Chapter 3

Yuquan Chen

Quiz 4/30, two pieces of A4 double sided material, problems covering chapter 2. Basic calculas and linear algebra tutorials at 2 p.m. this Saturday.

If we have $|\psi(t=0)\rangle = \sum_i c_i|\alpha_i\rangle \mapsto |\psi(t)\rangle = \sum_i c_i e^{-iE_n t/\hbar}|\alpha_i\rangle$,

1 Coupled spin-1/2 system

We have 2 particles, each with spin-1/2, use basis $\{|0\rangle, |1\rangle\}$ for each. Combinations: $\{|00\rangle, |01\rangle, |10\rangle, |11\rangle\}$, use outer product $\otimes$ to join the two qubits. For example,

$$|\psi_1\rangle = \begin{pmatrix} a_1 \\ b_1 \end{pmatrix},\ |\psi_2\rangle = \begin{pmatrix} a_2 \\ b_2 \end{pmatrix} \longmapsto |\psi_1\rangle \otimes |\psi_2\rangle = \begin{pmatrix} a_1 a_2 \\ a_1 b_2 \\ b_1 a_2 \\ b_1 b_2 \end{pmatrix} \tag{1}$$

For two qubits system, a general state expressed as $|\psi\rangle = c_0|00\rangle + c_1|01\rangle + c_2|10\rangle + c_3|11\rangle$.

Operator A and B for the first and the second particle, we have the operator $A \otimes B$:

$$(A \otimes B) \cdot (|\psi_1\rangle \otimes |\psi_2\rangle) = A|\psi_1\rangle \otimes B|\psi_2\rangle \tag{2}$$