Physics 371 Lecture 1

Chronology of QM

Max Planck (1901)

Black-body radiation

$E = nh\nu \quad , \quad n = 0, 1, 2, \ldots$

$h = 6.62618 \times 10^{-34}$ J s

Planck's constant

Einstein (1905)

Photoelectric effect

$h\nu = W + K.E.$

Bohr (1913)

Hydrogen atom

$$\mu = \frac{m_e m_N}{m_e + m_N}$$

Assumption : $\mu v r = n\hbar$

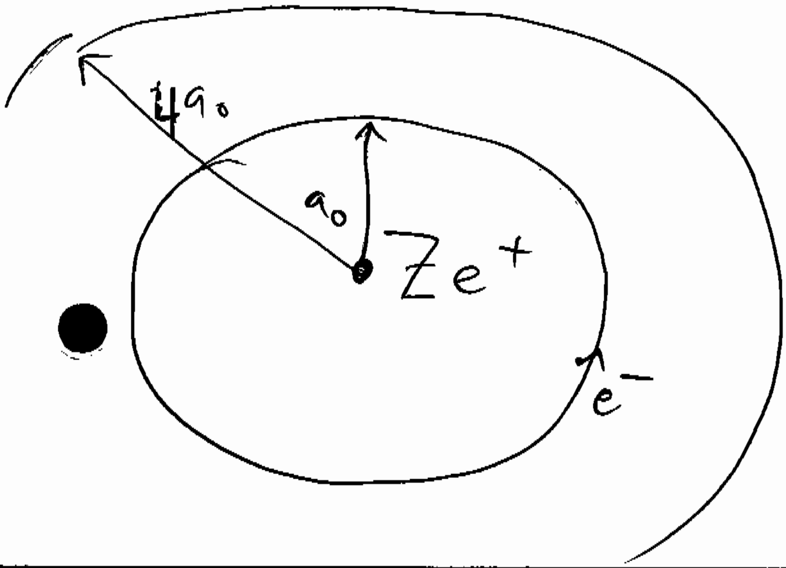
$n = 1, 2, 3, \ldots$

$$\hbar \equiv \frac{h}{2\pi}$$

$$\Rightarrow E_n = -\frac{\mu e^4}{2\hbar^2}\frac{Z^2}{n^2}$$

$\frac{\mu e^4}{2\hbar^2} = 13.6e$

$r_n = n^2 a_0$ $\quad a_0 = \frac{\hbar^2}{\mu e^2} \simeq 0.5$ Å



allowed circular orbits.

$9a_0$ ...

Sommerfeld (1915)

- extended Bohr's model to include elliptical orbits, more general (integrable) systems.

Einstein (1918)

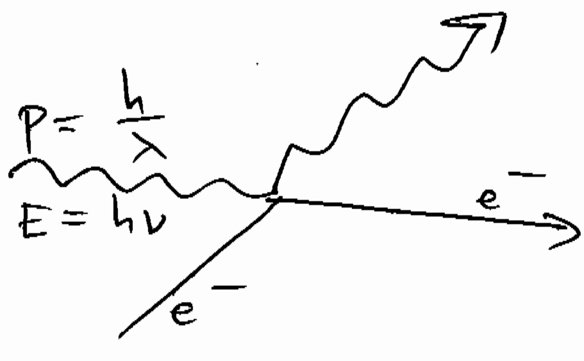
Critique of Bohr-Sommerfeld quantization rules — they only

- work for integrable systems, e.g., not for three-body problem.

[Gutzwiller (1970) solved Einstein's problem for classically chaotic systems.]

Compton (1923)

- Compton scattering



$$p = \frac{h}{\lambda}, \quad E = h\nu$$ } photon — waves behave like particles

de Broglie (1923)

particles behave like waves!

$$p = \frac{h}{\lambda}$$ electron

Explains Bohr's quantization of angular momentum:

$$mvr = n\hbar$$

$$pr = n\hbar$$

$$\frac{hr}{\lambda} = n\hbar \quad \Rightarrow \quad n\lambda = 2\pi r$$

standing waves

- **<u>Heisenberg</u>** (1925)
  matrix mechanics
  uncertainty principle
  $\Delta x \Delta p_x \gtrsim \hbar$

  <u>Schrödinger</u> (1925)
  wave mechanics

- **<u>Dirac</u>** (1927)
  shows approaches of H. & Sch.
  are equivalent.

  <u>Born, Bohr & Heisenberg</u> (late 1920's)

  Copenhagen interpretation
- QM = probabilistic theory

  Objections: Einstein et al.