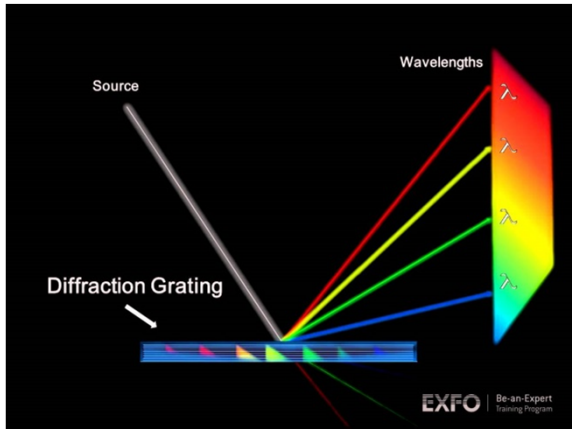
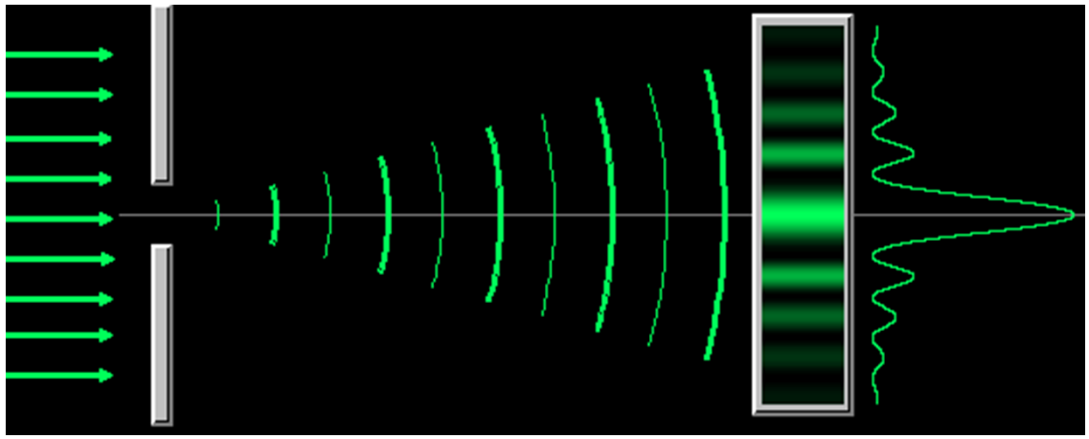
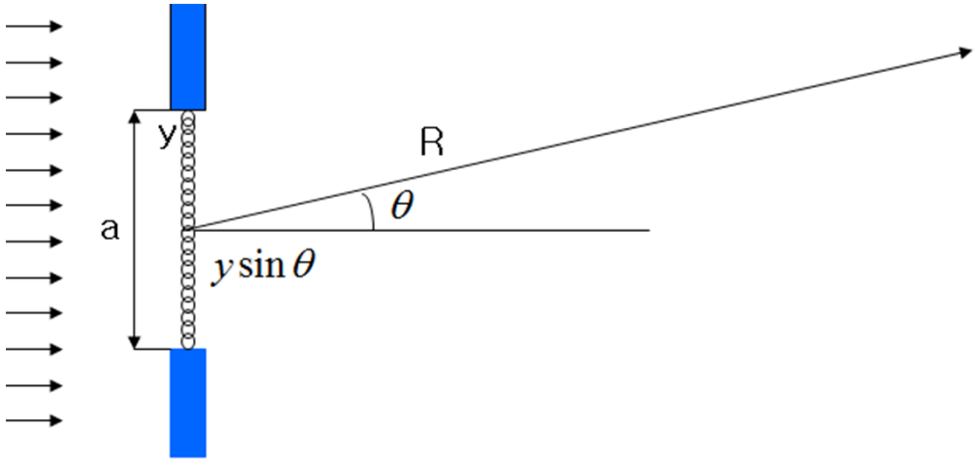
Lect. 12: Diffraction Gratings

