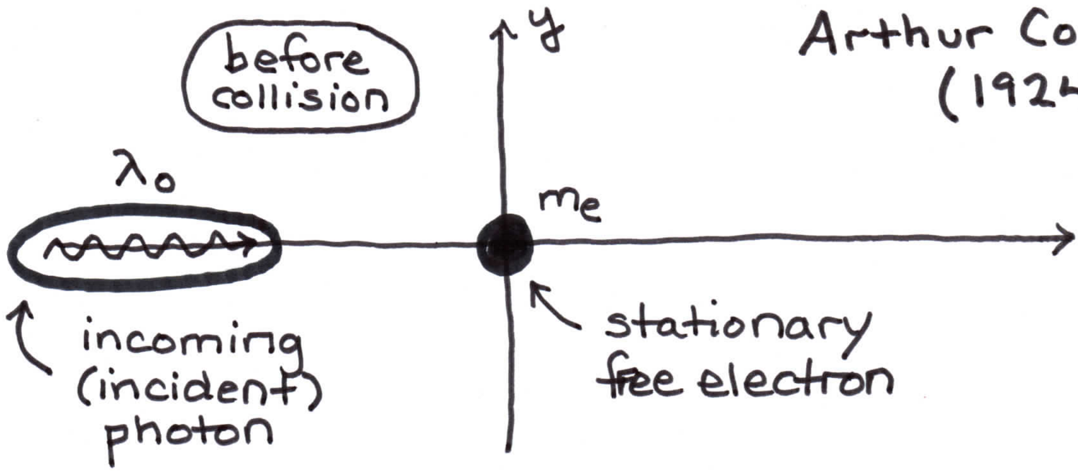
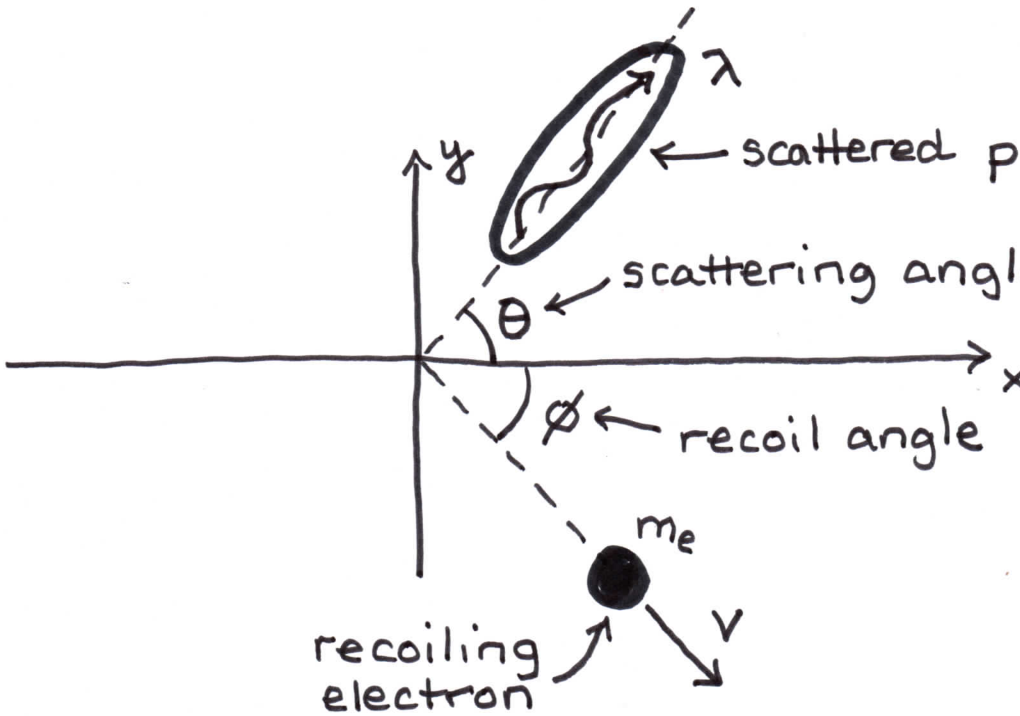
Compton Scattering

