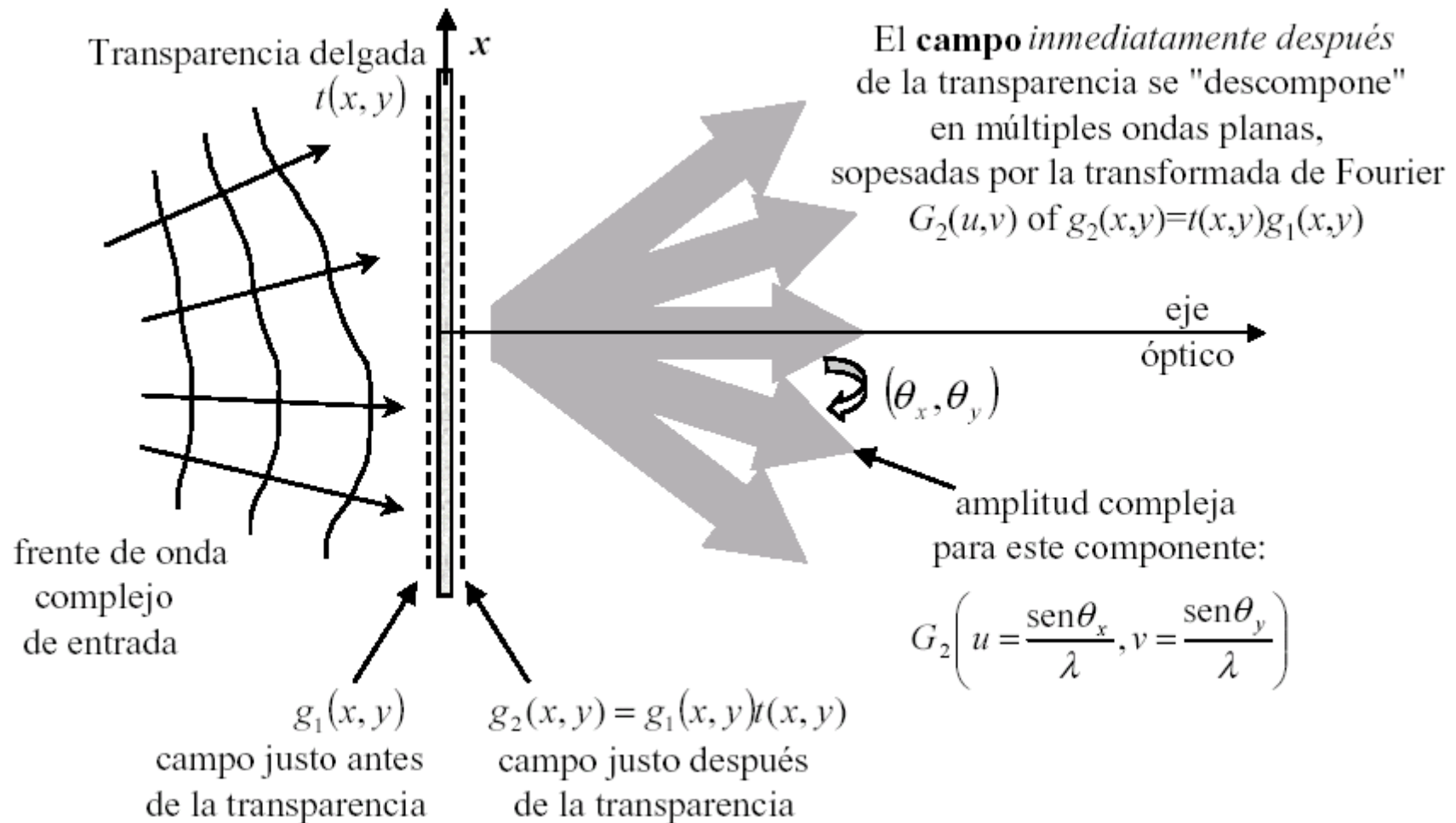


$$G_{\text{fuera}}(u, v; z) = \exp\left\{i2\pi \frac{z}{\lambda}\right\} G_{\text{dentro}}(u, v) \exp\left\{-i\pi\lambda z(u^2 + v^2)\right\}$$

