Physics 371 Lecture 1

Chronology of QM

Max Planck (1901)

Black-body radiation

$E = nh\nu$, $n = 0, 1, 2, \cdots$

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

Planck's constant

Einstein (1905)

photoelectric effect

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

Bohr (1913)

Hydrogen atom

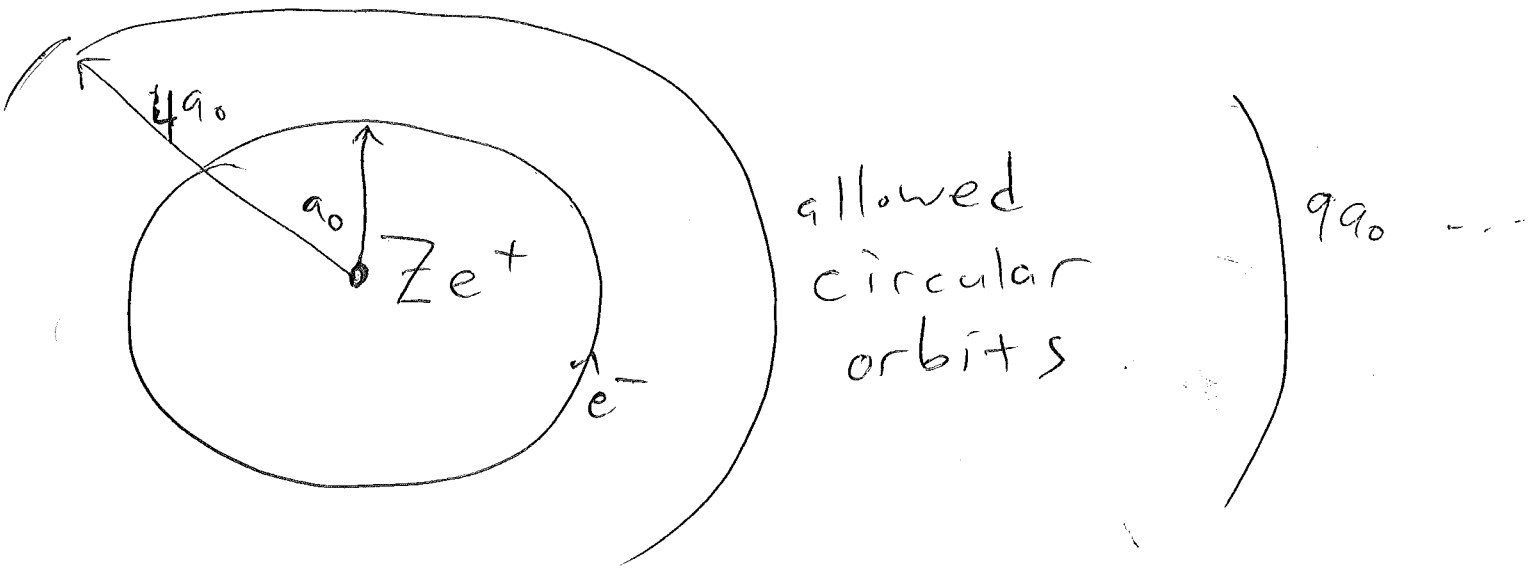
$$\mu = \frac{m_e m_N}{m_e + m_N}$$

Assumption: $\mu v r = n \hbar$ $\quad n = 1, 2, 3, \ldots$

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

$$\Rightarrow E_n = -\frac{\mu e^4}{2\hbar^2}\frac{Z^2}{n^2} \qquad \frac{\mu e^4}{2\hbar^2} = 13.6\,\text{eV}$$

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



Sommerfeld (1915)

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

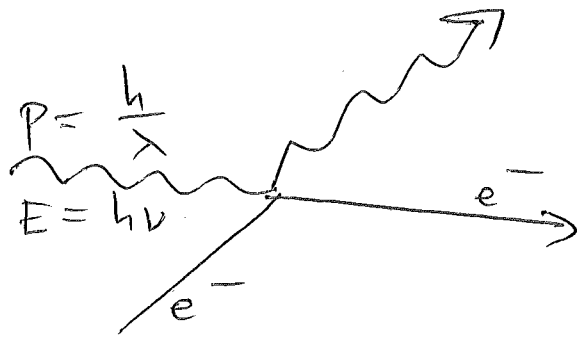
Einstein (1918)

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



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

$E = h\nu$

} photon

waves behave like particles

de Broglie (1923)

particles behave like waves!

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

Explains Bohr's quantization of angular momentum:

$mvr = n\hbar$

$pr = n\hbar$

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

standing waves

Heisenberg (1925)

matrix mechanics

uncertainty principle

$$\Delta x \, \Delta p_x \gtrsim \hbar$$

Schrödinger (1925)

wave mechanics

Dirac (1927)

shows approaches of H. & Sch. are equivalent.

Born, Bohr & Heisenberg (late 1920s)

Copenhagen interpretation

QM = probabilistic theory

Objections ò Einstein et al.