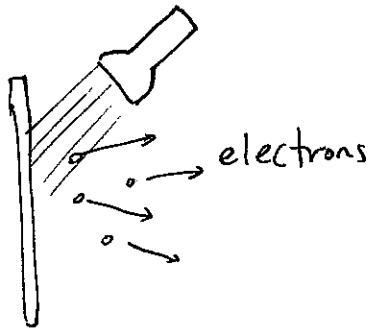
LAST TIME: photoelectric effect:

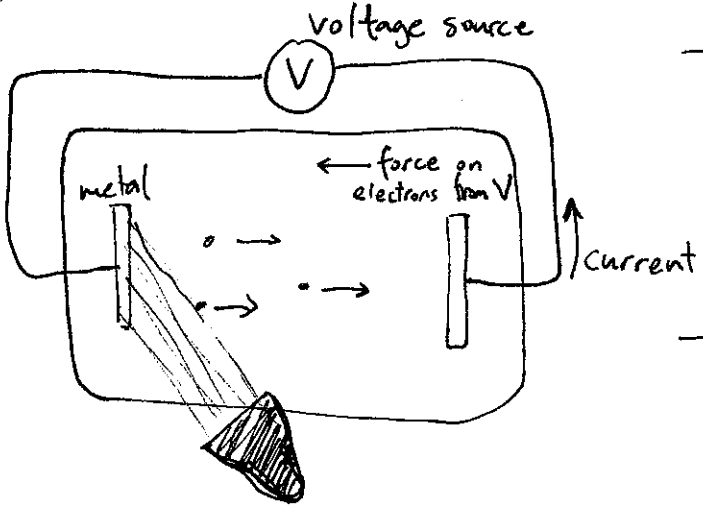


photon picture predicts:

$$E_K^{max} = hf - W$$

- E_K^{max}: max kin. energy of electrons
- hf: photon energy
- W: work function = min binding energy

Millikan



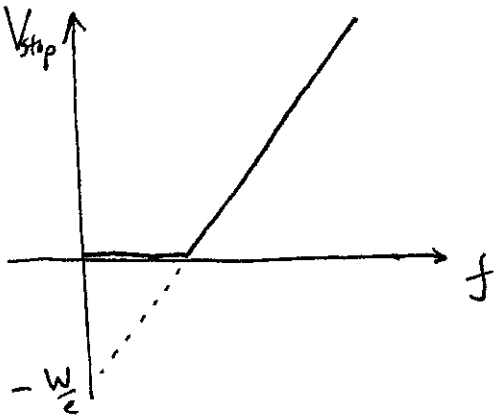
→ with voltage V, electrons need kinetic energy eV to cross

→ measure max kin. energy by

$$E_{max}^{k} = eV_{stop}$$

↑ voltage where no more electrons flow.

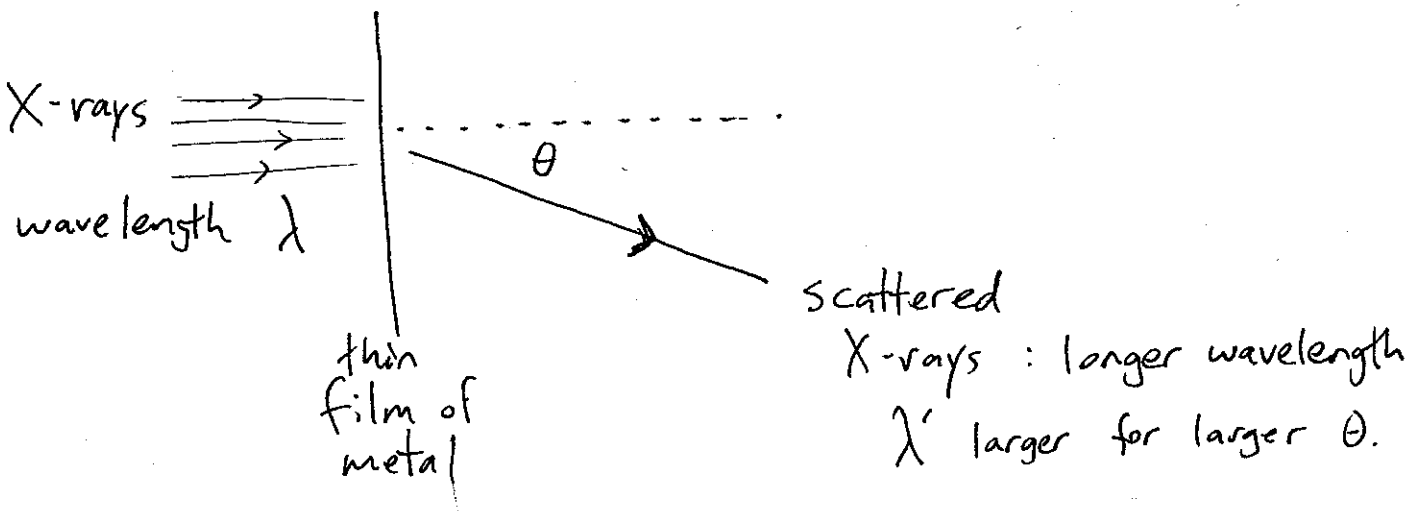
Prediction: $eV_{stop} = E_K^{max} = hf - W$



verified by Millikan's expt.