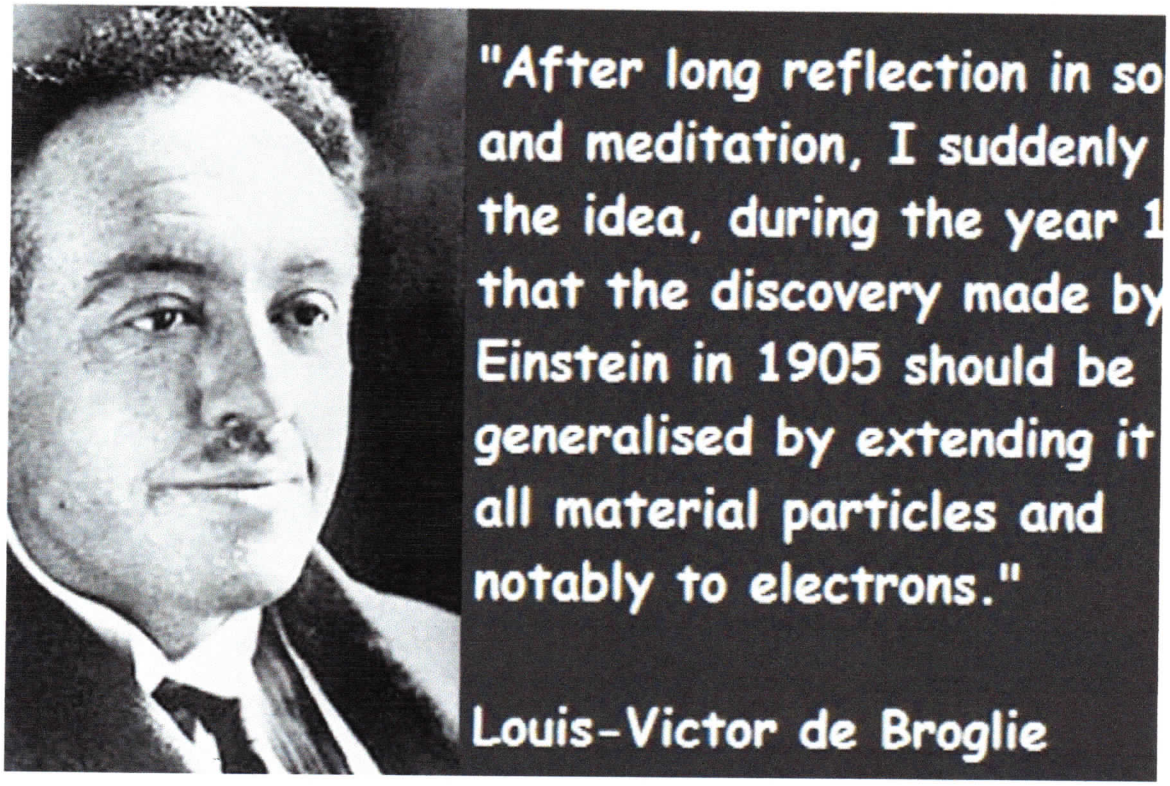
Arthur Compton (1924)





$$\lambda = \lambda_0 + \frac{h}{m_e c}(1 - \cos\theta)$$

called the Compton wavelength of the electron ← $\lambda_C = .00243$ nm



de Broglie's Hypothesis

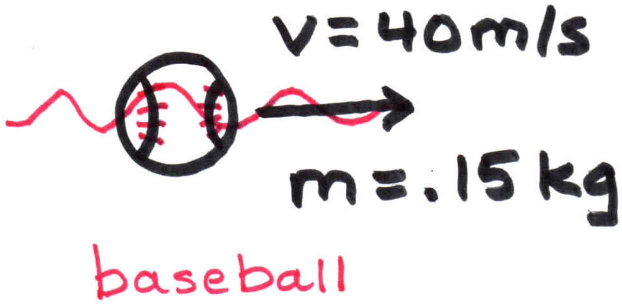
Whenever a particle has a momentum p, its motion is associated with ("guided by") a wave whose wavelength is