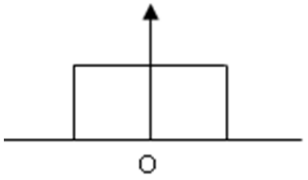


Lect. 12: Diffraction Gratings



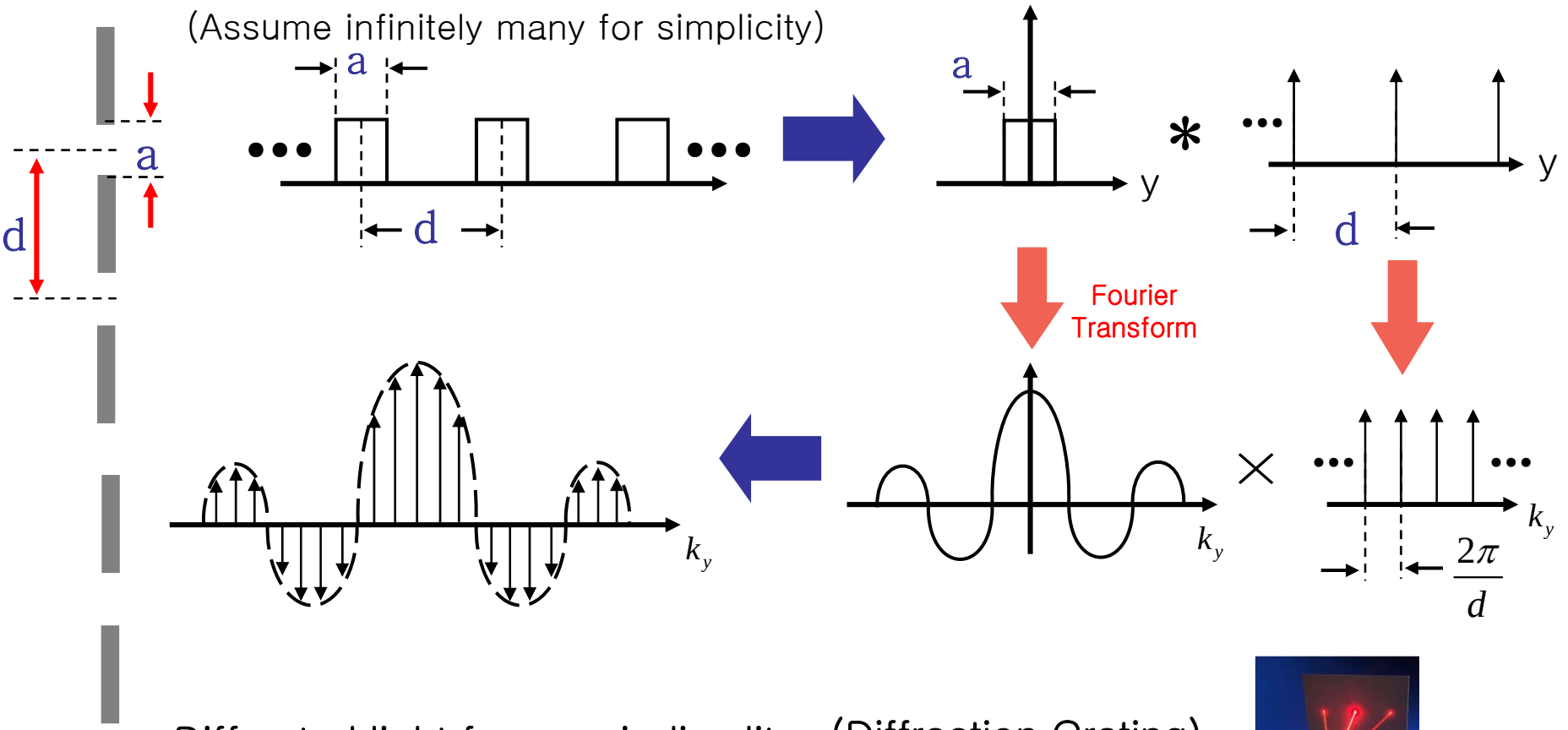


Slit shape ↔ far-field



$$\frac{\sin\left(k_y \frac{a}{2}\right)}{k_y \frac{a}{2}}$$

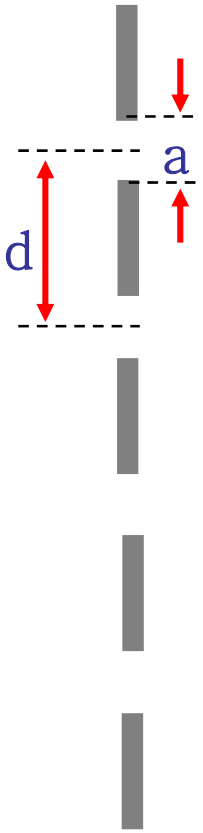
Lect. 12: Diffraction Gratings

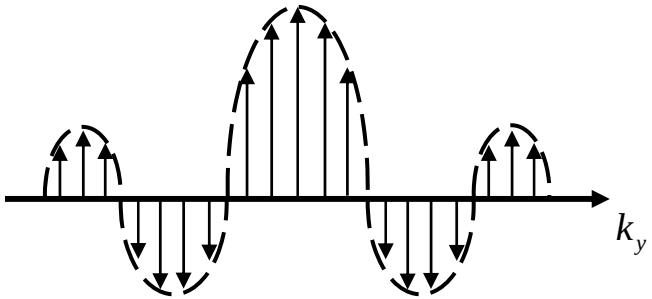


Diffracted light from periodic slits (Diffraction Grating)

