Chpt. 3 – Postulates

1. State of QM system completely specified by wavefunction $\Psi(x,t)$

$$P(x_0,t_0) = \Psi(x_0,t_0)^* \, \Psi(x_0,t_0)\, dx = |\Psi(x_0,t_0)|^2 dx$$

↑ probabality of finding the particle at x_0 at t_0 within dx

$$\int_{-\infty}^{\infty} |\Psi(x,t)|^2 dx = 1$$ ← probability of finding the particle somewhere

⇒ Ψ single valued

Ψ, $\frac{d\Psi}{dx}$ continuous

cannot be ∞ over a finite interval

2. Each observable is associated with a QM operator

Position: $\hat{x} = x$

momentum: $\hat{p}_x = \frac{\hbar}{i}\frac{\partial}{\partial x}$

KE: $\hat{E}_{kin} = -\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2}$

PE: $\hat{E}_{pot} = V(x)$

total E: $\hat{H} = -\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2} + V(x)$

Ang mom: $\hat{l}_x = \frac{\hbar}{i}\left(y\frac{\partial}{\partial z} - z\frac{\partial}{\partial y}\right)$

....

3. In a <u>single</u> measurement of an observable associated with $\hat{A}$, only eigenvalues of $\hat{A}$ are measured.

4. Expectation value: $\langle a \rangle = \dfrac{\int_{-\infty}^{\infty} \Psi^* \hat{A} \Psi \, dx}{\int_{-\infty}^{\infty} \Psi^* \Psi \, dx}$

average of the observable a, if many measurements are done.

if Ψ is an eigenfunction of $\hat{A}$, all measurements give the same result.

if Ψ is <u>not</u> an eigenfunction of $\hat{A}$

$$\Psi = \sum b_n \phi_n(x,t)$$

$\uparrow$ eigenfunctions of $\hat{A}$

$\langle a \rangle = \sum |b_m|^2 a_m$, assuming Ψ is normalized

Suppose $\psi(x) = \frac{1}{2}\phi_1(x) + \frac{\sqrt{3}}{2}\phi_2(x)$, ϕ_1, ϕ_2 being eigenfunctions of $\hat{A}$

$\hat{A}\phi_1 = a_1\phi_1$, $\hat{A}\phi_2 = a_2\phi_2$

How frequently do we measure a_1? a_2?

5. The time evolution of a QM system is given by

$$i\hbar \frac{\partial \Psi}{\partial t}(x,t) = \hat{H}\Psi(x,t)$$

If Ψ is a soln. of the time-independent SE -

$$\Psi = \psi(x) e^{-iEt/\hbar}$$