Phys 53 Fall 2023

Recitation #9 Solutions

① $|\psi\rangle = A|0\rangle + B|1\rangle$ S.H.O. state

since $|A|^2 + |B|^2 = 1$, can write a

$$|\psi\rangle = \cos\theta\,|0\rangle + \sin\theta\,|1\rangle$$

with $\hat{q} = \frac{1}{\sqrt{2}}(a + a^+)$

$$\langle q\rangle = \frac{1}{\sqrt{2}}(\cos\theta\sin\theta + \sin\theta\cos\theta)$$

$$= \frac{1}{\sqrt{2}}\sin(2\theta) \quad \text{max} \quad 2\theta = \frac{\pi}{2}$$

$$\theta = \pi/4$$

then $|\psi\rangle = \frac{1}{\sqrt{2}}(|0\rangle + |1\rangle)$

② $|\psi(t)\rangle = \frac{1}{\sqrt{2}}e^{-i\omega_0 t}\left(|0\rangle + e^{-i\omega_0 t}|1\rangle\right)$

$\langle\psi(t)|q|\psi(t)\rangle =$

$$\frac{1}{\sqrt{2}}\frac{1}{2}\left(\langle 0| + e^{i\omega_0 t}\langle 1|\right)(a + a^+)\left(|0\rangle + e^{-i\omega_0 t}|1\rangle\right)$$

$$= \frac{1}{2\sqrt{2}}\left(e^{-i\omega_0 t} + e^{i\omega_0 t}\right) = \frac{1}{\sqrt{2}}\cos(\omega_0 t)$$