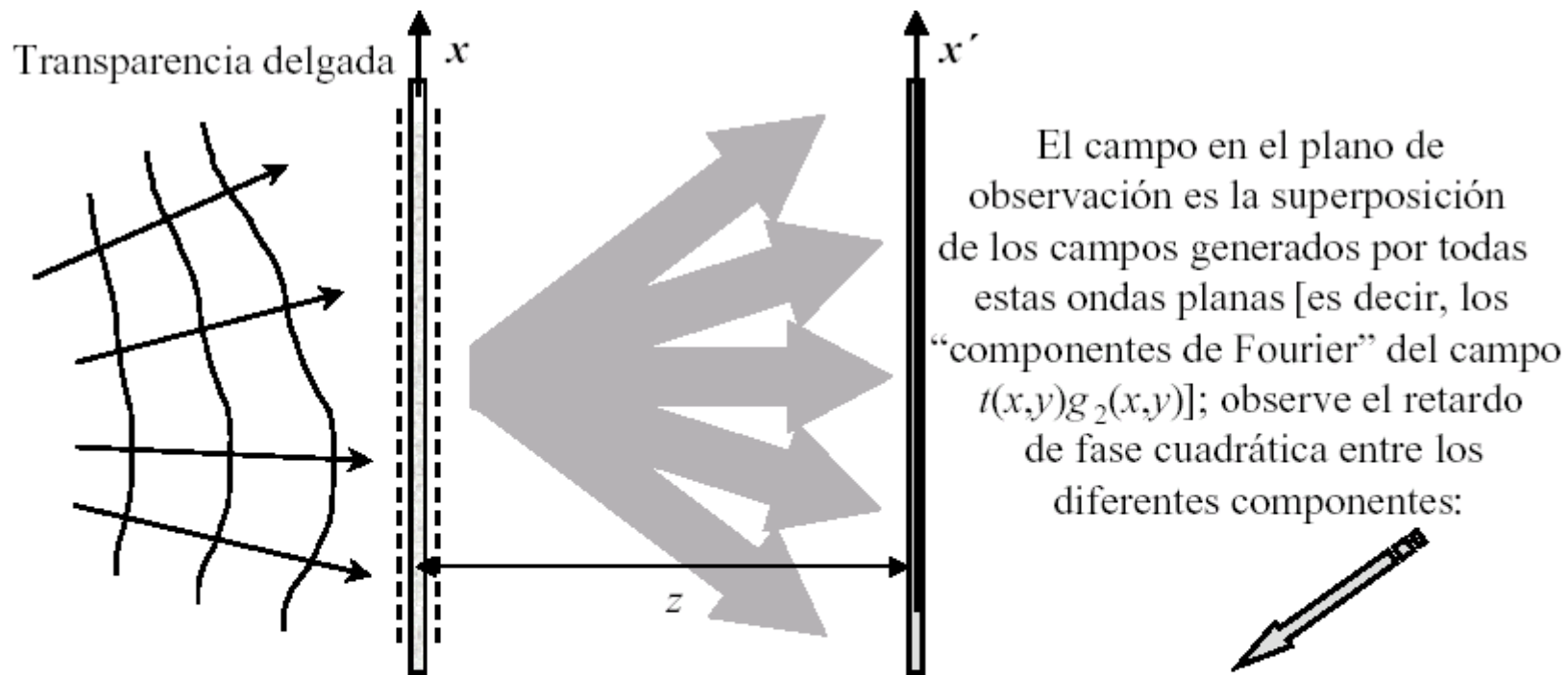
# Propagación de Fresnel: imagen de Huygens



