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HW5

1. Measurement Problem

In QM we take a postulate to be that a measurement will collapse the wavefunction. We do this without defining what a measurement is. Moreover, we can't get the measurement postulate from the other postulates. If we are unsure as to whether or not a measurement has been made, we have no way of collapsing the wavefunction since we have no way to define it, and hence we can't model the evolution of the system correctly.

2. Dressed States

The dressed states are the eigenstates of the hamiltonian of a coupled system, including the interaction term, but not including terms from the surrounding environment.

e.g. The dressed states of a 2 level atom coupled with the laser are the eigenstates of $\hat{H}_{\text{atom}} + \hat{H}_{\text{laser}} + \hat{H}_{\text{interaction}}$. Notice that there is not term which includes the vacuum.

Q3. a) In the $|m\rangle$ basis we have

$$\rho_{mn} = \langle m|\hat{\rho}|n\rangle$$

$$\Rightarrow \frac{d\rho_{mn}}{dt} = \langle m|\frac{d\hat{\rho}}{dt}|n\rangle$$

since $\hat{M}$ is an observable, $\hat{M}^\dagger = \hat{M}$

$$= 2mn\langle m|\hat{\rho}|n\rangle - m^2\langle m|\hat{\rho}|n\rangle - n^2\langle m|\hat{\rho}|n\rangle$$

$$= -(n-m)^2\rho_{mn}$$

$$\Rightarrow \rho_{mn}(t) = \rho_{mn}(0)\, e^{-(n-m)^2 t}$$

For an initial pure state, $\hat{\rho}(0) = |\psi\rangle\langle\psi|$, where $|\psi\rangle = \sum_m c_m|m\rangle$

$$\Rightarrow \hat{\rho}(0) = \sum_{m,n} c_m c_n^* |m\rangle\langle n|$$

$$\Rightarrow \rho_{mn}(t) = c_m c_n^*\, e^{-(n-m)^2 t}$$

b) As $t \to \infty$ $\quad \rho_{mn} \to 0$, $m \neq n$

$$\rho_{mm} = |c_m|^2$$

This means that $\hat{\rho}$ becomes a mixed state of all the $|m\rangle$ states with probability of being in that state being given by $|c_m|^2$. Since all off-diagonal terms are zero, there is no coherence between these states.