Davisson-Germer Experiment

Photons:

$$E_{ph} = h\nu$$

$$p = \hbar k = h/\lambda$$

Wave → Particle

What about the opposite?

Particle → Wave ?

$$\lambda = h/p$$

Matter waves:

$$\lambda_B = \frac{h}{p} = \frac{h}{mv} = \frac{h}{\sqrt{2mK}}$$

Wavelength for a walking man?

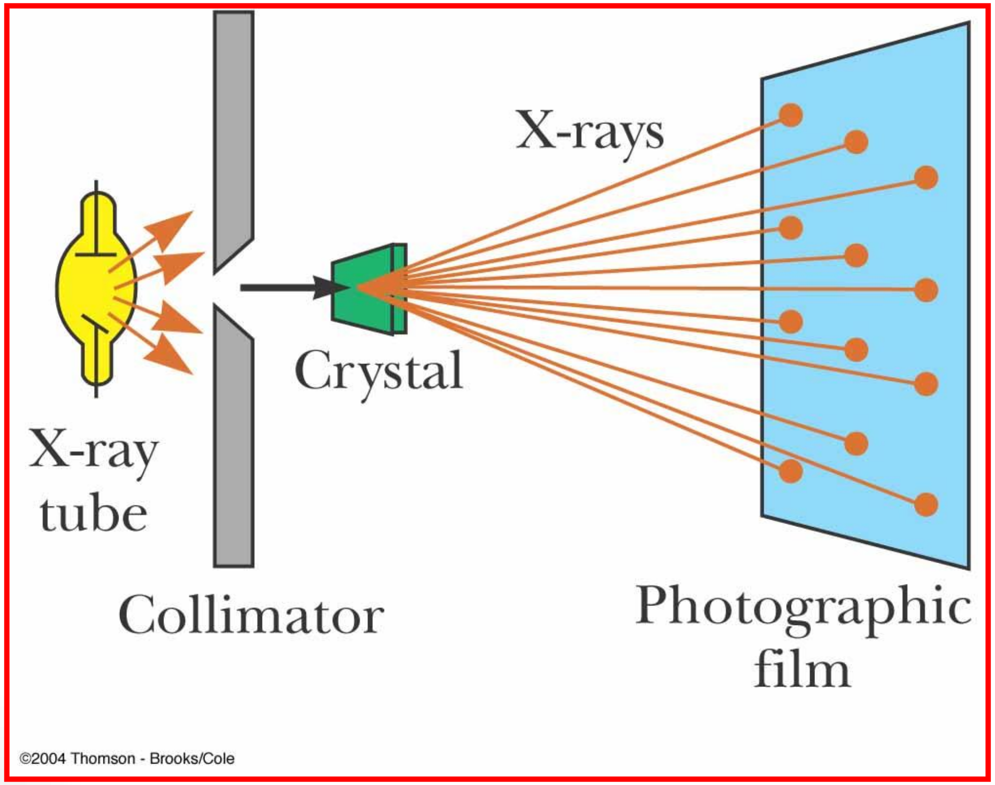
Wavelength for a moving electron?

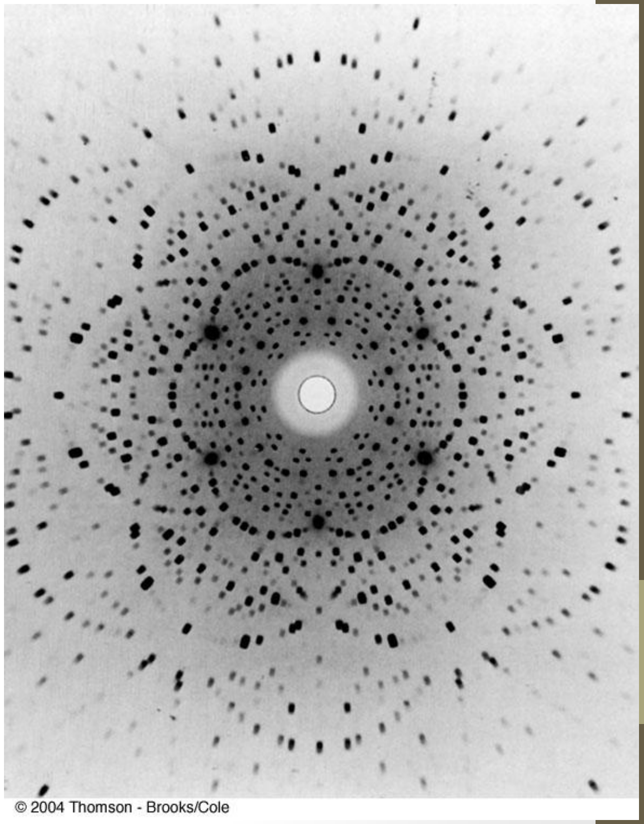
What is the wavelengths difference for 5 eV electron and 5 eV photon?

