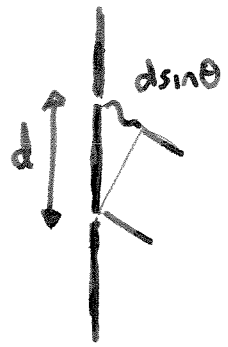
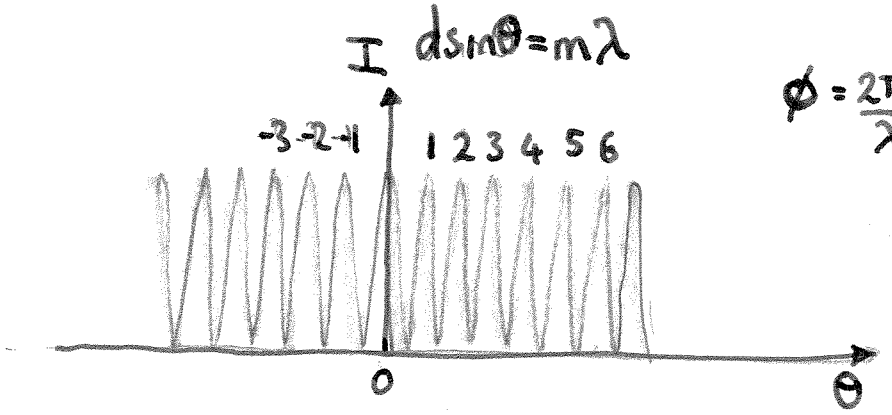
6. DIFFRACTION OFF MULTI-SLITS AND CRYSTALS

Today we will study the diffraction patterns produced by more complex sources, such as a two slit, or a multi slit source in a diffraction grating. The ultimate diffraction device is however not a grating, but a crystal. Analysis of the diffraction patterns of crystals have led to the elucidation of the structures of biological crystals of proteins and D.N.A.