==> Far-field with only discrete k_y's

Lect. 12: Diffraction Gratings





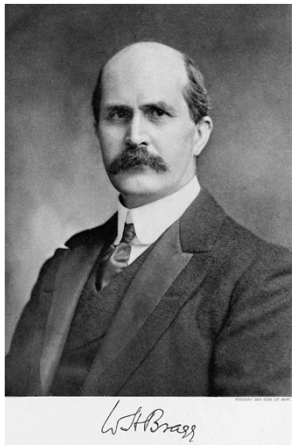
$$k_y = m\frac{2\pi}{d}$$

$$\frac{\sin\theta}{\lambda} = m \cdot \frac{1}{d}$$

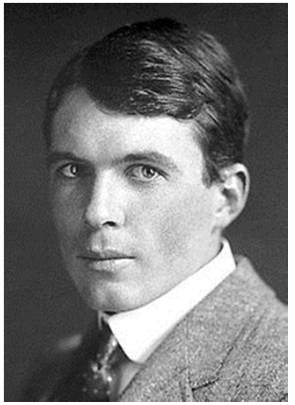
$$d\sin\theta = m\lambda$$

Grating equation

Bragg Condition



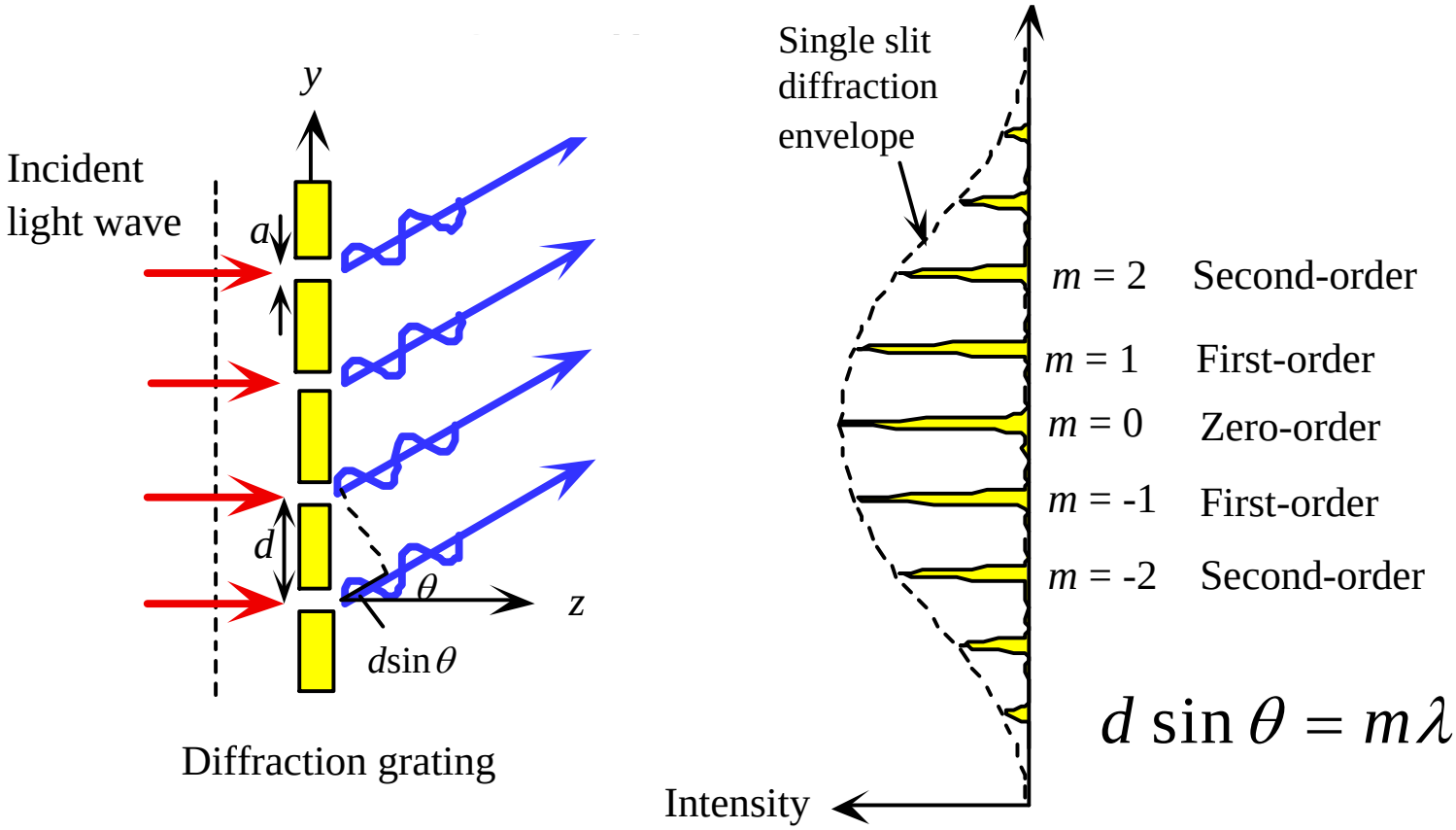
William Henry Bragg
(1862-1942)