Einstein Nobel prize 1921

More evidence for photon picture: the Compton Effect



Photon picture:

BEFORE:

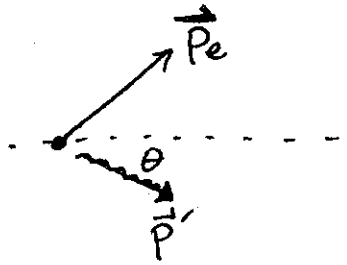
momentum $\vec{p}$

photon

e^-

electron

AFTER:



Use Energy + Momentum conservation:

x-mom: $\quad p = (p_e)_x + |\vec{p}'| \cos\theta$

y-mom: $\quad 0 = (p_e)_y - |\vec{p}'| \sin\theta$

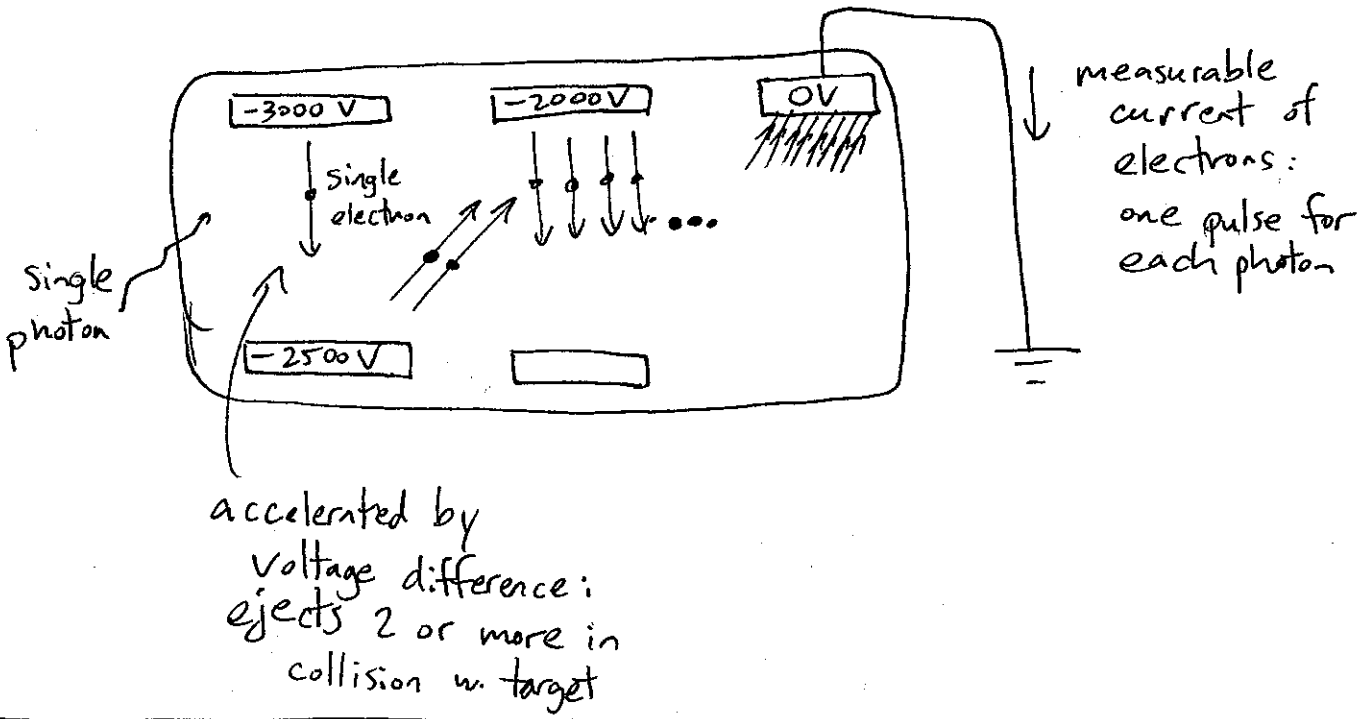
energy: $\quad pc + m_e c^2 = p'c + \sqrt{m_e^2 c^4 + c^2 |\vec{p}_e|^2}$ ← get from here

Result: $\boxed{\lambda' - \lambda = \frac{h}{m_e c}(1 - \cos\theta)}$ Matches experiment.

wavelength shift <u>cannot</u> be predicted from classical wave picture.

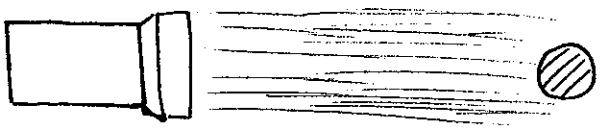
λ' always larger than λ: photon gives up some of its energy to the electron.

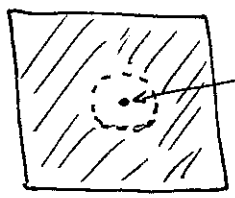
Now: can "see" individual photons with <u>photomultiplier</u>



BUT Wave property of light still essential to explain interference, diffraction, etc...

e.g.





pattern: on screen

bright spot in middle of shadow!