12/9/98

Lecture #39 Review

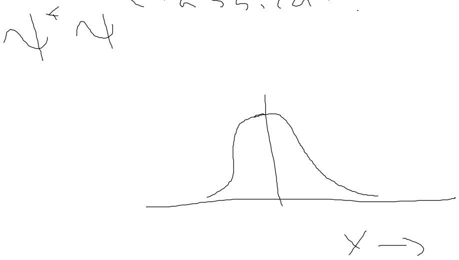
Quantum mechanics describes the motion of small objects. A measurement must disturb a system to some level. Therefore

$$\Delta p \, \Delta x \geq \hbar/2$$

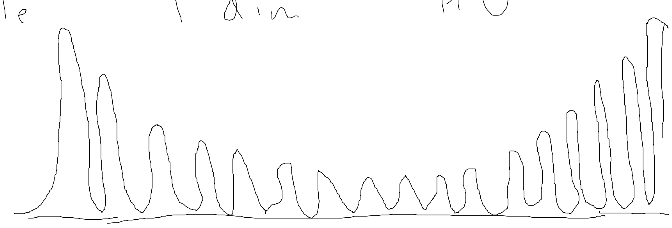
Since $p = mv$ we can determine both the velocity and position of massive objects

$$\Delta v \, \Delta x \geq \frac{\hbar}{2m} \rightarrow 0$$

Thus QM reduces to classical mech. for massive objects. Correspondence principle in limit of large quantum number QM system corresponds with classical. Example 1 dim HO



Ground state (pure QM)



Large n prob. dist close to classical

Postulates of QM

1) The state of a system is represented by a normalized vector $|\Psi\rangle$ (wave function)

2) Observable quantities $Q(x,p,t)$ are represented by Hermitian operators $\hat{Q}$; the expectation value of Q is $\langle\Psi|\hat{Q}\Psi\rangle$

3) A measurement of the observable Q on a system in the state $|\Psi\rangle$ is certain to yield λ iff $|\Psi\rangle$ is an eigenvector of $\hat{Q}$ with eigenvalue λ.

$$\hat{Q}|\Psi\rangle = \lambda|\Psi\rangle$$

3') A measurement of Q in the state $|\Psi\rangle$ is <u>certain</u> to get one of the eigenvalues of $\hat{Q}$. The prob. of getting λ is equal to the absolute square of the λ component of $|\Psi\rangle$

Eigenvectors $\hat{Q}|\lambda\rangle = \lambda|\lambda\rangle$

<u>Completeness</u> can expand any $|\Psi\rangle$

$$|\Psi\rangle = \sum_\lambda c_\lambda |\lambda\rangle$$

Expansion coef. $c_\lambda = \langle\lambda|\Psi\rangle$

Orthogonality

$$\langle \lambda_i | \lambda_j \rangle = \delta_{ij}$$

Prob. of getting λ $\quad P_\lambda = |c_\lambda|^2$

Expectation value

$$\langle \hat{Q} \rangle = \langle \Psi | \hat{Q} \Psi \rangle$$

$$= \sum_\lambda P_\lambda \lambda$$

Generalized Uncert. principle

$$\sigma_A^2 = \langle \hat{A}^2 \rangle - \langle \hat{A} \rangle^2$$ Variance

σ_A = standard deviation

$$\sigma_A \sigma_B \geq \frac{1}{2i} \langle [\hat{A}, \hat{B}] \rangle$$

$$[\hat{A}, \hat{B}] = \hat{A}\hat{B} - \hat{B}\hat{A}$$ Commutator