Copyright statement

- The images and the pictures in this lecture are provided by the CDs accompanied by the books

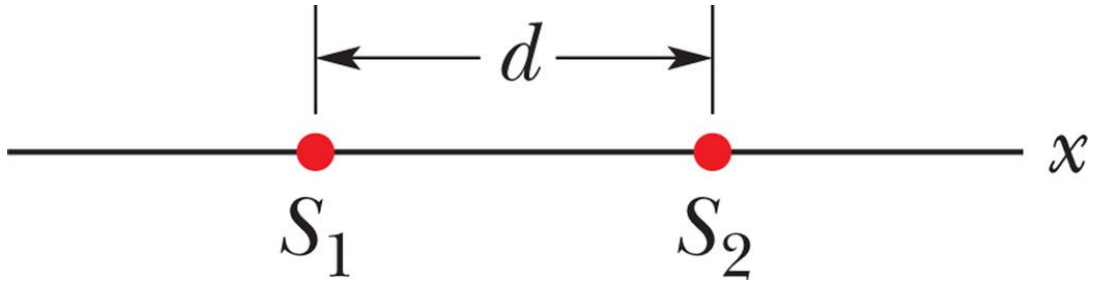
  1. University Physics, Bauer and Westfall, McGraw-Hill, 2011.
  2. Principles of Physics, Halliday, Resnick, and Walker, Wiley, 8th and 9th Ed.

- The rest is made by me.

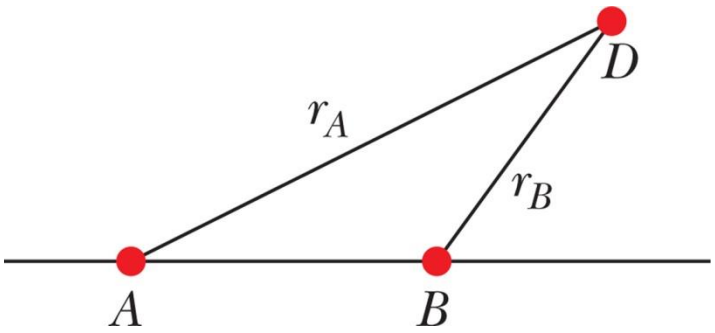
Problem

$d = 2.0\text{m},\ \lambda = 0.50\text{m}$

# of maxima around a big loop



Problem



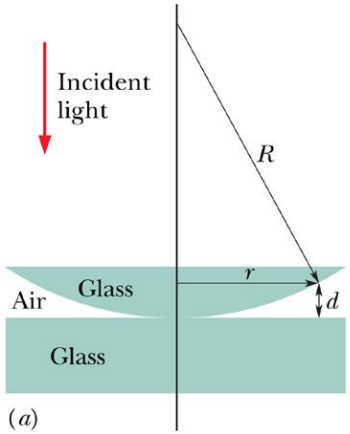
$\lambda = 400\ \mathrm{m}$

A가 B보다 90도 앞선다.

$r_A - r_B = 100\ \mathrm{m}$

D에서 파동의 위상차는?