# Propagación de Fresnel: imagen de Fourier



# Propagación de Fresnel: imagen de Fourier

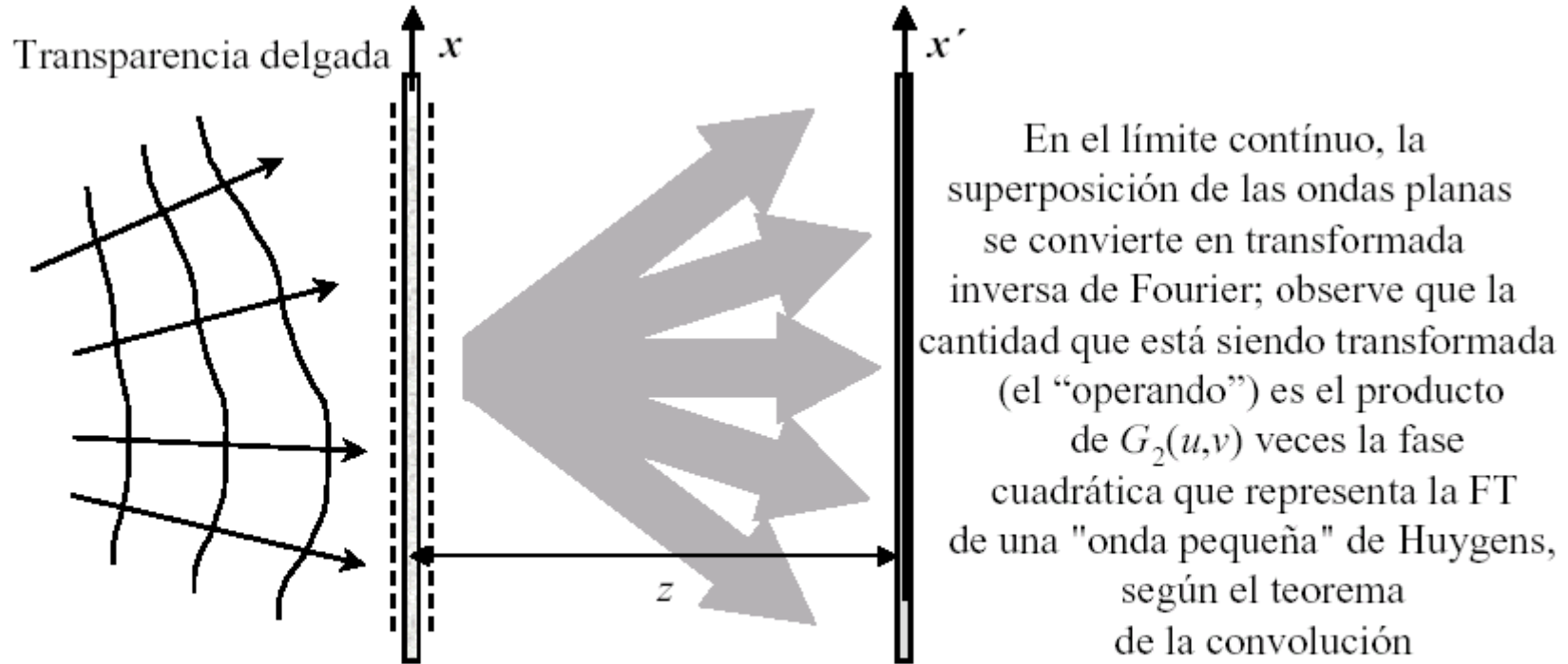


$$g_3(x', y') = G_2(u_1, v_1) \exp \left\{ i2\pi(u_1 x' + v_1 y') + i2\pi \left( 1 - \frac{\lambda^2 (u_1^2 + v_1^2)}{2} \right) \frac{z}{\lambda} \right\} +$$

$$G_2(u_2, v_2) \exp \left\{ i2\pi(u_2 x' + v_2 y') + i2\pi \left( 1 - \frac{\lambda^2 (u_2^2 + v_2^2)}{2} \right) \frac{z}{\lambda} \right\} +$$

... etc.