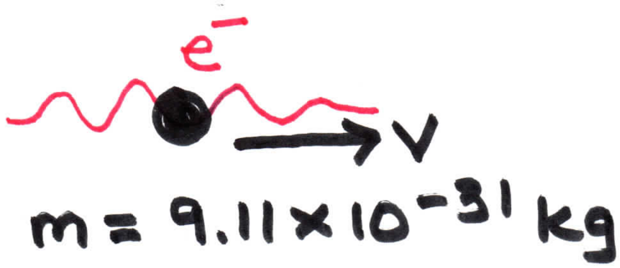
$$\lambda = \frac{h}{p} \qquad (1924)$$

from his 1924 dissertation

Planck's constant 6.63×10^{-34} J·s

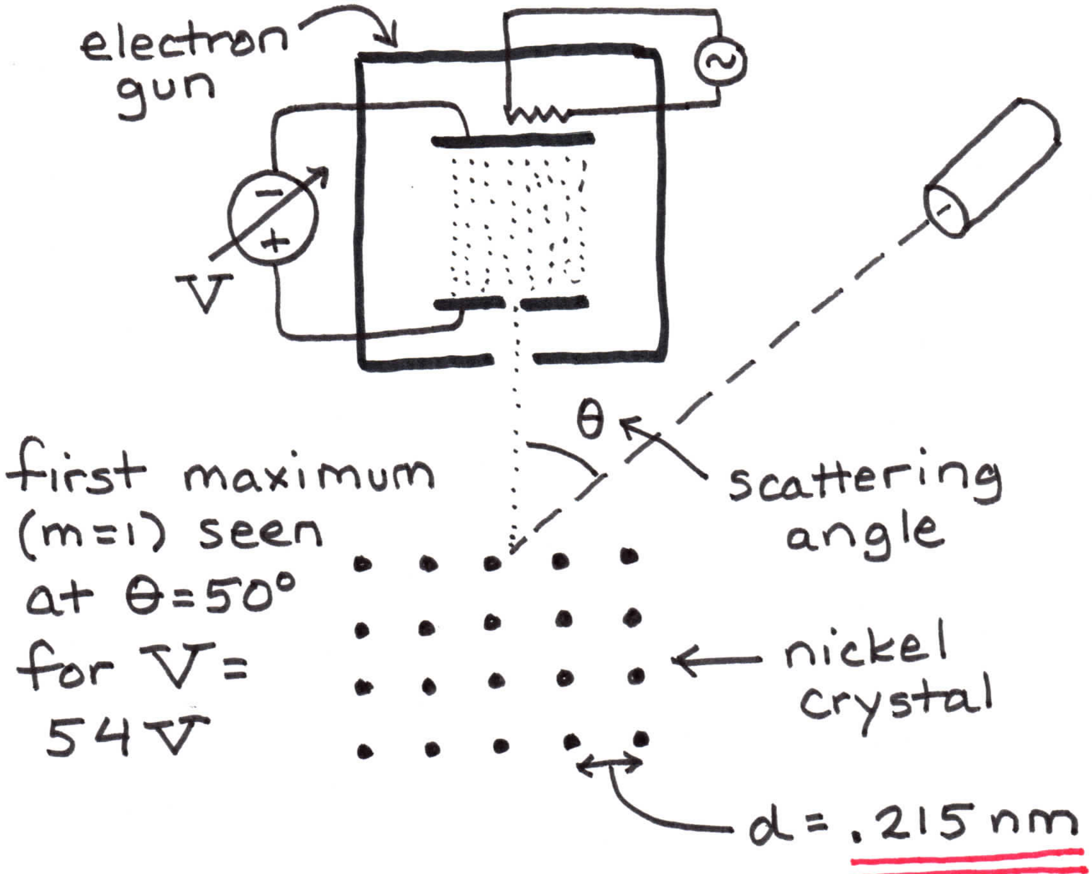
de Broglie Wavelength





electron accelerated
across $\Delta V = 100 V$

Davisson-Germer Experiment



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

