

Exercise Set 6

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Exercise 1

$$\begin{aligned} |\langle \vec{\sigma} \rangle|^2 &= |\langle \sigma_x \rangle|^2 + |\langle \sigma_y \rangle|^2 + |\langle \sigma_z \rangle|^2 \\ &= (c_+^* c_- + c_+ c_-^*)^2 + (-ic_+^* c_- + ic_+ c_-^*)^2 + (|c_+|^2 - |c_-|^2)^2 \\ &= 4|c_+|^2 |c_-|^2 + (|c_+|^2 - |c_-|^2)^2 \\ &= (|c_+|^2 + |c_-|^2)^2 \\ &= 1 \end{aligned}$$

Exercise 2

1. $|\psi\rangle = |+\rangle$
2. $H|+\rangle = \frac{1}{\sqrt{2}}(|+\rangle - |-\rangle)$
3. $\frac{1}{\sqrt{2}}(|+\rangle - |-\rangle) \rightarrow \frac{1}{\sqrt{2}}(e^{-i\omega T}|+\rangle - |-\rangle)$
4. $\frac{1}{\sqrt{2}}(e^{-i\omega T}|+\rangle - |-\rangle) \rightarrow \frac{1}{2}(e^{-i\omega T} - 1)|+\rangle - \frac{1}{2}(e^{-i\omega T} + 1)|-\rangle$
5. $P_{|+\rangle} = \frac{1}{4}(e^{-i\omega T} - 1)(e^{i\omega T} - 1) = \frac{1}{2}(1 - \cos(\omega T))$