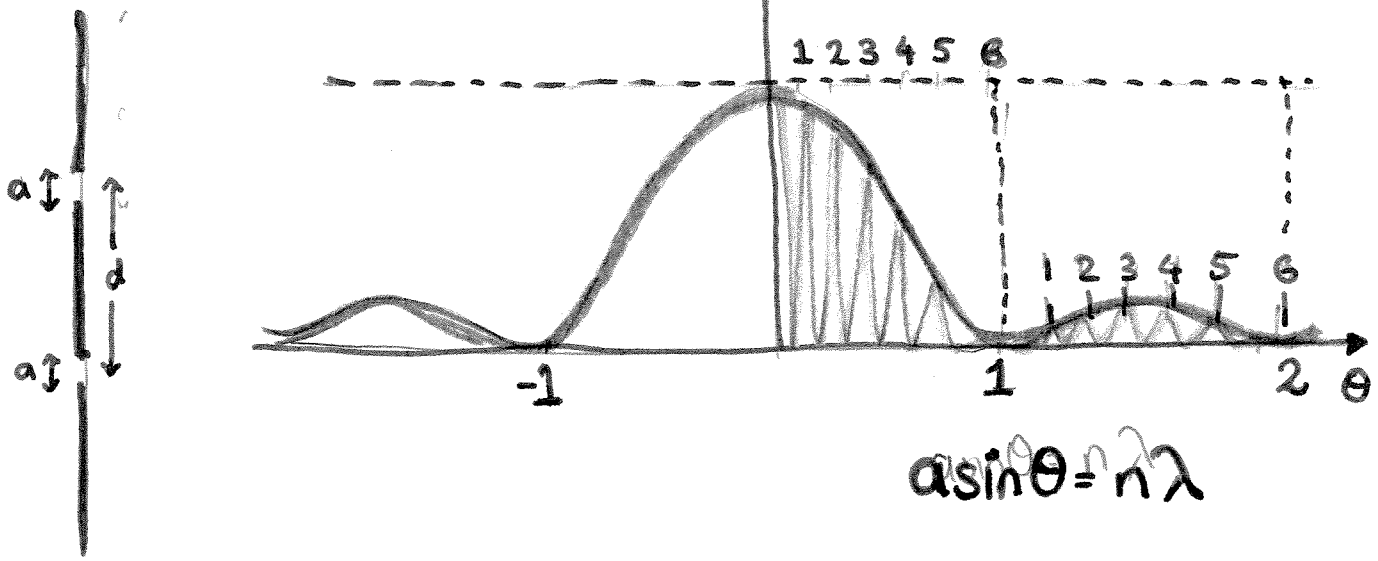
36.4 Two Slits, Finite Width





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

$d = 6a$

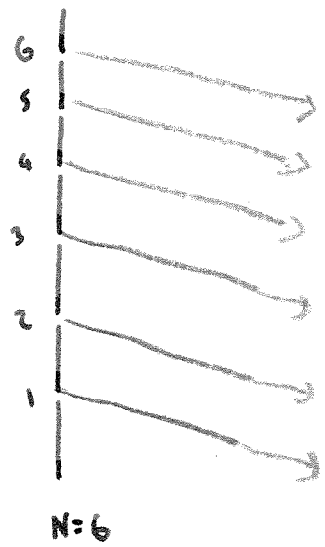


$$a\sin\theta = n\lambda$$

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

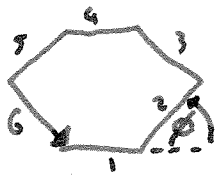
$$\beta = \frac{2\pi}{\lambda} a\sin\theta$$

36. SEVERAL SLITS + GRATINGS



$\phi = 0$ 

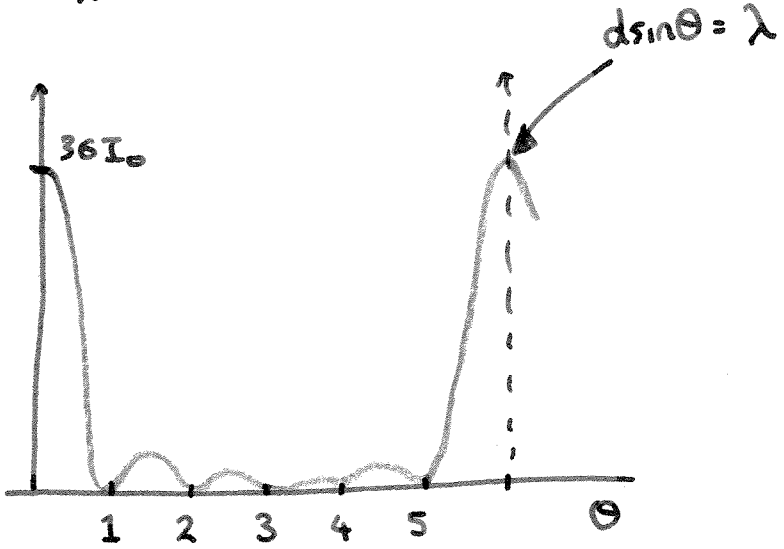
$\phi = \frac{2\pi}{6}$ (60°)

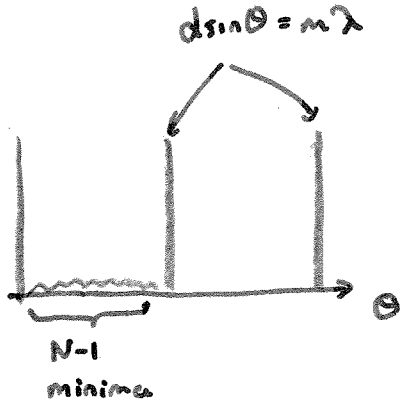


$\phi = \frac{2\pi}{3}$ (120°)

