VIVEKANANDA COLLEGE
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NAAC ACCREDITED ‘A’ GRADE

Topic: Postulates of Quantum Physics - II (https://www.youtube.com/watch?v=DTEBFcmCGKo)

Course Title: Elements of Modern Physics

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Unit: 2

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Name of the Teacher: Arvind Pan

Name of the Department: Physics UG

Postulates of Quantum Mech

1. Representation of states: Ψ

2. Observables $\rightarrow$ Hermitian Operators

Position	Operator
x, y, z	$\hat{x}, \hat{y}, \hat{z}$
$V(x,y,z)$	$\hat{V}(\hat{x},\hat{y},\hat{z})$
Linear Momentum $\left\{ p_x, p_y, p_z \right.$	$-i\hbar\frac{\partial}{\partial x}, -i\hbar\frac{\partial}{\partial y}, -i\hbar\frac{\partial}{\partial z}$
$\bar{p}$	$-i\hbar\nabla$
Energy	$i\hbar\frac{\partial}{\partial t}$
Kinetic Energy $\left(\frac{\bar{p}^2}{2m}\right)$	$-\frac{\hbar^2}{2m}\nabla^2$
Hamiltonian	$-\frac{\hbar^2}{2m}\nabla^2 + \hat{V}$
Angular Momentum $\bar{L}(\bar{r} \times \bar{p})$	$-i\hbar\,\bar{r} \times \nabla$
$L_x = y p_z - z p_y$	$-i\hbar\left(y\frac{\partial}{\partial z} - z\frac{\partial}{\partial y}\right)$
$L_y = z p_x - x p_z$	$-i\hbar\left(z\frac{\partial}{\partial x} - x\frac{\partial}{\partial z}\right)$
$L_z = x p_y - y p_x$	$-i\hbar\left(x\frac{\partial}{\partial y} - y\frac{\partial}{\partial x}\right)$

Postulates of Quantum Mech

Postulate 3: Expectation values

$$\hat{A}\psi = a\psi$$

$$\langle \hat{A} \rangle = \frac{\int \psi^* \hat{A} \psi \, d\tau}{\int \psi^* \psi \, d\tau} = \frac{a \int \psi^* \psi \, d\tau}{\int \psi^* \psi \, d\tau}$$

Postulate 4: Completeness & eigenvalues eqn = a

$$\hat{A}\psi_n = a_n \psi_n$$

$\psi_n \rightarrow$ complete set of eigenvector

Postulate 5: Time evolution of states:

For free particle $E = p^2/2m$

$$\frac{\partial \psi}{\partial t} = -\frac{iE}{\hbar}\psi$$

$$\frac{\partial^2 \psi}{\partial x^2} = -\frac{p^2}{\hbar^2}\psi$$

$$\psi(x) = A e^{i(kx - \omega t)}$$

$k = p/\hbar$ DeBroglie

$\omega = E/\hbar$ Planck's

$$= A e^{i(px - Et)/\hbar}$$

$$E\psi = i\hbar \frac{\partial \psi}{\partial t}$$

$$p^2 \psi = -\hbar^2 \frac{\partial^2 \psi}{\partial x^2}$$

$$i\hbar \frac{\partial \psi}{\partial t} = -\frac{\hbar^2}{2m}\frac{\partial^2 \psi}{\partial x^2}$$

For a particle in potential $V(x) \Rightarrow E = \frac{p^2}{2m} + V$

$$i\hbar \frac{\partial \psi}{\partial t} = -\frac{\hbar^2}{2m}\frac{\partial^2 \psi}{\partial x^2} + V\psi = \hat{H}\psi$$

Schrödinger Eqn

$$\boxed{i\hbar \frac{\partial \psi}{\partial t} = \hat{H}\psi}$$