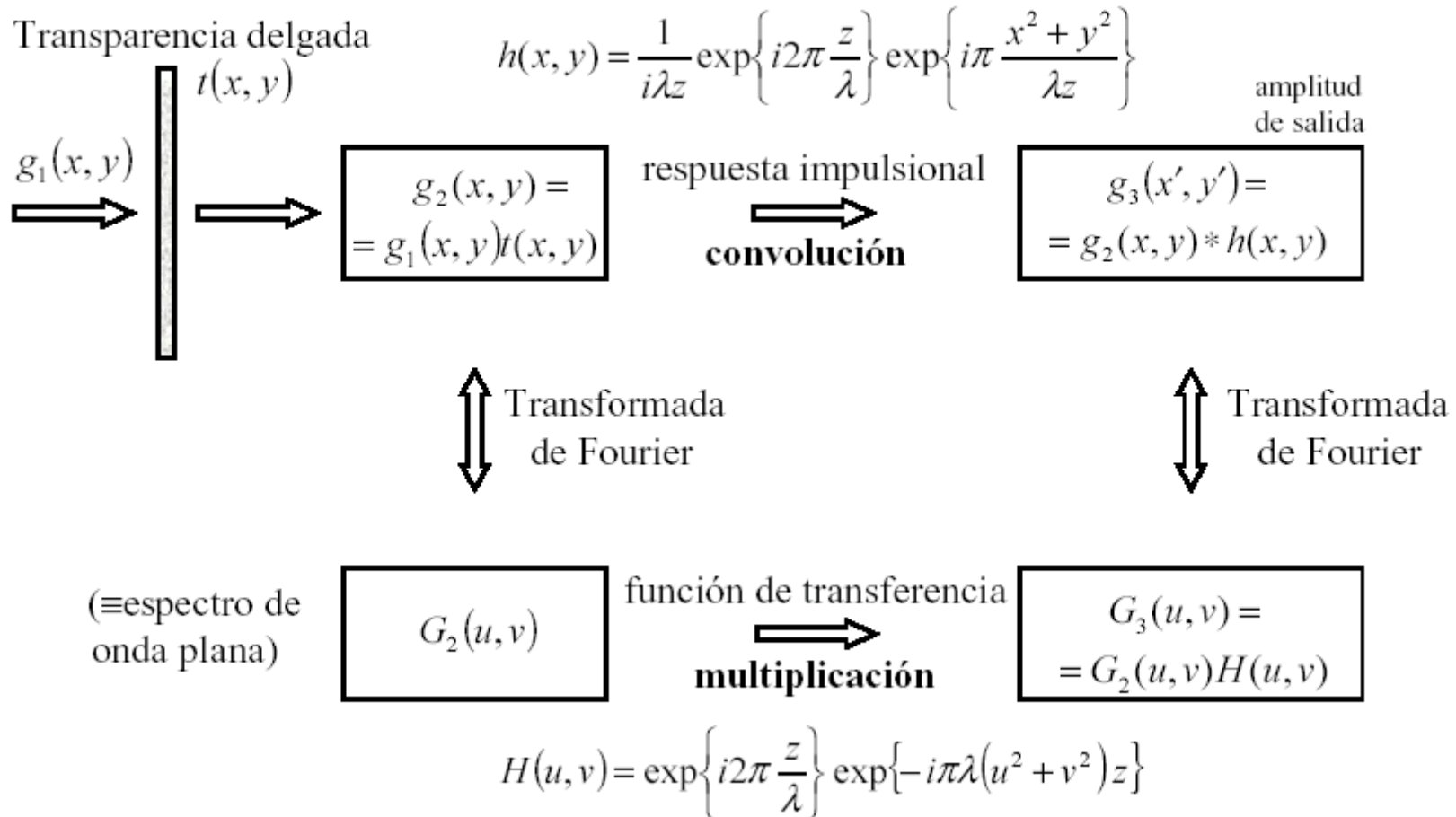
# Propagación de Fresnel: imagen de Fourier