William Lawrence Bragg
(1890-1971)

Nobel Prize in Physics (1915)

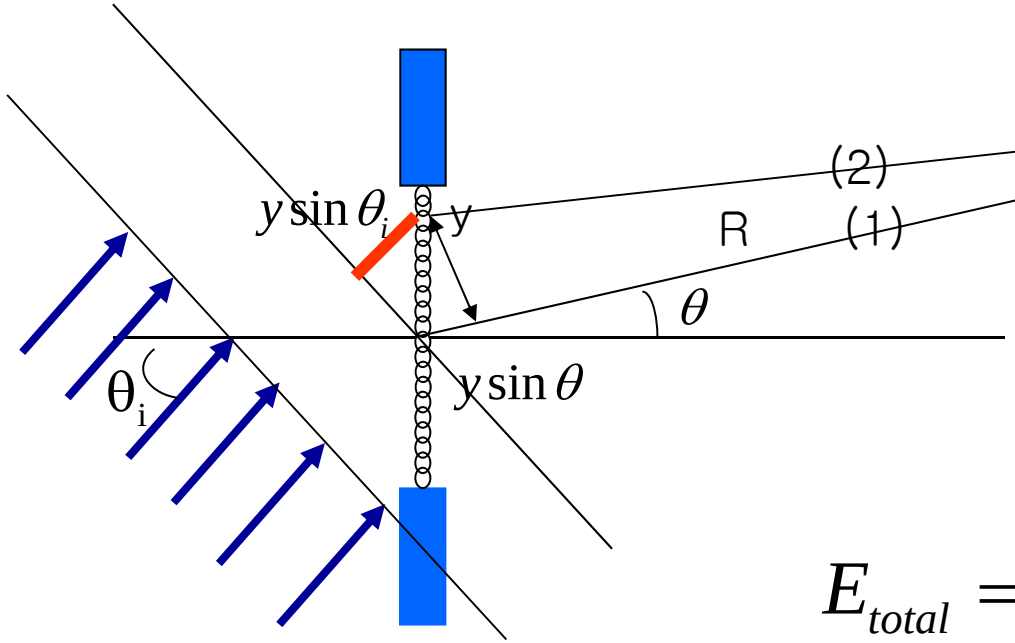
Lect. 12: Diffraction Gratings



$$d \sin\theta = m\lambda$$

Width for each diffracted beam?

Input with tilted angle

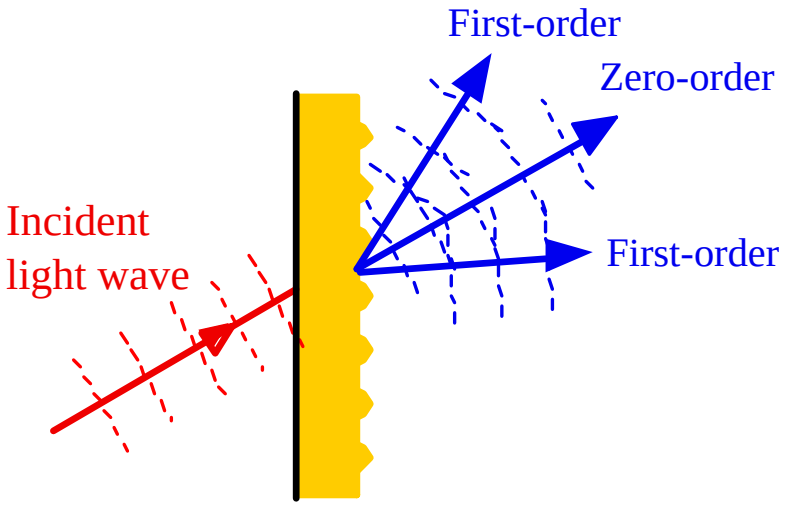


$$\frac{A}{R}e^{jky\sin\theta}$$

$$\Longrightarrow \frac{A}{R}e^{jky(\sin\theta-\sin\theta_i)}$$

$$E_{total}=\int_{-\infty}^{\infty}\frac{A}{R}e^{jky(\sin\theta-\sin\theta_i)}dy$$