Newton 고리

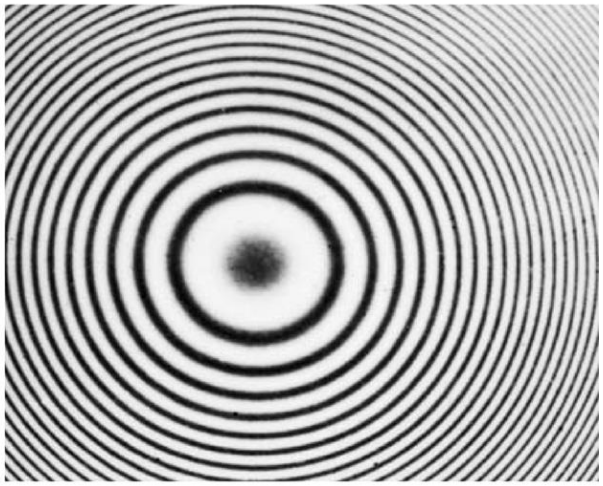


$$\lambda = 546 \text{ nm}$$

$$n : 0.162 \text{ cm}$$

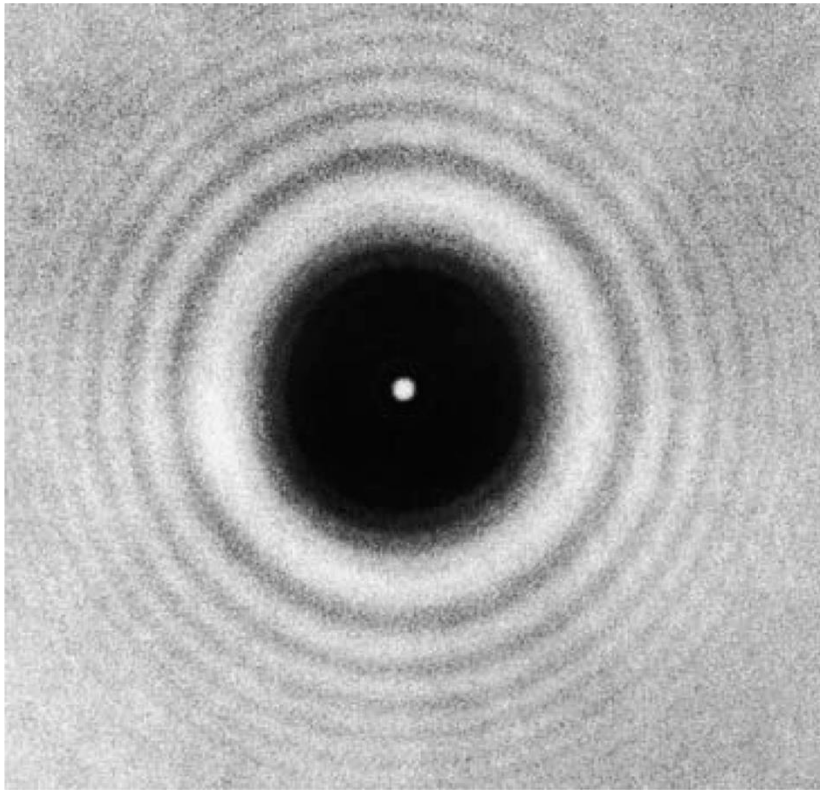
$$(n + 20) : 0.368 \text{ cm}$$

렌즈의 반지름은?

