Quantum Mechanics

B. de Broglie Hypothesis

A photon traveling at c must have zero mass.

why? $E = \gamma m c^2$

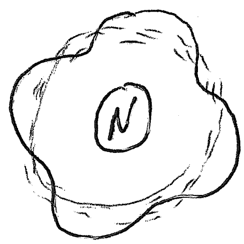
unless $m = 0$ E would increase to infinity

Photon Momentum (p)

$$p = \frac{E}{c} = \frac{hf}{c} = \frac{h}{\lambda}$$

$$\lambda = \frac{h}{p} = \frac{h}{mv}$$ wavelength of material objects

Using the idea of wavelength, an electron orbit can be thought of as a standing wave pattern about the nucleus.



Quantization can be explained by fitting a whole number of wavelengths into a circular orbit.

$$n\lambda = 2\pi r$$

Bohr - de Broglie Link

Bohr

$$mvr = n\hbar = \frac{nh}{2\pi}$$

$$mv = \frac{nh}{2\pi r}$$

de Broglie

$$mv = \frac{h}{\lambda}$$

$$\frac{nh}{2\pi r} = \frac{h}{\lambda}$$

$$\boxed{n\lambda = 2\pi r}$$

Bohr & de Broglie agree.

de broglie now offers an explanation for the quantized atomic shells.

Experiments have shown that electrons can be diffracted.

Diffraction is a wave property.

Therefore, an electron, like a photon must have a dual nature.

By extension all matter can be diffracted if a small enough opening can be achieved.

In order to observe diffraction of a 1.0 kg object the opening must be smaller than λ for the object.

$$\lambda = \frac{h}{mv}$$

suppose the object moves at 1.0 m/s

$$\lambda = \frac{6.626E\text{-}34\ Js}{(1.0\ kg)(1.0\ m/s)} = 6.626E\text{-}34\ m$$

This is much smaller than the atomic nucleus!

* Diffraction of slow, massive objects will not be observed.