ISAQC Research Recruitment Submission

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Question:

The measurement performed above is a quantum measurement, however, humans can only observe classical information. How would you "see/observe" the result of the above collapse?

My Answer:

When a quantum measurement collapses, it collapses to a classical state. The uncertainty lies in what state it will collapse to. But once collapsed, it acts like a classical state. This is because a quantum state is a combination of several classical states, that is, it is a superposition of several classical states.

As to how to obtain an outcome, projector system is used. Through probability of certain states, we calculate the PVM (if it exists for the operator). As given in the paper in Resources of this question,

these operators have properties: 1) P_i is Hermitian: $P_i = {P_i}^\dagger$; 2) P_i is positive semi-definite: $P_i \geq 0$; 3) P_i is idempotent: ${P_i}^2 = P_i$; 4) P_i is pairwise orthogonal: $P_i P_j = \delta_{ij} = 0$, for $i \neq j$; 5) $\{P_i, i \in M\}$ forms a resolution of the identity on H: $\sum_{i \in M} P_i = I_H$.

The probability of obtaining outcome i for a given state $s = |\psi\rangle$ is specified by

$$p_m(\mathrm{i}|\psi) = \mathrm{P}(\mathrm{m} = \mathrm{i}|s = |\psi\rangle) = \langle\psi|P_i|\psi\rangle \tag{1}$$

And the post-measurement state is given by

$$|\psi_{post}^{(i)}\rangle = \frac{P_i|\psi\rangle}{\sqrt{\langle\psi|P_i|\psi\rangle}} \tag{2}$$

For mixed state, specified by the density matrix ρ, the probability of obtaining outcome i is given by

$$p_m(\mathrm{i}|\rho) = \mathrm{tr}(P_i\rho) \tag{3}$$

where $\mathrm{tr}(\cdot)$ is the trace operation. And the post-measurement state is specified by the following density matrix:

$$\rho_{post}^{(i)} = \frac{P_i \rho P_i}{\mathrm{tr}(P_i\rho)} \tag{4}$$

We can find the probability of certain state from the linear combination occurring after collapse. We will choose the most probable state after collapse and measure it