$\phi = 2\pi$ 

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





$N d\sin\theta = n\lambda$

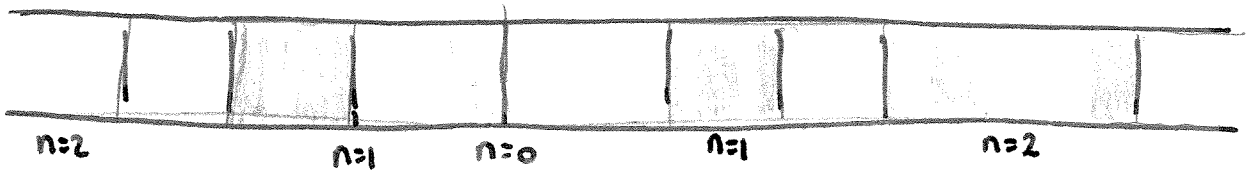
$(n = 1, 2, 3, 4, 5)$

RESOLVING POWER

$R = \frac{\lambda}{\Delta\lambda} = mN$

Resolution

$\left(\delta\sin\theta = m\frac{\delta\lambda}{d} \qquad \delta\sin\theta = \frac{\lambda}{d}\frac{1}{N} \text{ (1st minimum)} \right)$

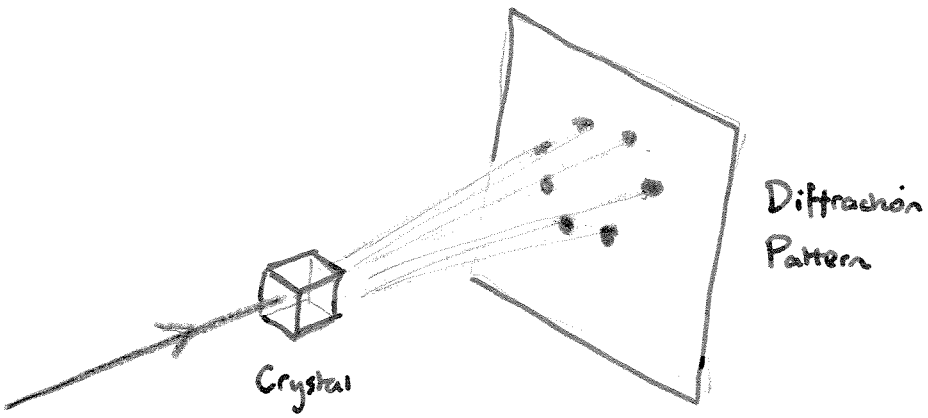


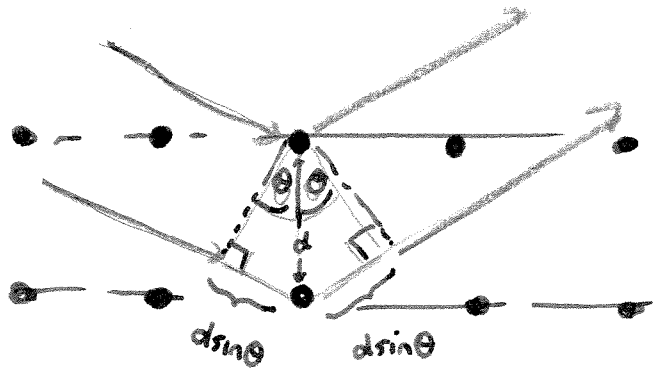
$$\sin\theta_{min} = m \frac{\lambda_{min}}{d}$$

$$\sin\theta_{max} = m \frac{\lambda_{max}}{d}$$

36.6 X-Ray Diffraction

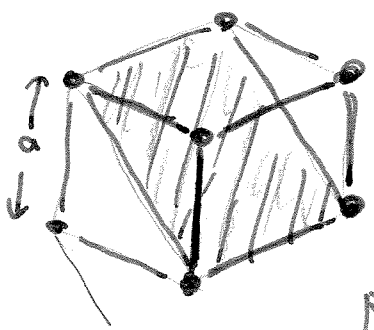
Roentgen 1895 $\lambda_{x\text{-rays}} \sim 10^{-10}$ m





$$2d\sin\theta = m\lambda$$

BRAGG.