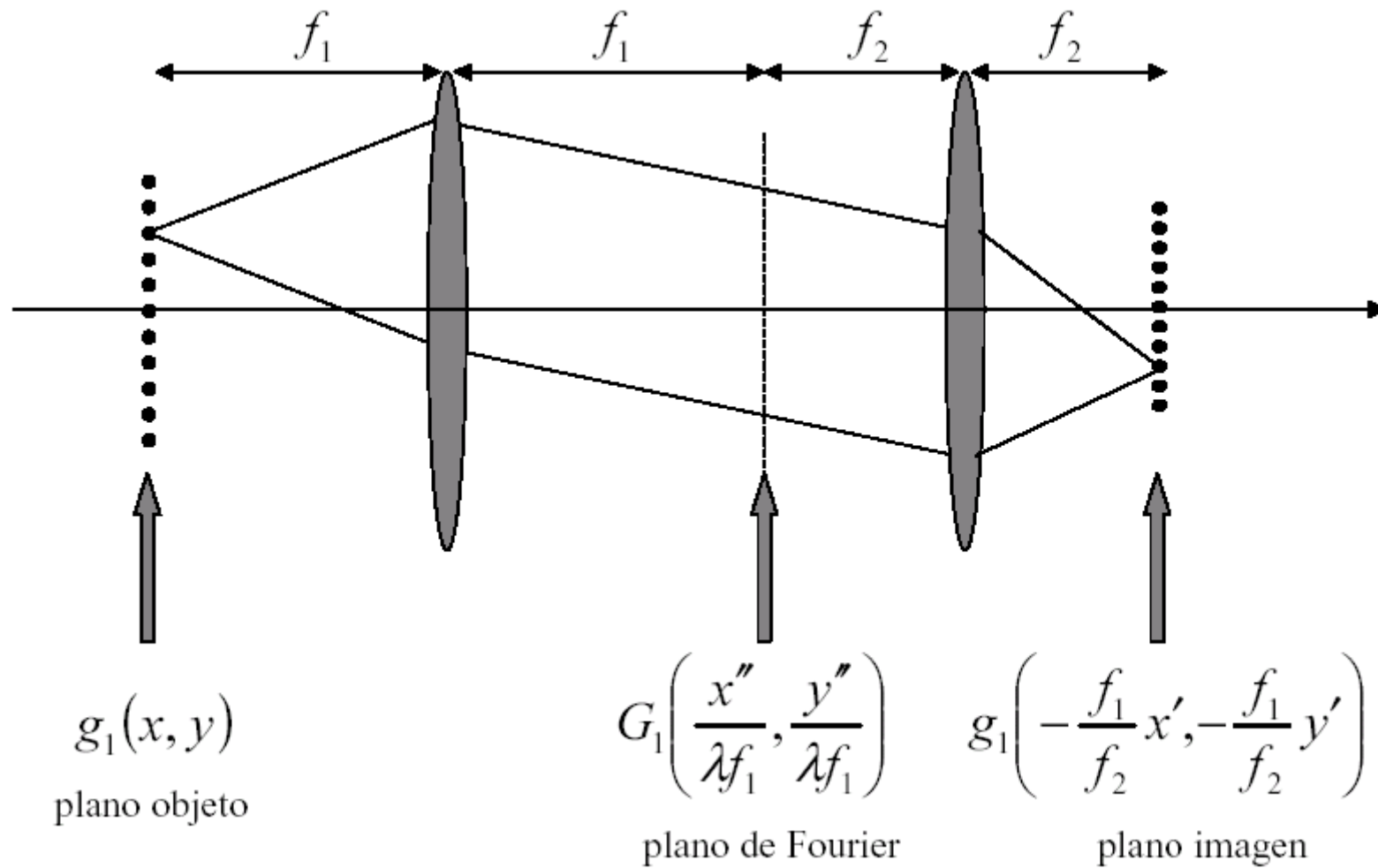
$$g_3(x', y') = \exp\left\{i2\pi \frac{z}{\lambda}\right\} \underbrace{\iint [G_2(u, v) \times \exp\{-i\pi\lambda z(u^2 + v^2)\}]}_{\text{FT de } g_2(x, y)} \underbrace{\exp\{i2\pi(ux' + vy')\}}_{\text{núcleo de la FT inversa}} du dv$$