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

$$= \frac{.215\,\text{nm}\,(\sin 50°)}{1}$$

$$= \boxed{.165\,\text{nm}}$$

$$\lambda_{dB} = \frac{h}{p} = \frac{h}{\sqrt{2m_e K}}$$

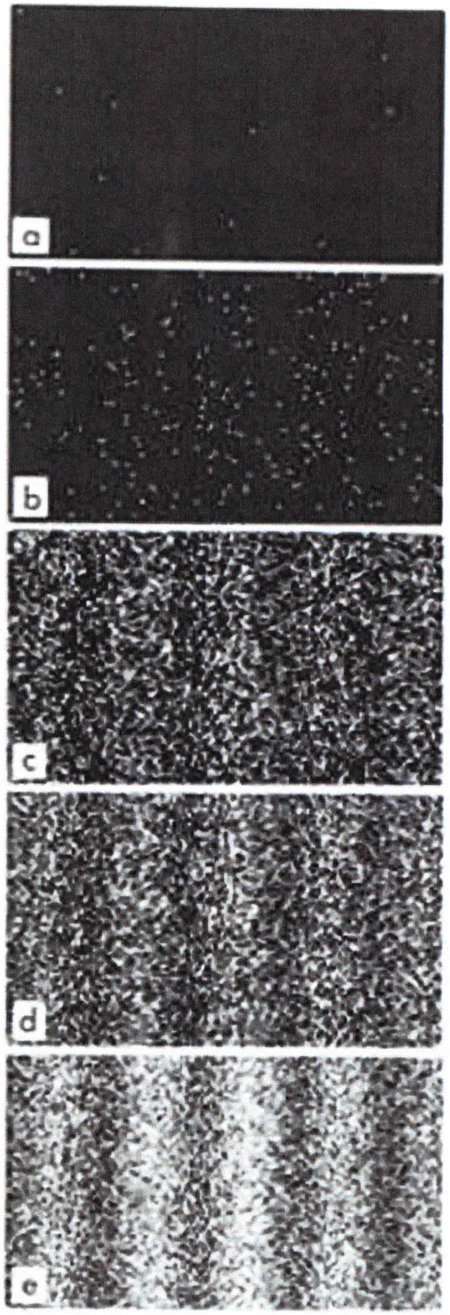
$$= \frac{hc}{\sqrt{2m_e c^2 K}}$$

$$= \frac{1240\,\text{eV}\cdot\text{nm}}{\sqrt{2(511{,}000\,\text{eV})(54\,\text{eV})}}$$