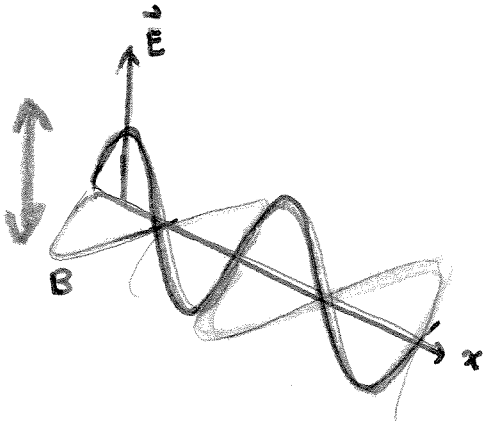
$d = a/\sqrt{2}$

$d = \frac{a}{\sqrt{3}}$

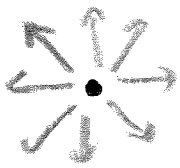
$d = P$

D.N.A. (Rosalind Franklin 1953)

33.5 POLARIZATION

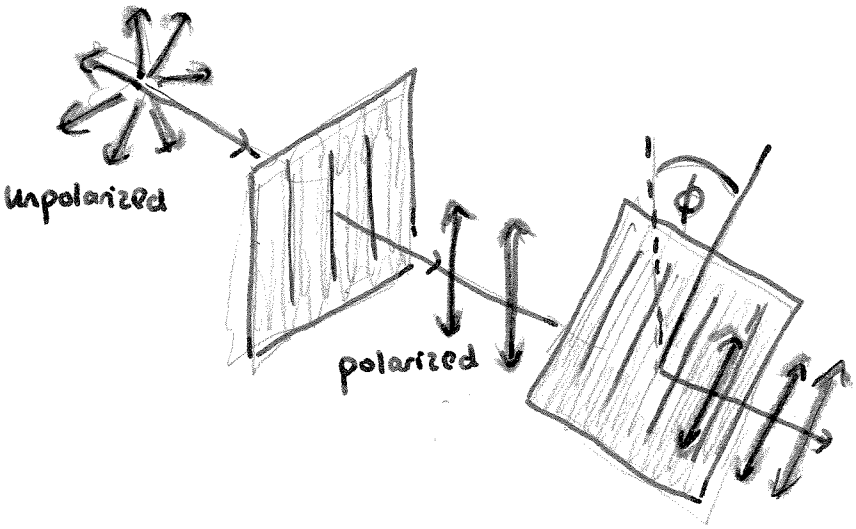


Unpolarized



Polarized

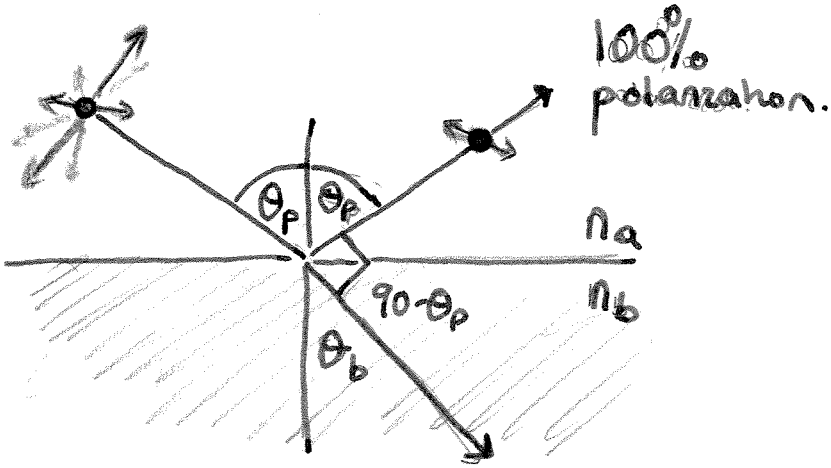
I. CRYSTAL POLARIZER



$$I = I_{max} \cos^2 \phi$$

II. POLARIZATION BY REFLECTION

$$n_a \sin\theta_p = n_b \sin\theta_b$$
$$= n_b \sin(90 - \theta_p)$$
$$= n_b \cos\theta_p$$



$$\tan\theta_p = \frac{n_b}{n_a}$$

$\theta_p = 53.1°$
AIR → WATER

BREWSTER ANGLE