FT de  $\exp\left\{i\pi \frac{x^2 + y^2}{\lambda z}\right\}$

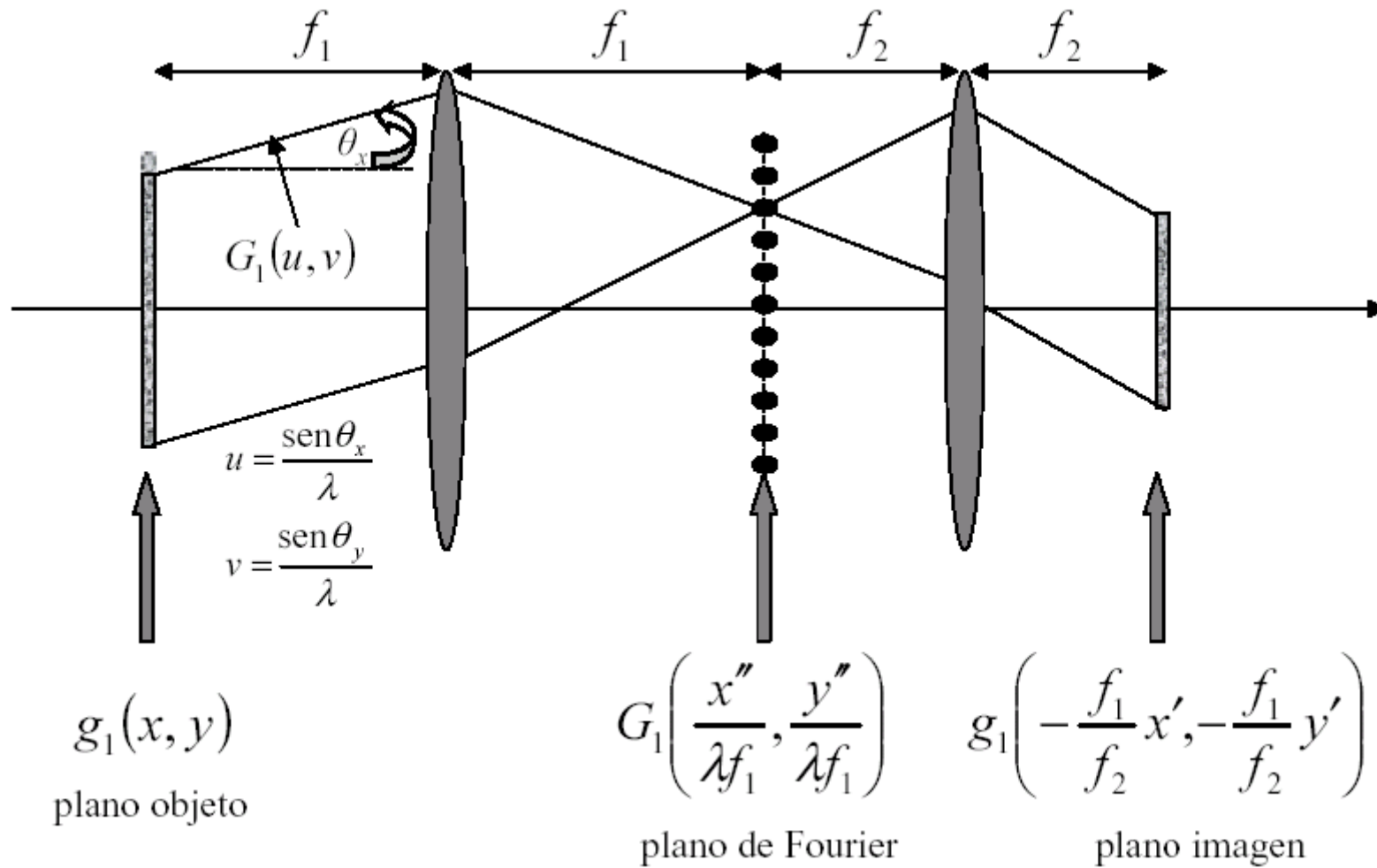
# La difracción de Fresnel como sistema lineal invariante a desplazamientos