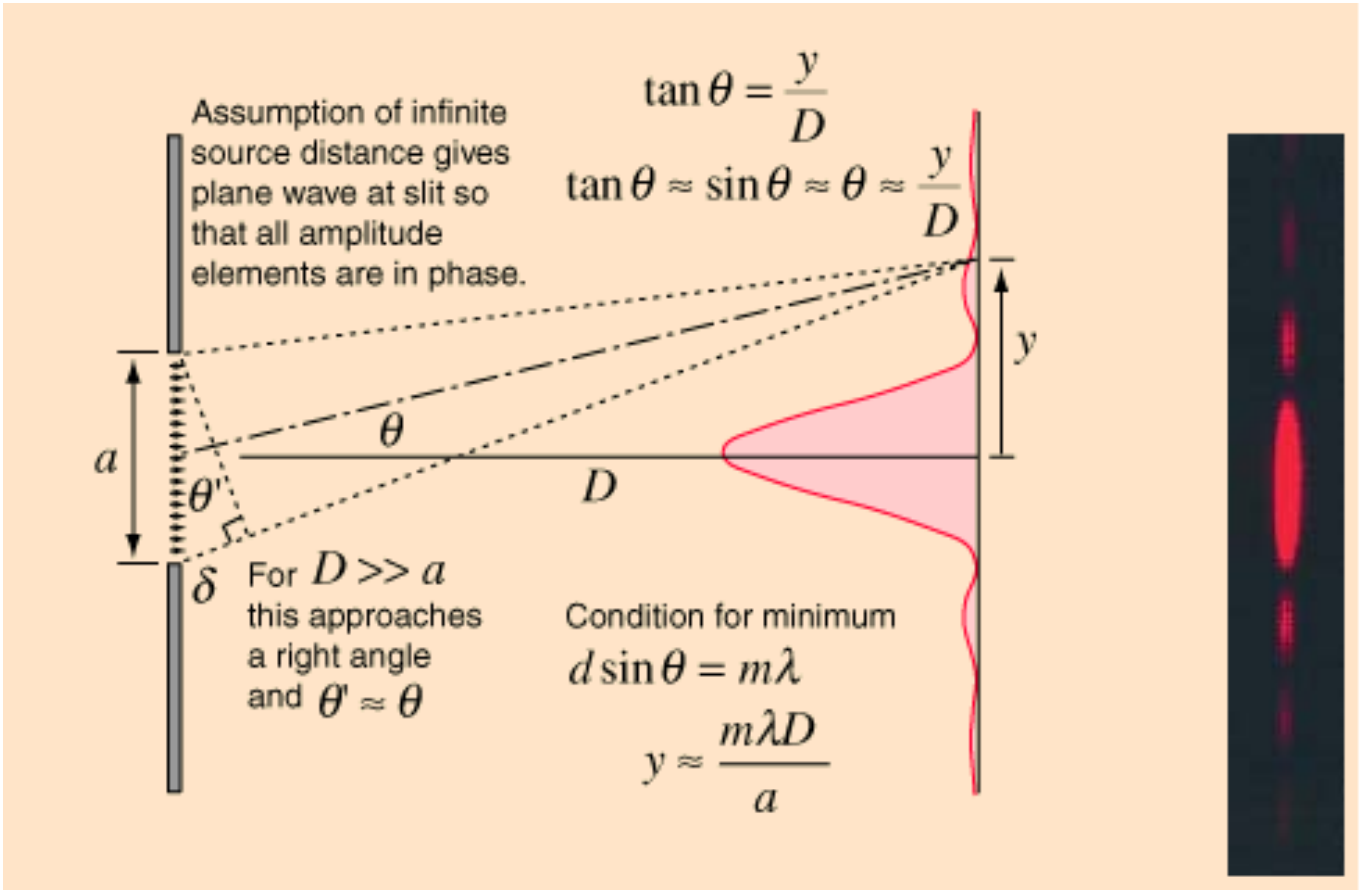


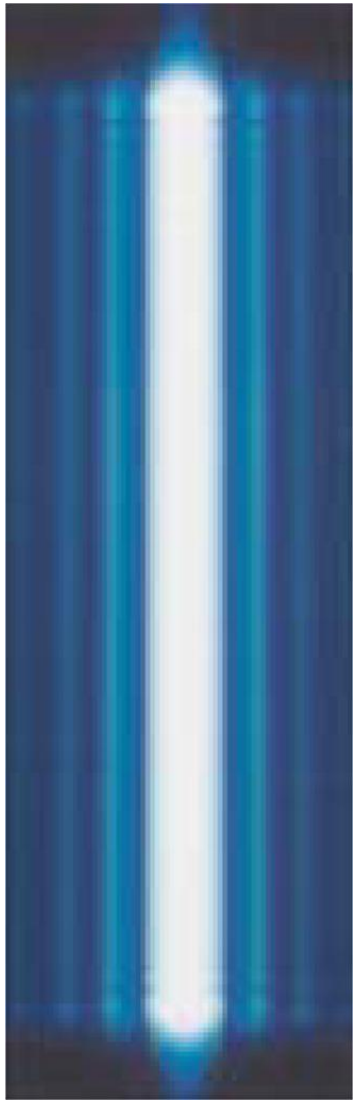
Fresnel의 밝은 점

기하광학적 상황

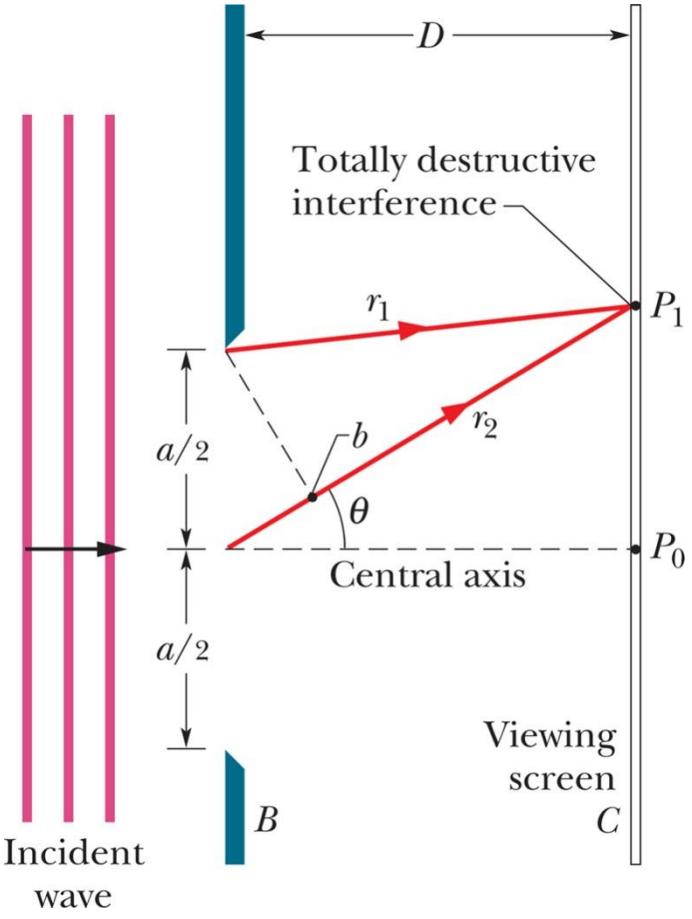


single slit diffraction

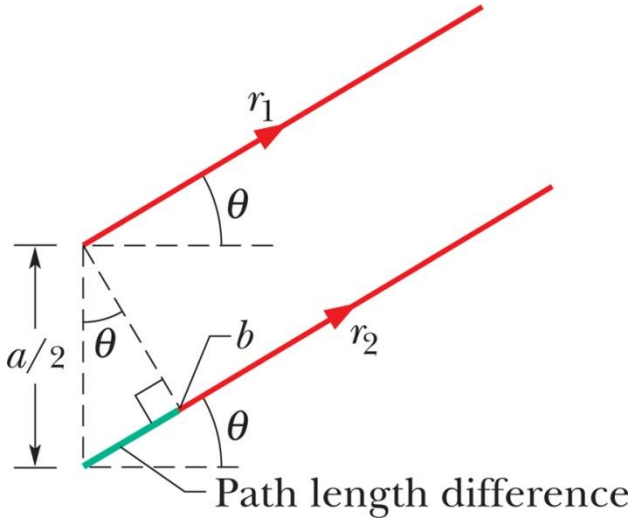




Single slit diffraction



First dark spot

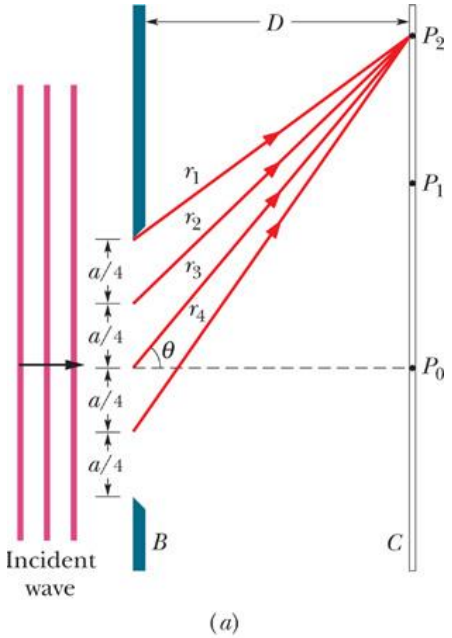


Brightest spot