Tilted incidence on grating

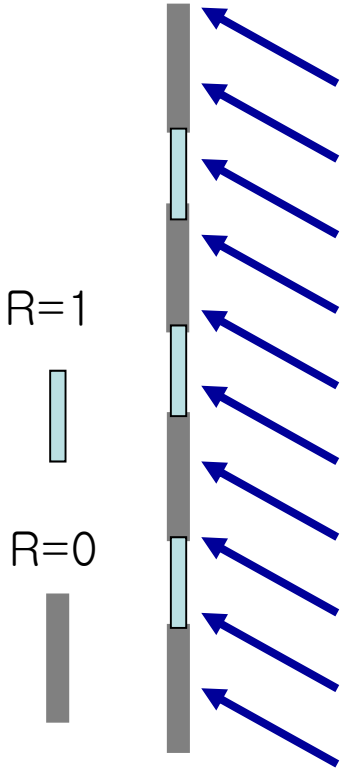


$$d \sin\theta = m\lambda$$

$$\rightarrow \quad d\left(\sin\theta - \sin\theta_i\right) = m \cdot \lambda$$

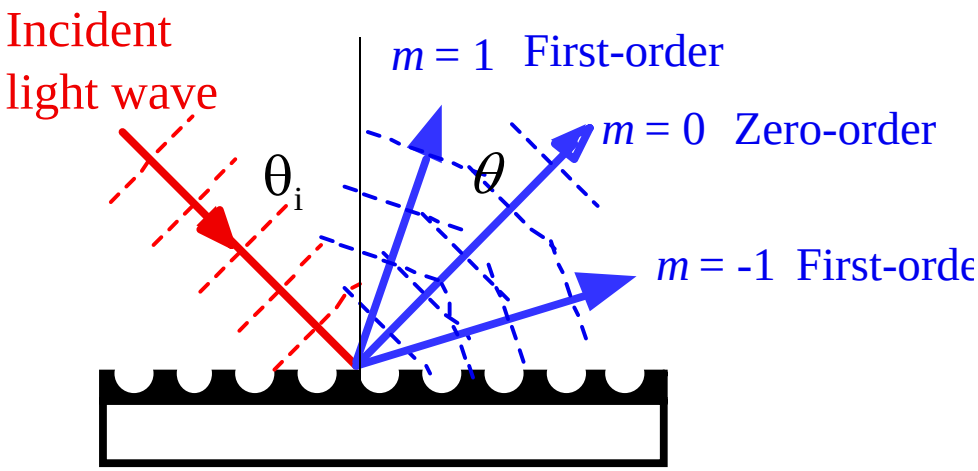
Lect. 12: Diffraction Gratings

Reflection-type grating



Same diffraction equation applies

$$d(\sin\theta - \sin\theta_i) = m \cdot \lambda$$



Reflection grating

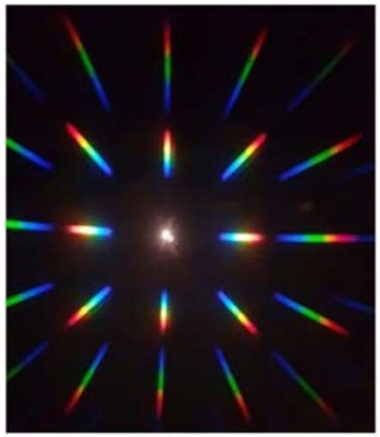
Grating can be realized as long as reflection surface is periodic

Gratings are widely used as λ demultiplexer

Lect. 12: Diffraction Gratings

Homework

The following figure shows the moon looked through a two-dimensional diffraction grating. The grating period in both x-direction and y-direction is d.



(a) Why are there discrete bands of diffracted light?

(b) Why is the red further away from the image of the moon in the center than the blue within the same band?

(c) Explain how you can estimate the distance between the moon and the earth from above figure. Use d, the grating period, and x, the distance between the center and a point of a particular color whose wavelength is λ.