Matrix Formulasim

Formulasim of Q. Theory established in 1926 was truely a major break-through in the development of modern Physics (After 1925, Pauli exc-Principle).

But even in 1927 the Situation was that the formulasm of wave mechanics estiblished by Schrödinger contained a number of uninterpretted terms such as wave function.

Schrödinger firmly convinced that ψ represents something physically real in terms of wave function $\psi\psi^*$. He interpretted Q. Th as a Simple classical Th. of waves.

He denied discrete energy levels and Quantum jumps on the ground that in wave mechanics.

Meanwhile, a new interpretation of ψ was put forward by Born, which had far-reaching consequences for moder physics not only from purely technical point of view but also with respect to its philosophical contents.

He proposed for the first time, a probabilistic interpretation of ψ.

$$\int \psi^*(x)\psi(x)\,d\tau = 1 \Rightarrow \text{Normalization condition.}$$

Notes

The probability density

Appointment

Contacts

$$\rho(x) = |\psi(x)|^2.$$

The probability density $\rho(r) = |\psi(r)|^2$, represents a convenient starding point for the consideration of particle and charge currents as computed quantum mechanically.

$$\frac{d\rho(r)}{dt} = \frac{d}{dt}\left(\psi^*\psi\right)$$

$$= \psi^* \frac{\partial \psi}{\partial t} + \psi \frac{\partial \psi^*}{\partial t} \quad \text{--- (1)}$$

This time rate of change of probability density at any given point in space requires a difference between the particle currents flowing into and out of the differential volume surrounding the point under consideration.

i.e

$$\frac{d\rho}{dt} = -\nabla\cdot j \quad \text{--- (2)}$$

where, $\nabla\cdot j \Rightarrow$ Divergence of Particle current density at the point of question.

So,

$$\nabla\cdot j = -\left(\psi^* \frac{\partial \psi}{\partial t} + \frac{\partial \psi^*}{\partial t}\psi\right) \quad \text{--- (3)}$$

To evaluate the quantity on r.h.s. of the above eq^n, let us write the complex conjugate of schrödinger eq^n in the following form

$$\left(-\frac{\hbar^2}{2m}\nabla^2 + V(r)\right)\psi^* = -i\hbar \frac{\partial \psi^*}{\partial t} \quad \text{--- (4)}$$

$$i\hbar\left(\psi^* \frac{\partial \psi}{\partial t} + \psi \frac{\partial \psi^*}{\partial t}\right) = \frac{\hbar^2}{2m}\left(\psi \nabla^2 \psi^* - \psi^* \nabla^2 \psi\right)$$

$$= -\frac{\hbar^2}{2m} \operatorname{div}\left(\psi^* \nabla \psi - \psi \nabla \psi^*\right)$$

After comparing (3) and (5) eqⁿ. !
we get

$$j = -\frac{i\hbar}{2m}\left(\psi^* \nabla \psi - \psi \nabla \psi^*\right) \quad (6)$$

within an arbitrary const. which vanishes if $j = 0$ whenever $\psi' = 0$.

so, $$\boxed{\frac{\partial P}{\partial t} + \text{div } j = 0}$$

→ eqⁿ. of continuity responsible for conservation of charge.

Uncertainty principle –

$$\boxed{\Delta P \Delta x = \Delta E \Delta t \geq h}$$

Consequences of Uncertainty principle –

(a) Non existance of Electron in Nucleus.

The electron must have the minimum energy of 95.22 MeV to reside inside the nucleus. But electron emitted during β-decay has the energy of the order of 3 MeV only. Hence, the existance of electron inside the nucleus is not possible.

(b) Finite width of spectral lines in Atomic Spectra

(c) Minᵐ. energy of Harmonic oscillator.

–(5)