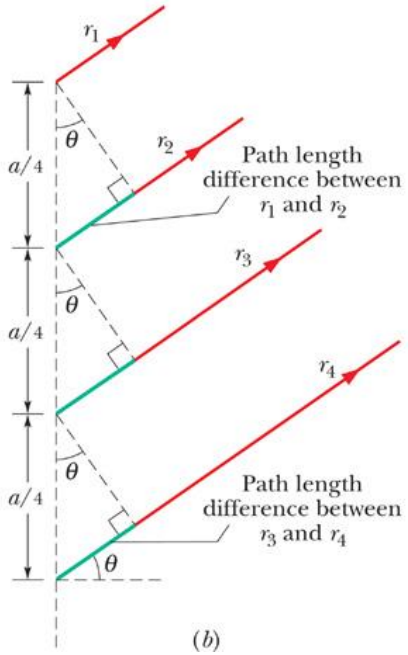
$$\frac{a}{2}\sin\theta = \frac{\lambda}{2}$$

First extremum

$$a\sin\theta = \lambda$$



(a)



(b)

Position of the 2nd extremum

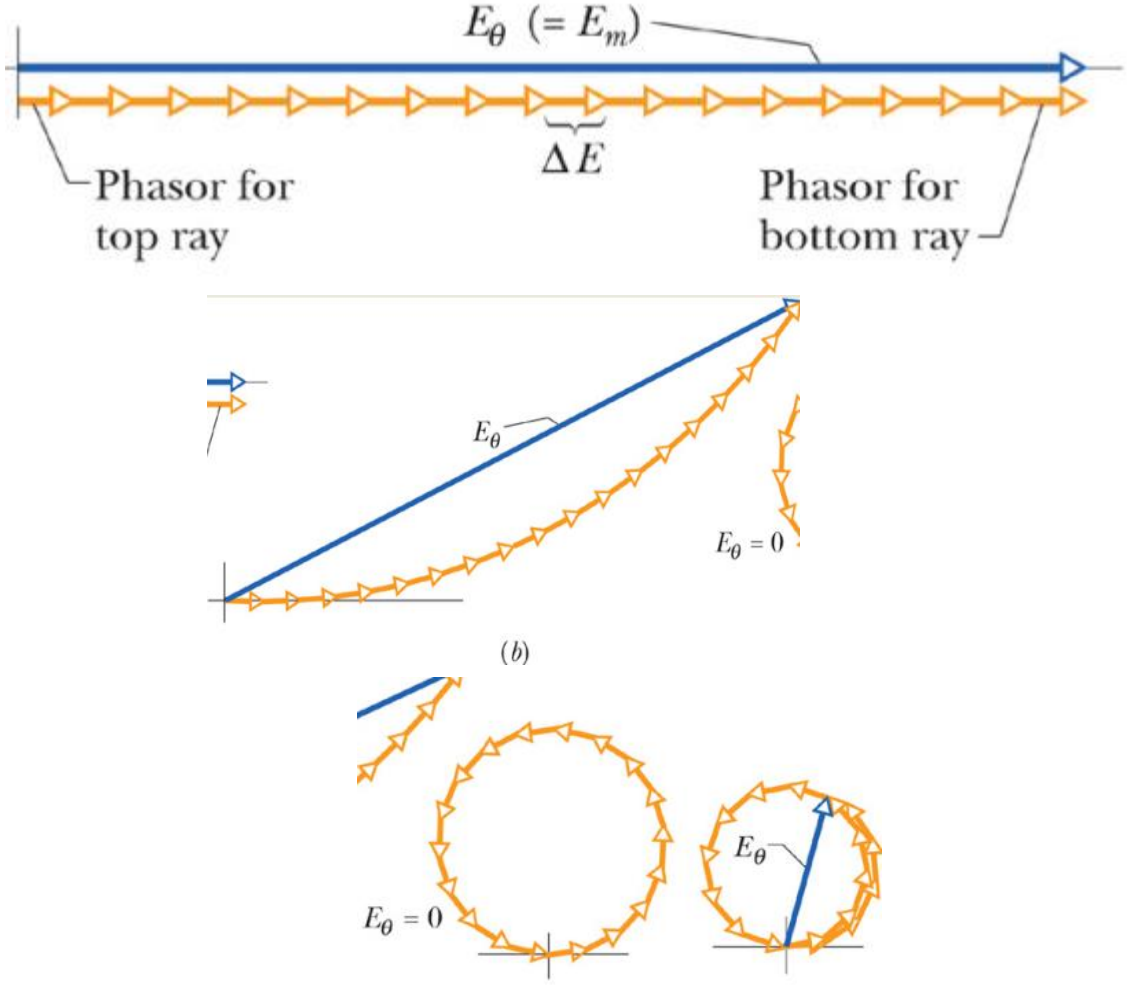
$$\frac{a}{4}\sin\theta = \frac{\lambda}{2} \quad \rightarrow \quad a\sin\theta = 2\lambda$$

