N slit diffraction

$$I = I_0 \frac{\sin^2\beta}{\beta^2}\left(\frac{\sin N\alpha}{\sin\alpha}\right)^2 \qquad \beta = \tfrac{1}{2}kb\sin\theta,\ b = \text{slit width}$$

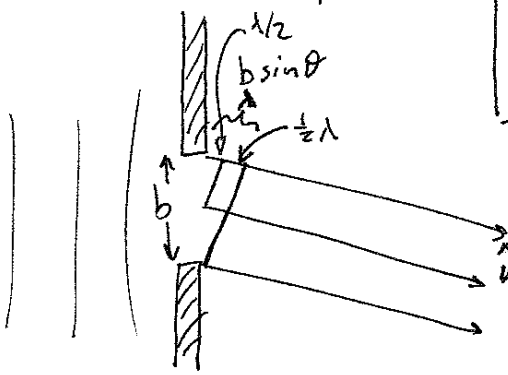
$$\alpha = \tfrac{1}{2}ka\sin\theta,\ a = \text{slit spacing}$$

$\frac{\sin^2\beta}{\beta^2}$: slit width term

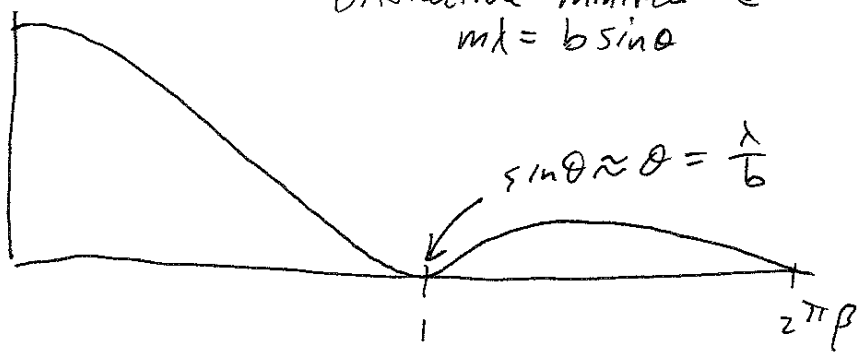
$\left(\frac{\sin N\alpha}{\sin\alpha}\right)^2$: slit spacing term

N = 1

$$I = I_0 \frac{\sin^2\beta}{\beta^2}$$



Diffractive minima @ $m\lambda = b\sin\theta$



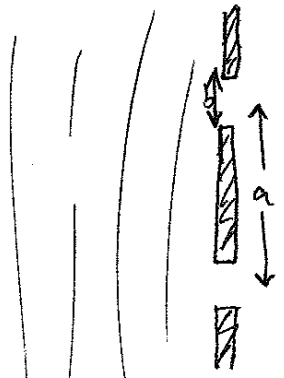
cancel At first minimum, $b\sin\theta = \lambda$