How to reveal the wave properties of electrons?

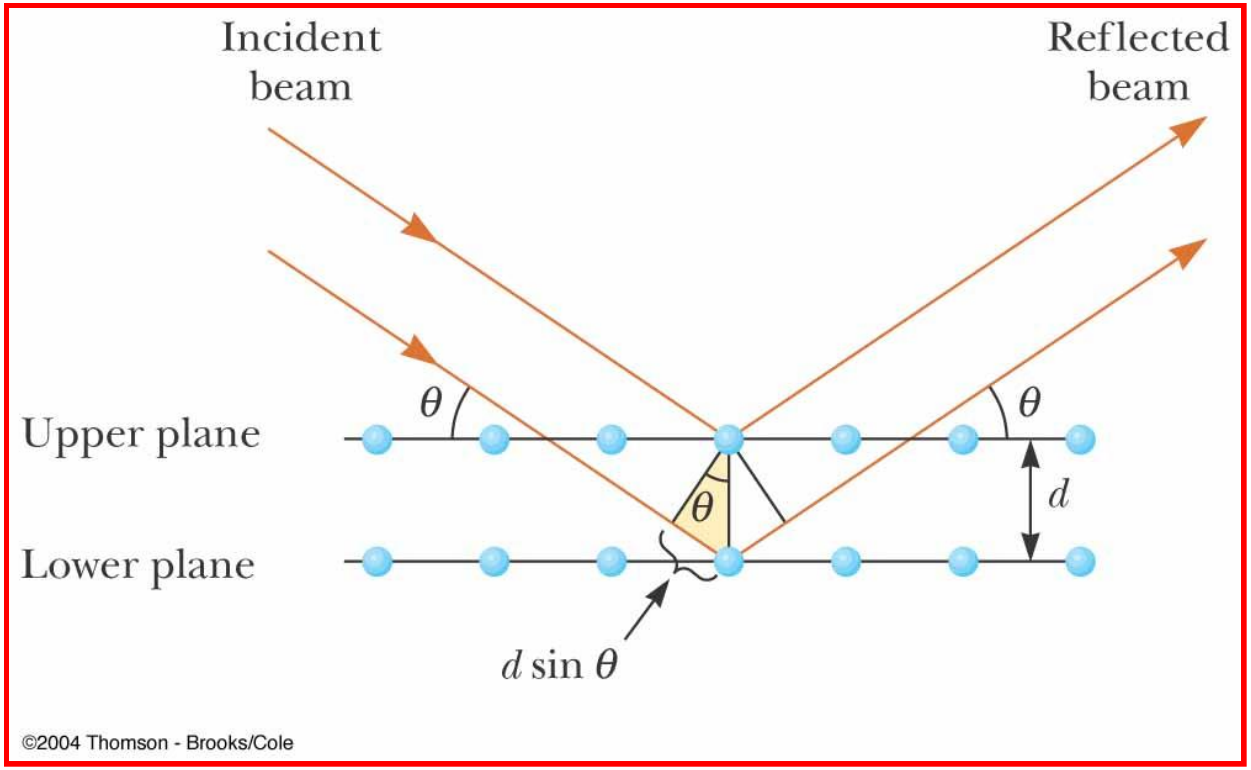
X-rays diffraction:

X-rays are electromagnetic waves with
$\lambda = 10^{-8}$ to 10^{-12} *m* = 10 – 0.001 *nm*





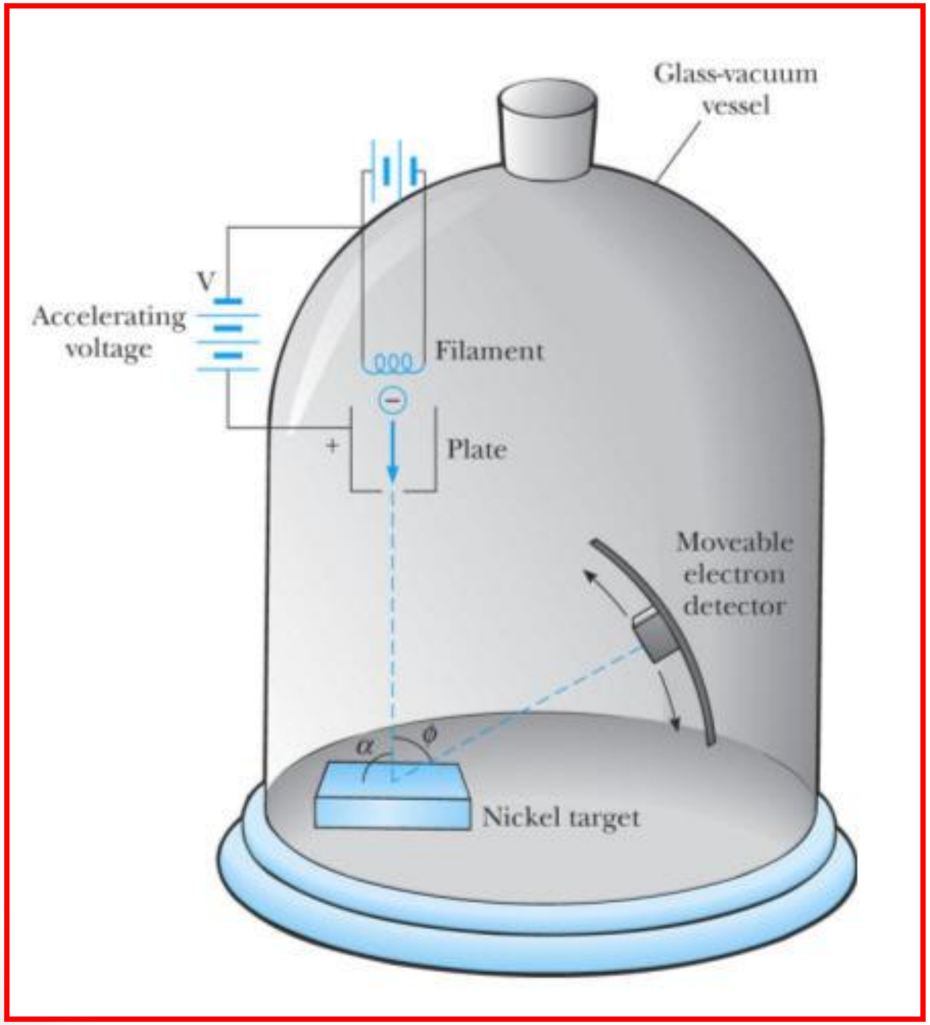
Bragg's law:



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

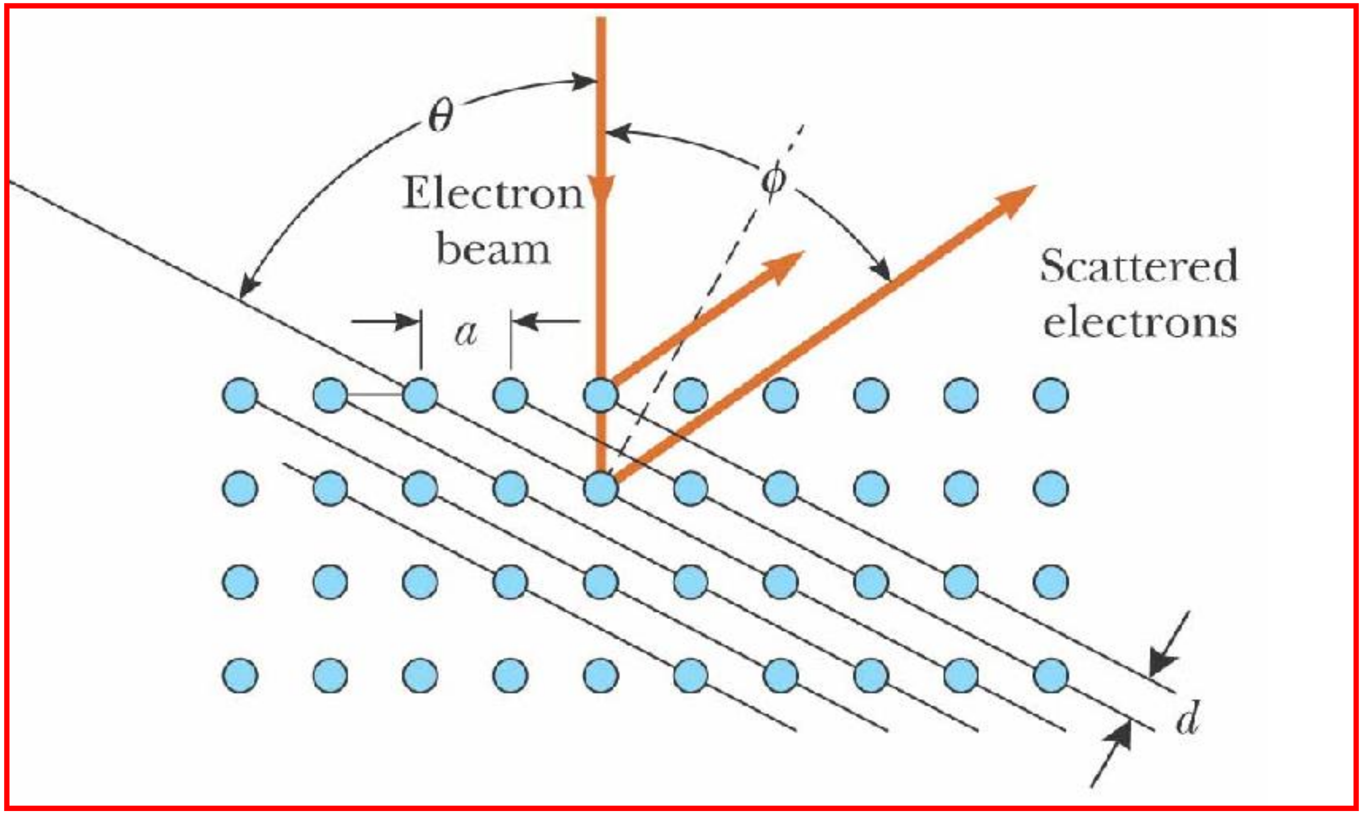
If *θ* and *λ* are known, *d* can be determined

Davisson-Germer experiment:



- Electrons were directed onto nickel crystals
- Accelerating voltage is used to control electron energy: $E = |e|V$
- The scattering angle and intensity (electron current) are detected
  - φ is the scattering angle