$$= \boxed{.167\,\text{nm}}$$


1927
Lester Germer
Clinton Joseph Davisson
29852

2 Slit Electron Diffraction



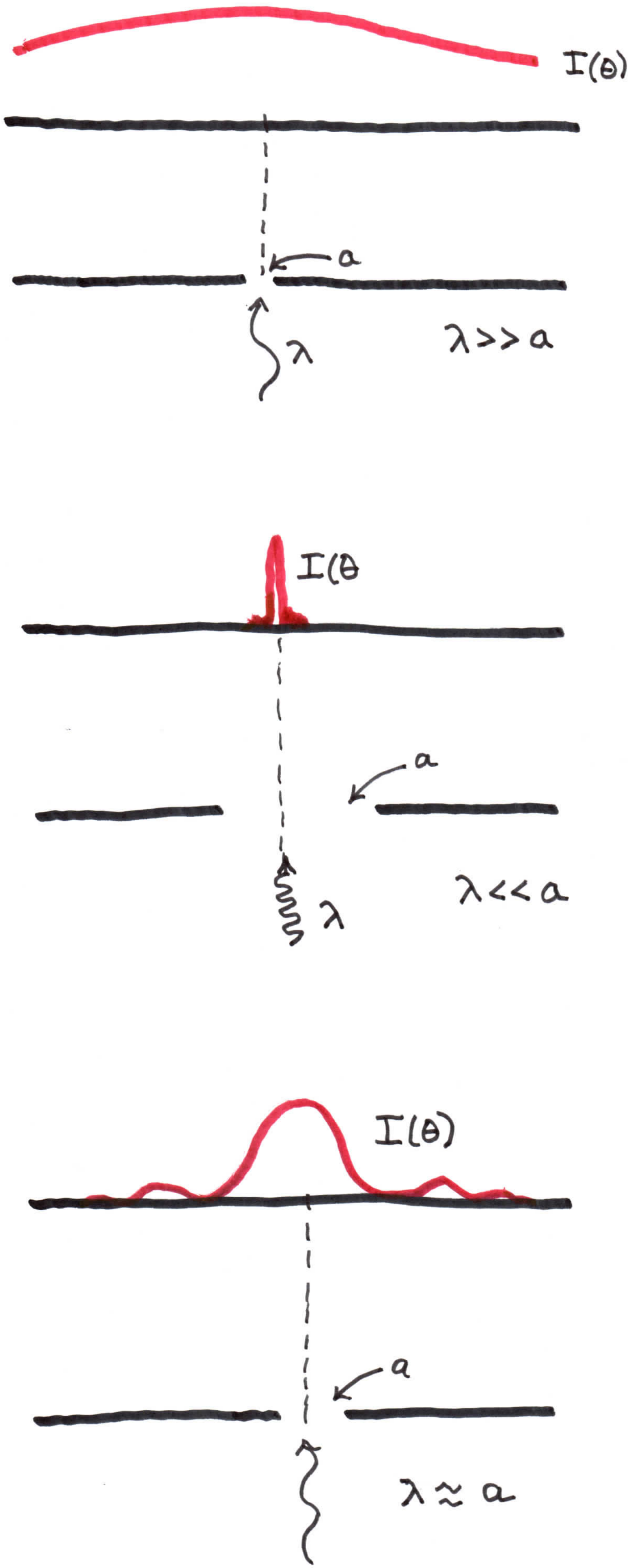
a) After firing a few individual electrons towards the two slits, we detect the arrival of each one.

b) After a few hundred electrons, there is still not a clear interference pattern.

c) After thousands of electrons, a clear pattern emerges.