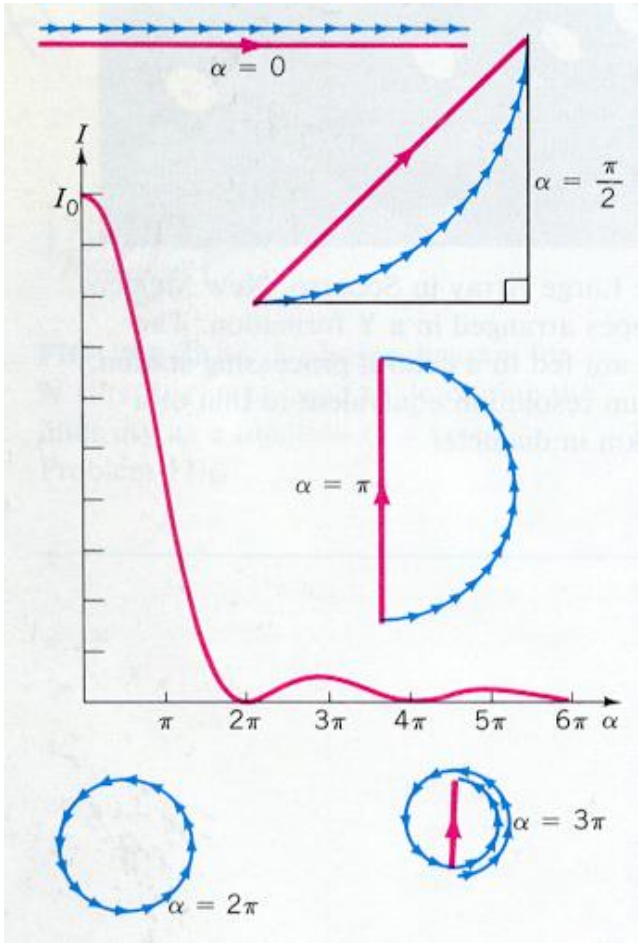
In general, the m-th extrema are

$$a\sin\theta = m\lambda \ (m = 1, 2, 3, \cdots)$$

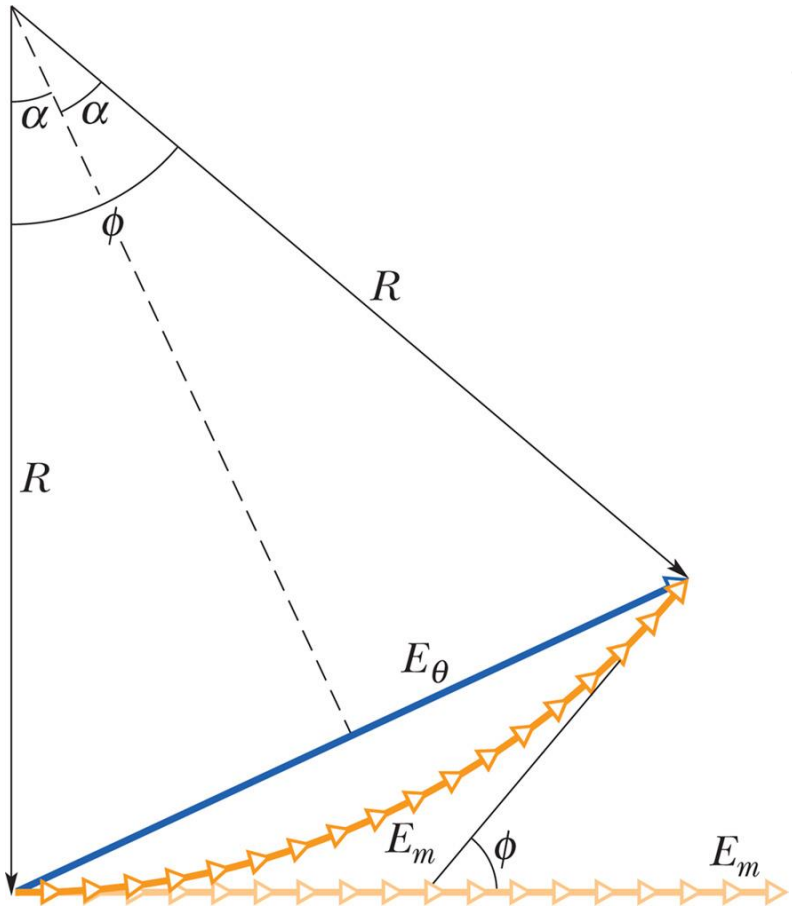
Do we trust this method?

Intensity of single slit diffraction





Quantitative analysis



$$\text{위상차} = \frac{2\pi}{\lambda}(\text{경로차}) \longrightarrow \Delta\phi = \frac{2\pi}{\lambda}\Delta x \sin\theta$$