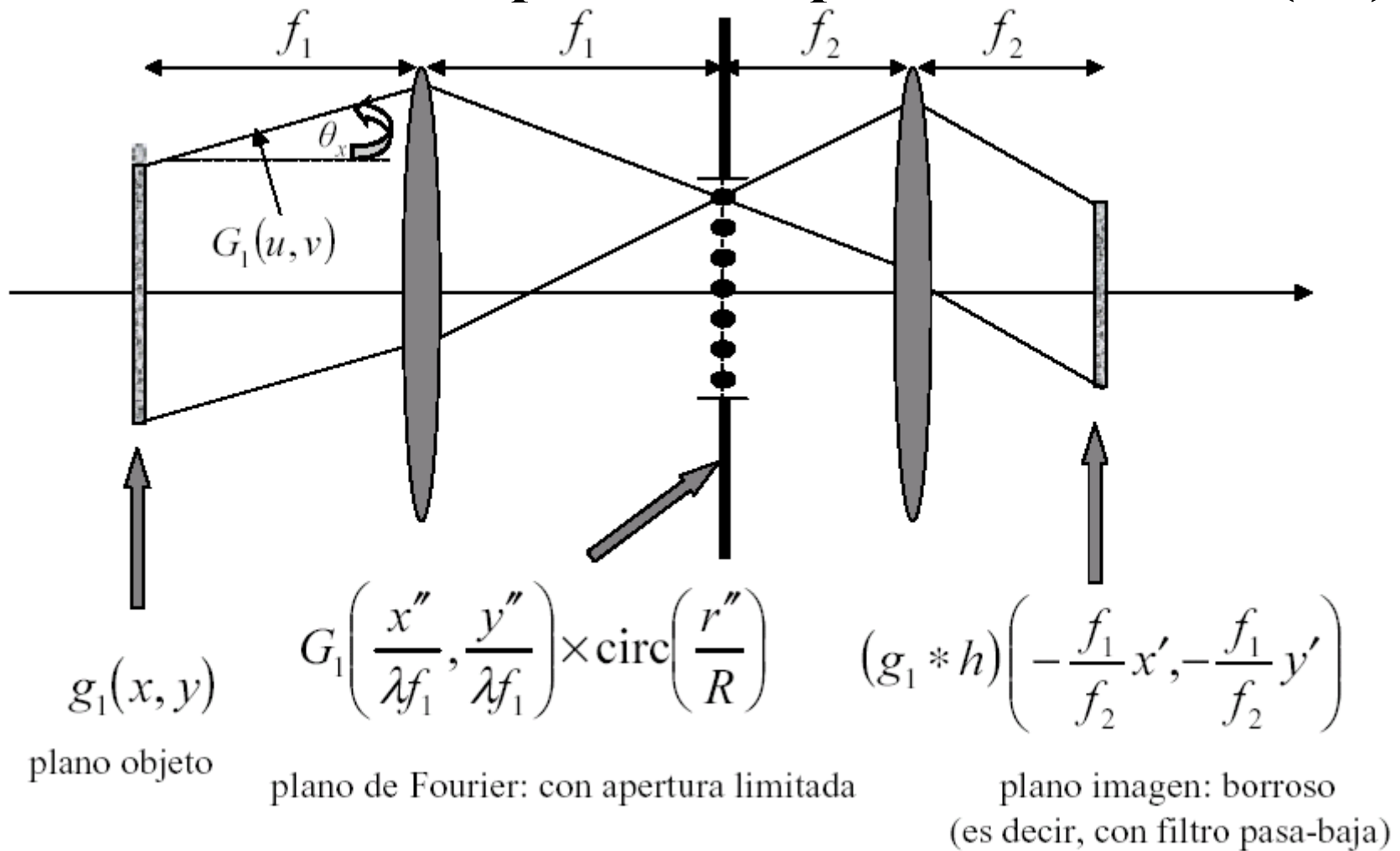
## El sistema 4F



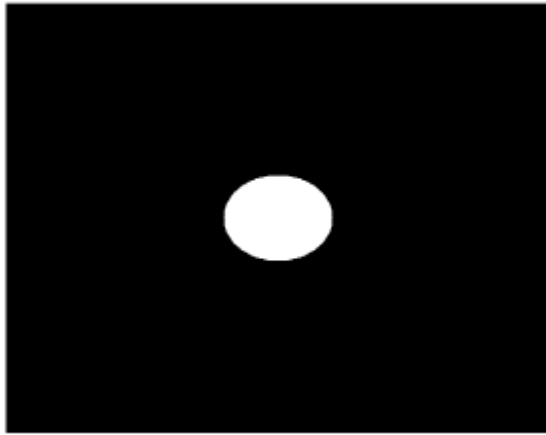
## El sistema 4F



# El sistema 4F con apertura de plano de Fourier (FP)

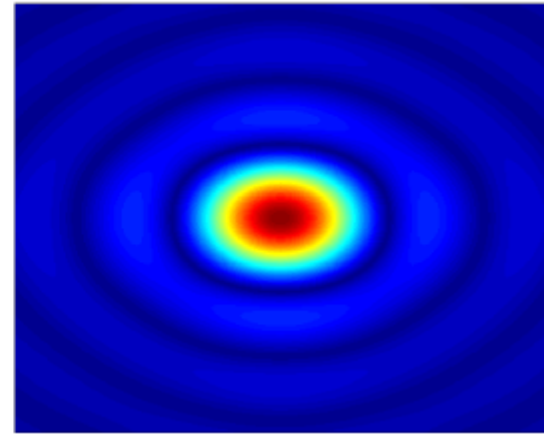


# El sistema 4F con apertura FP



Función de transferencia:  
apertura circular

$$\text{circ}\left(\frac{r''}{R}\right)$$



Respuesta impulsional:  
disco de Airy

$$\text{sinc}\left(\frac{r'R}{\lambda f_2}\right)$$