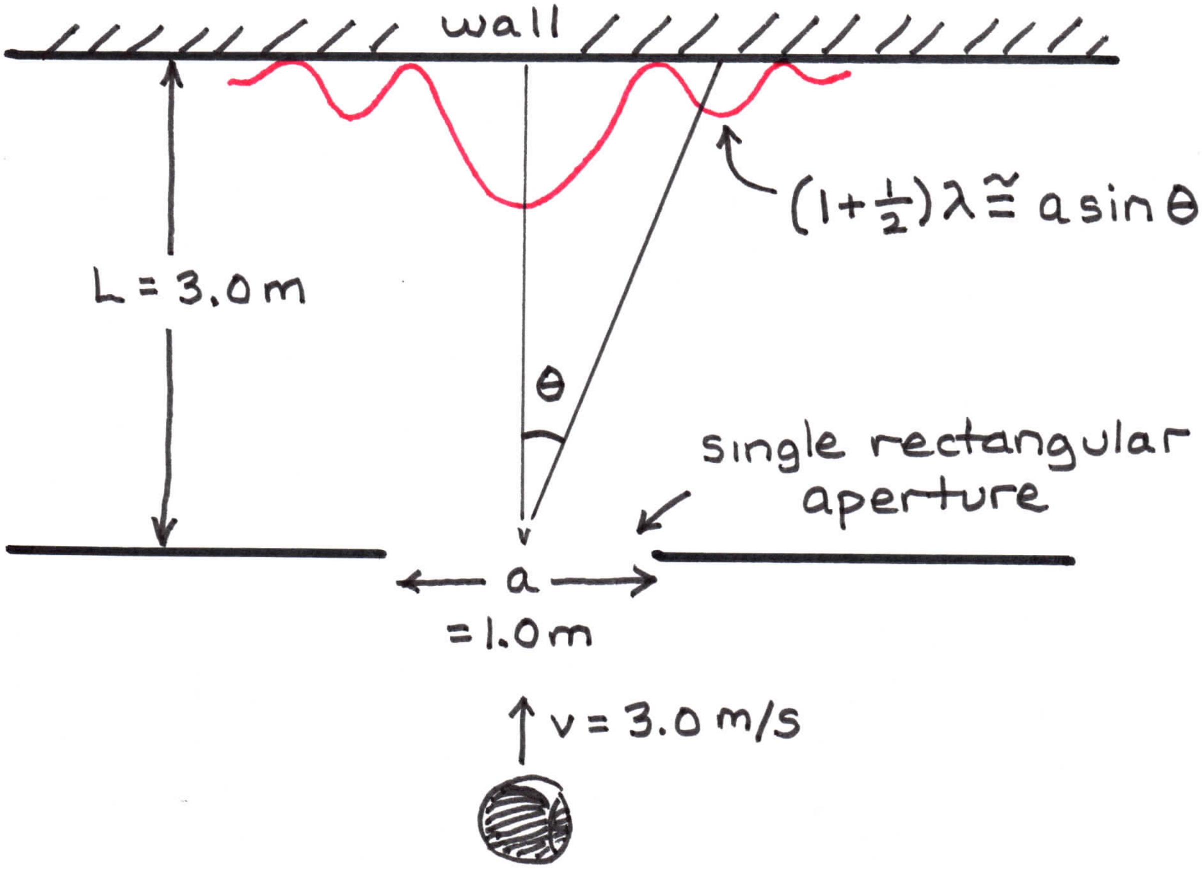
d) After many thousands of electrons, the pattern is better defined.

e) As we keep firing electrons, the pattern gets more and more sharp.



I(θ)
a
λ
λ >> a
I(θ
a
λ
λ << a
I(θ)
a
λ ≈ a

Diffraction Through a Door



Heisenberg Uncertainty Principle

W. Heisenberg (1927)

* It is impossible to know simultaneously an object's exact position and momentum.

$X = 1.395\,nm \pm .005\,nm$

$x \pm \Delta x \leftarrow$ uncertainty in x-position

$p_x \pm \Delta p_x \leftarrow$ uncertainty in x-momentum

$$\Delta p_x \Delta x \geq \frac{h}{4\pi} \qquad \Delta E \Delta t \geq \frac{h}{4\pi}$$

example

e^-

electron $\longrightarrow$ $v = 300\,m/s \pm .03\,m/s$

$$p = mv = 9.11\times10^{-31}\,kg\,(300\,m/s \pm .03\,m/s)$$

$$= 2.73\times10^{-28}\,kgm/s \pm \underbrace{2.73\times10^{-32}}_{\Delta p_x}\,kgm/s$$

$$\Delta x_{best} = \Delta x_{min} = \frac{h}{4\pi\Delta p_x}$$

$$= \frac{6.63\times10^{-34}\,J.s}{4\pi(2.73\times10^{-32}\,kgm/s)} = \boxed{1.93\,mm}$$

Google "Richard Feynman on Electron 2 Slit Experiment"

find youtube video

Richard Feynman
lecture: Fall 1964
Cornell University

⇨ youtube.com/watch?v=citY6G8ePJw