$$|\psi(t=0)\rangle = A\left[|0\rangle + 2e^{i\pi/2}|1\rangle\right]$$

$$\langle\psi|\psi\rangle = 1 = |A|^2\left(\langle 0|0\rangle + 4\langle 1|1\rangle\right)$$

$$\Rightarrow A = 1/\sqrt{5}$$

$$|\psi(t=0)\rangle = \frac{1}{\sqrt{5}}\left[|0\rangle + 2e^{i\pi/2}|1\rangle\right]$$

$$|\psi(t)\rangle = \frac{1}{\sqrt{5}}e^{-i\omega t/2}\left[|0\rangle + 2e^{i\pi/2}e^{-i\omega t}|1\rangle\right]$$

$$\langle x\rangle = \sqrt{\frac{\hbar}{2m\omega}}\langle\psi|a^\dagger + a|\psi\rangle \Leftarrow$$

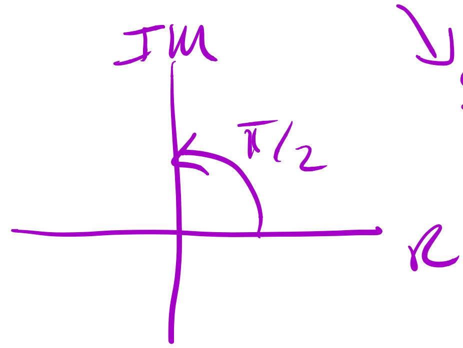
$$a|n\rangle = \sqrt{n}\,|n-1\rangle$$

$$a^\dagger|n\rangle = \sqrt{n+1}\,|n+1\rangle$$

$$\langle x\rangle = \sqrt{\frac{\hbar}{2m\omega}}\,\frac{1}{5}\left(4e^{-i\omega t} + 2e^{-i\pi/2} - e^{i\omega t}\right)$$

$$\langle x\rangle = \frac{2\sqrt{2}}{5}\left(\frac{\hbar}{m\omega}\right)^{1/2}\underbrace{\cos(\pi/2-\omega t)}_{\sin(\omega t)}$$

$$i = e^{-i\pi/2}$$



$$\langle x\rangle = \sqrt{\frac{\hbar}{2m\omega}}\,\frac{4}{5}\sin(\omega t)$$

$$\langle p\rangle = i\sqrt{\frac{\omega\, m\hbar}{2}}\langle\psi|a^{\dagger}-a|\psi\rangle$$

$$= \sqrt{\frac{m\omega\hbar}{2}}\,\frac{4}{5}\cos(\omega t)$$

$$\langle p \rangle = m \frac{d}{dt}\langle x \rangle$$

In Class Example

$\frac{\hbar\omega}{2}$ $\Downarrow$ $|0\rangle$

$\frac{3\hbar}{2}$ $\Downarrow$ $|1\rangle$

$$\langle x \rangle = -\sqrt{\frac{\hbar}{2m\omega}}\sin(\omega t)$$

$$\left(n + \frac{1}{2}\right)\hbar\omega$$

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

$$\langle\psi|H|\psi\rangle \qquad \langle 0|\psi\rangle \qquad \langle 1|\psi\rangle$$

$$|\psi(0)\rangle = \frac{1}{\sqrt{2}}\left(e^{i\theta_0}|0\rangle + e^{i\theta_1}|1\rangle\right)$$

$$|\psi(t)\rangle = \frac{1}{\sqrt{2}}\,\underline{e^{-i\omega t/2}}\left(e^{i\theta_0}|0\rangle + e^{i\theta_1}\,\underline{e^{-i\omega t}}\,|1\rangle\right)$$

$$\langle x \rangle = \langle \psi | x | \psi \rangle$$

$$x = \sqrt{\frac{\hbar}{2m\omega}}\left(a^{+} + a\right)$$

$$\langle x \rangle = -\sqrt{\frac{\hbar}{2m\omega}} \cos(\omega t + \theta_0 - \theta_1)$$

$$\theta_0 - \theta_1 = \pi/2$$

$$\langle p \rangle = \langle \psi | \hat{p} | \psi \rangle$$

$$m \frac{d\langle x \rangle}{dt} = \langle p \rangle \; ?$$