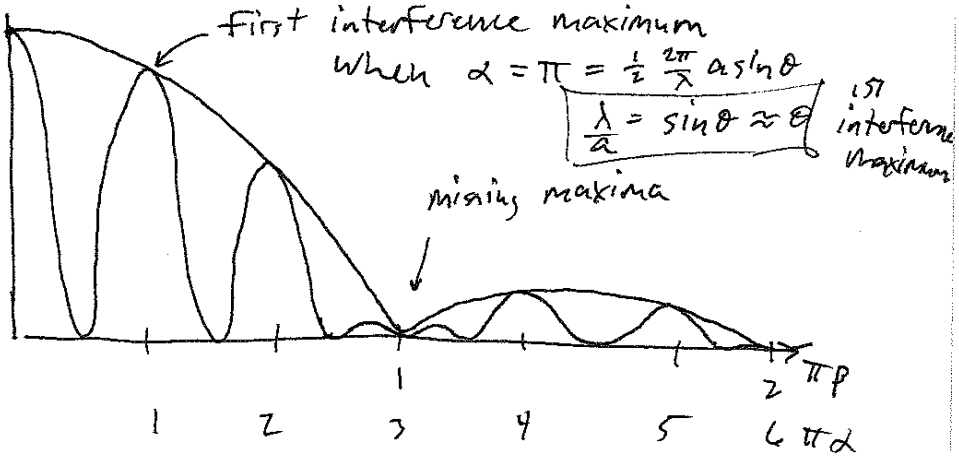
N = 2

$$I = I_0 \frac{\sin^2\beta}{\beta^2}\left(\frac{\sin 2\alpha}{\sin\alpha}\right)^2 = I_0 \frac{\sin^2\beta}{\beta^2}\left(\frac{2\sin\alpha\cos\alpha}{\sin\alpha}\right)^2 = I_0 \frac{\sin^2\beta}{\beta^2}(2\cos\alpha)^2$$

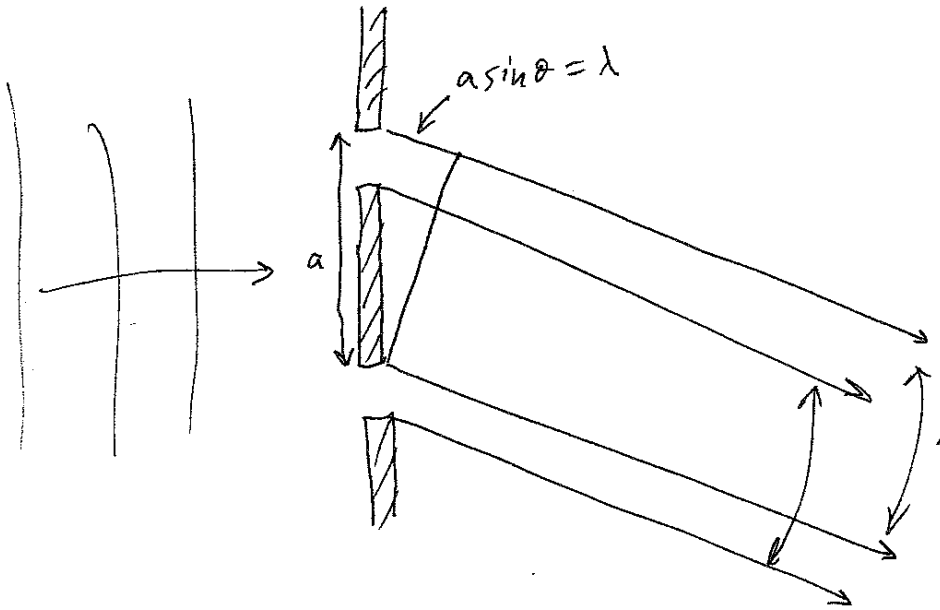
$(2\cos\alpha)^2$: N^2 factor

Suppose $a = 3b$



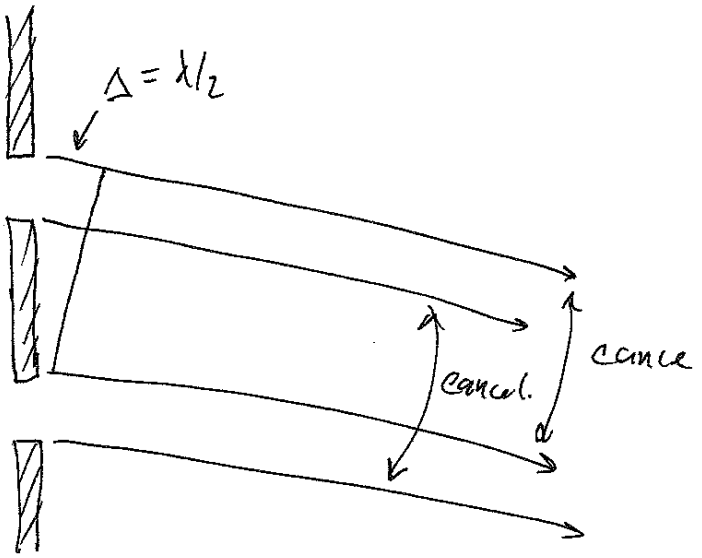


At first interference maximum:



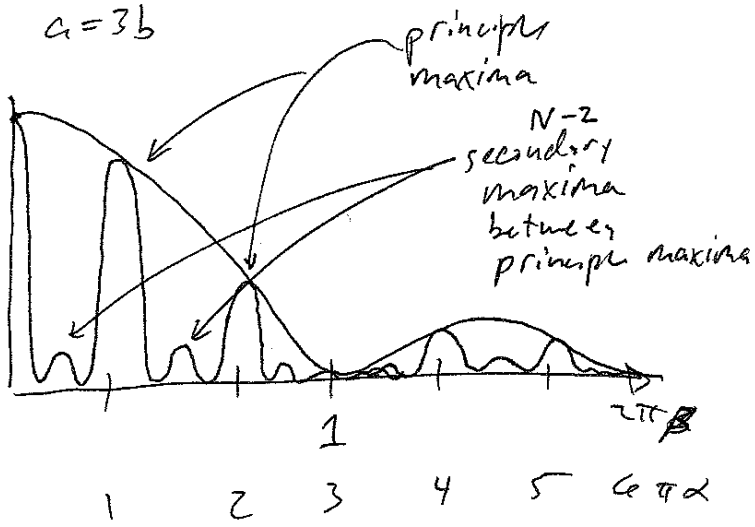
Add constructively when $\sin\theta = \frac{a}{\lambda}$

At First interference minimum:



$N=3$

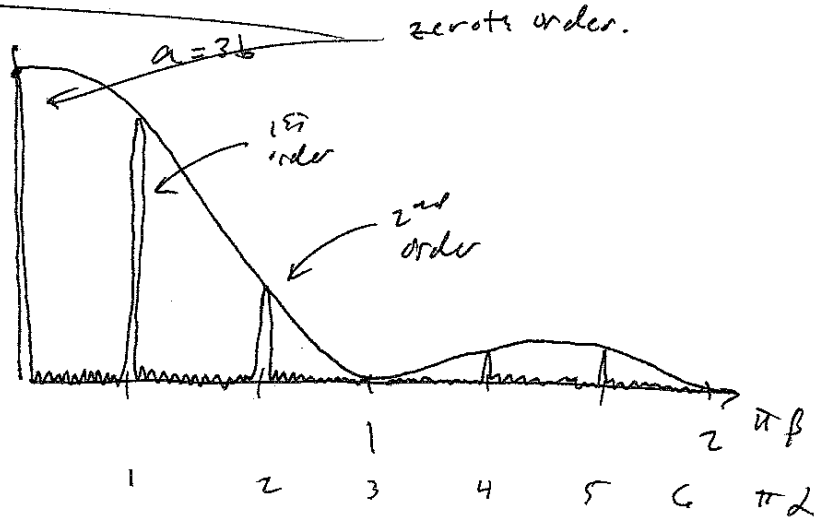
$$I = I_0 \frac{\sin^2\beta}{\beta^2}\left(\frac{\sin 3\alpha}{\sin\alpha}\right)^2$$



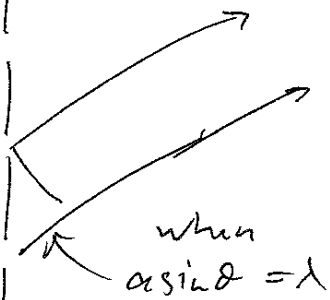
$N \to \infty$: Diffraction Grating

Principle Maxima become extremely narrow.

Secondary maxima become unobservably small



Maxima occur when $a\sin\theta = n\lambda$



when $a\sin\theta = \lambda$, Constructive interference.

$$\boxed{a\sin\theta = n\lambda}$$ grating equation

visible light

400 nm → 700 nm