Quantum Optics P572 Teaser Question Mar. 24, 2015

Question: *Measurement-conditioned master equation.*

We know how measurements of a closed quantum system affect the state through the collapse postulate of quantum mechanics. How do measurements of the *reservoir* affect the system state in open quantum dynamics? To be concrete, let's consider a two-level atom coupled to light with only spontaneous emission. With no observation of the reservoir, at time t the state is $\rho(t)$. You don't need to calculate this; take $\rho(t)$ as given.

Imagine that you build a perfect efficiency photon detector encompassing the full 4π solid angle around your atom. This doesn't affect the dynamics of the system; although it detects photons, the photons were being "detected" by something any way: a interaction with a macroscopic object like a ceiling or dog, or the planet Mars.

Now consider the scenario in which you, in a short – feel free to take it infinitesimal – time window around time $t_{\rm ph}$, observe a photon.

- What is the quantum state of the atom at times infinitesimally after time $t_{\rm ph}$? (You can ignore the propagation velocity of the light.)
- What is the state infinitesimally before time t? Unlike the former question, the answer to this may depend on your preferred interpretation of quantum mechanics and doesn't have direct experimental implications.
- What is the state if at time t you haven't detected any photons?