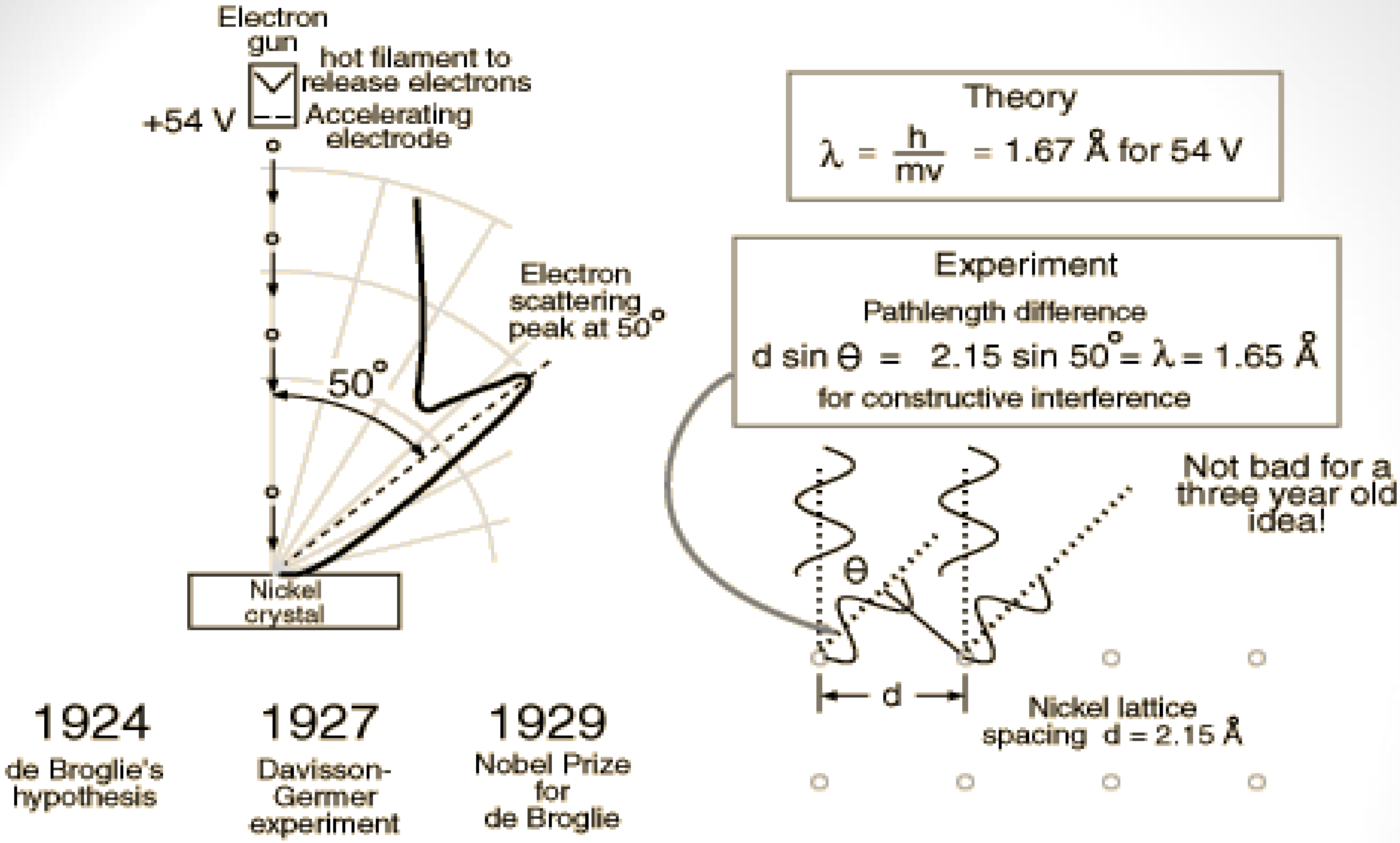
Electron scattering:



From X-ray experiments:
d **= 0.091 nm**

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

For φ **= 50°**
(θ **= 65°):**
λ **= 0.165 nm**



Davisson-Germer experiment

- Application of diffraction to measure atomic spacing
- Single crystal Ni target
- Proved deBroglie hypothesis that $\lambda = h/p$

Proof that $\lambda=h/p$

Accelerated electrons have energy eV:

$$eV= \frac{1}{2} mv^2 \Rightarrow v = (2Ve/m)^{1/2}$$

de Broglie said:

$$\lambda=h/p=h/(mv)=h/(2mVe)^{1/2}=1.67\ \text{Å}$$

Davisson-Germer found lattice spacing: $\lambda=d\sin\theta=1.65\ \text{Å}$

Excellent agreement between theory and experiment!

Application: Pressure sensing

- Atomic spacing changes with pressure:

  Pressure=E(ΔL/L)

  Where E=Young's modulus (N/m^2)
- As d (spacing between atomic planes) changes, the angle of diffraction changes
- Diffraction rings move apart or closer together