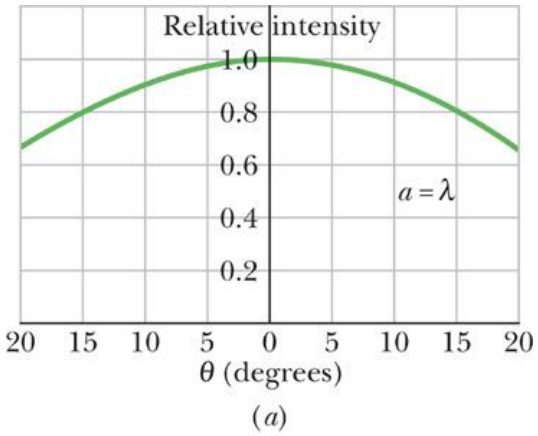
$$\sin\frac{\phi}{2} = \frac{E_\theta}{2R}, \quad \phi = \frac{E_m}{R}$$

$$\longrightarrow E_\theta = \frac{E_m}{\phi/2}\sin\frac{\phi}{2}$$

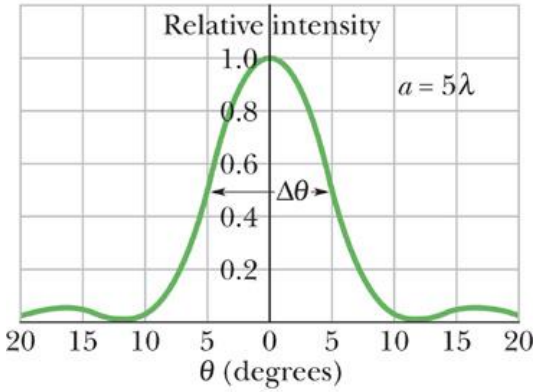
$$\frac{I(\theta)}{I_m} = \frac{E_\theta^2}{E_m^2} \longrightarrow I(\theta) = I_m\Big(\frac{\sin\alpha}{\alpha}\Big)^2, \quad (\alpha = \phi/2)$$

$$\phi = \frac{2\pi}{\lambda}a\sin\theta$$

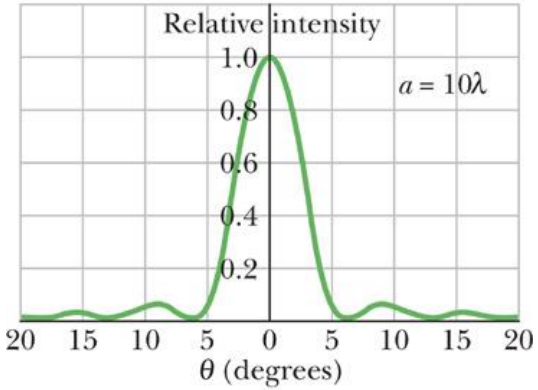
Intensity of single slit diffraction



(a)



(b)



(c)

$$I = I_m \left(\frac{\sin \alpha}{\alpha} \right)^2$$

$$\alpha = \frac{\pi a}{\lambda} \sin \theta$$

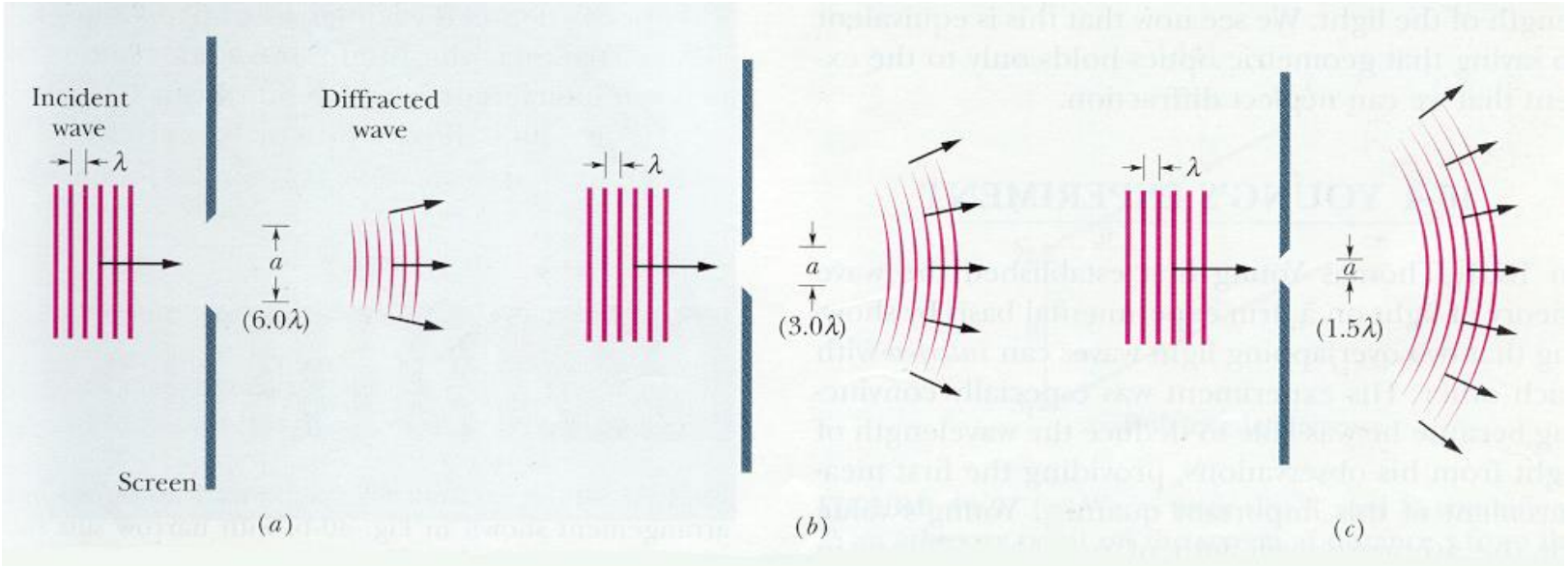
극소점의 위치

$$\alpha = \frac{\pi a}{\lambda} \sin \theta = m\pi$$

$$a \sin \theta = m\pi$$

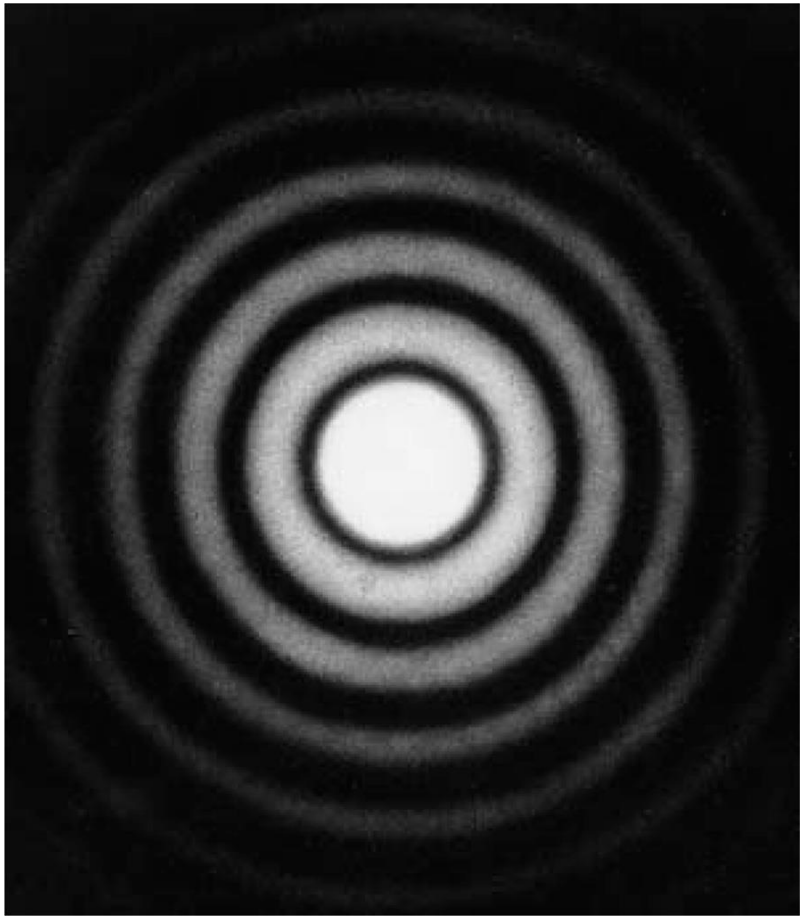
극대점의 위치: 대략 $a \sin \theta = (m + 1/2)\pi$
정확하게는 $dI/d\alpha = 0$ 으로부터 구한다.

Single slit diffraction

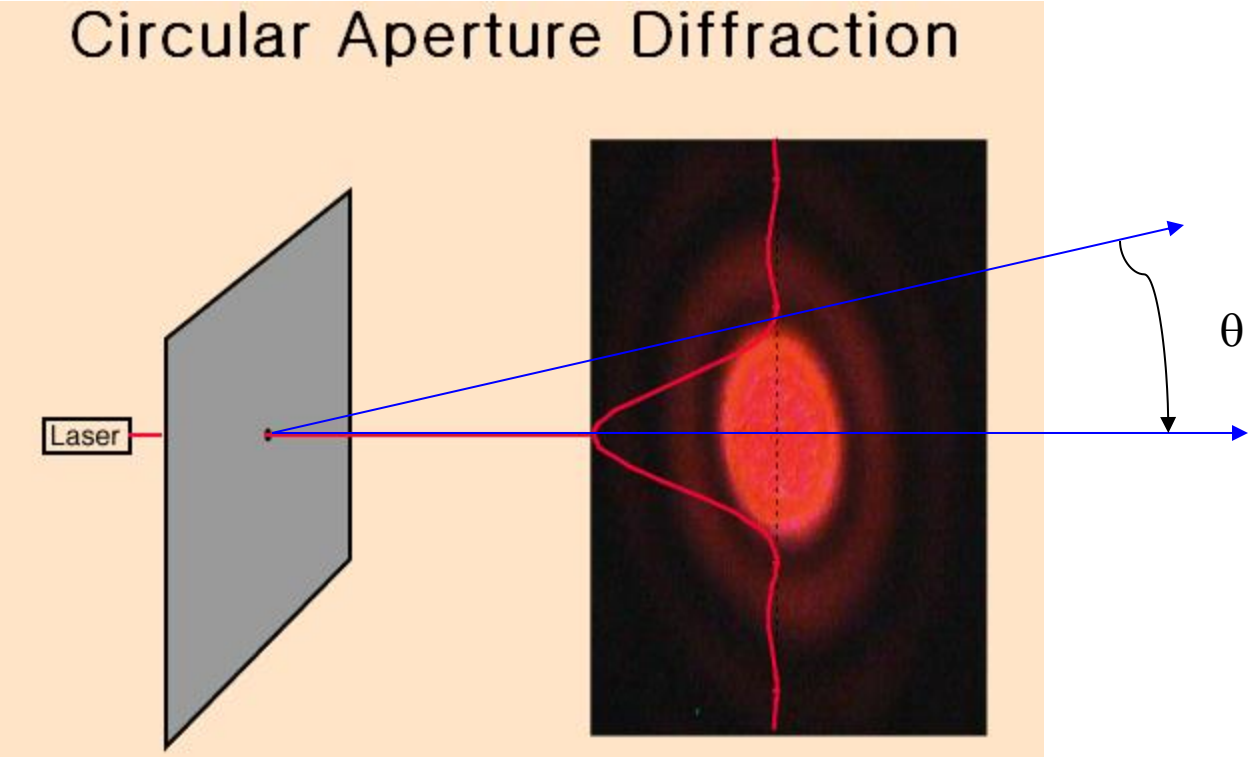


$$a \sin\theta = \lambda$$

Diffraction by a circular opening



Diffraction by a circular aperture

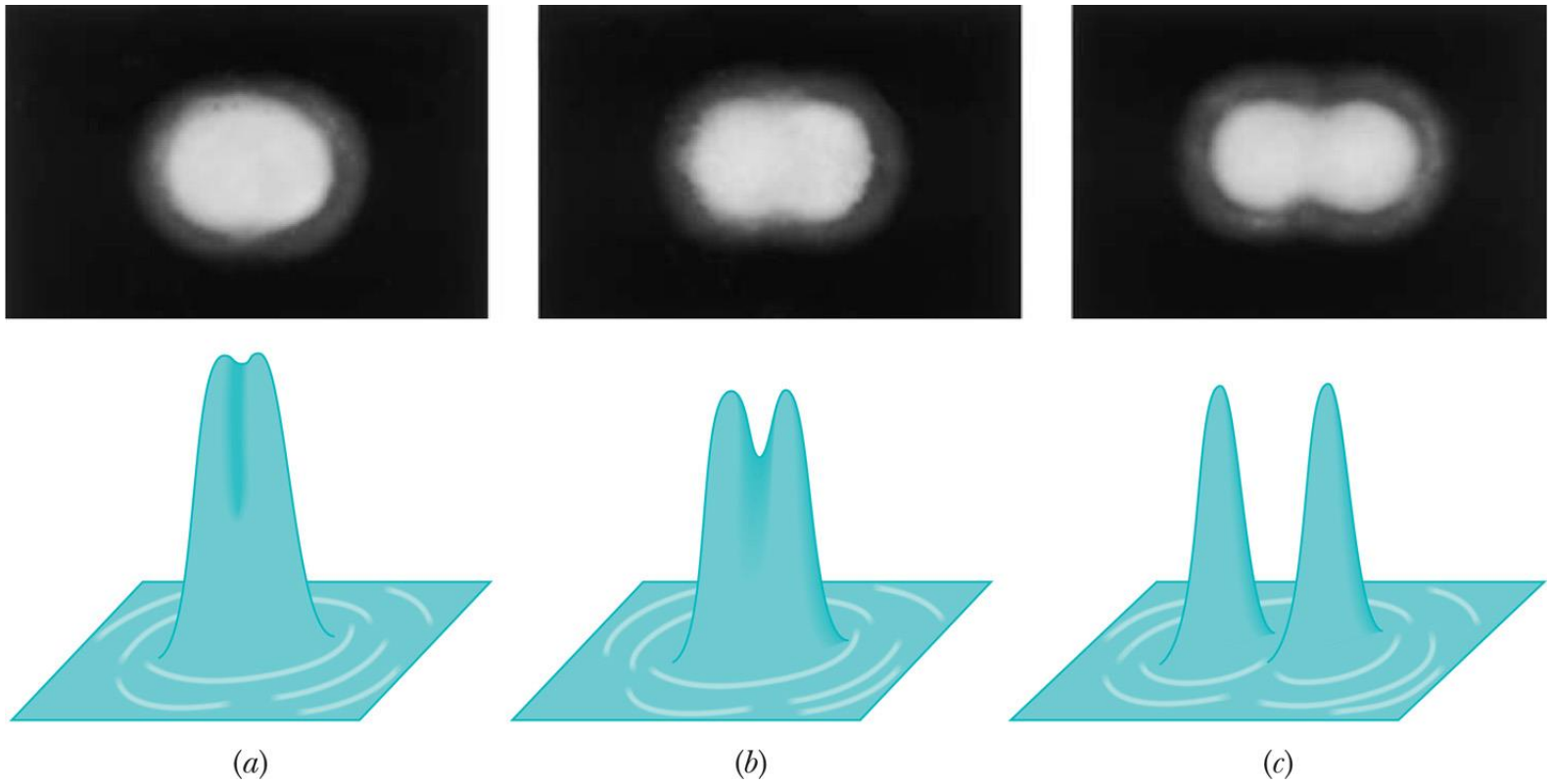


First minimum $\sin\theta = 1.22\dfrac{\lambda}{d}$

N.B. first minimum of single slit

$$\sin\theta = \frac{\lambda}{a}$$

Rayleigh's criterion for a telescope



분해능 (resolution)

$$\theta_R = \sin^{-1} \frac{1.22\lambda}{d}$$

Rayleigh's criterion: $\theta_R = 1.22\frac{\lambda}{d}$