Re: Superposed observers (was No new Einstein)

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- *From*: "I.Vecchi" <vecchi@xxxxxxxxxxxxx>
- *Date*: Wed, 21 Sep 2005 07:05:20 +0000 (UTC)

rof@xxxxxxxxxxxx ha scritto:

>
> So that you can get an idea of how this sounds from my point of view,
> imagine that you toss a coin and look at the result, but don't
> show me. The result might be tails (for example), and you would
> know that but I wouldn't. If I were to say to you, "Relative
> to the Italo who saw heads, the coin landed on heads, but
> relative to the Italo who saw tails, the coin landed on tails,"
> then you might think I was a little odd.

Well, that's precisely the example I provide in my paper [1], where my model is proposed.
I hope you appreciate the difference between "odd" and "provenly wrong".

>
> That is, when you toss a coin and look at the result, I may
> imagine two possible cases, one in which you saw heads and
> one in which you saw tails, but wouldn't you agree that
> it's a little strange to talk as though there really are two
> Italos, one of whom saw heads and the other of whom saw
> tails?

Not stranger that talking about two superposed SQUID currents, one turning right, the other left ([2]). As I said, the scientifically relevant point is whether those instances can be experimentally detected.

>
> You might say that it does nobody any harm to talk this
> way. I would say, though, that it hampers communication
> and leads to confusion when purely hypothetical objects
> are spoken of as if they genuinely exist in a non−hypothetical
> way.
>
> You might also say that there's a difference between
> the coin tossing case and the Schrodinger's cat case,
> since interference between the two scenarios can in

> theory be detected in the second case, and so we
> have more of a reason to consider each of the two
> scenarios to be "real". I would have to go back to
> what I said before, then, which is that any
> experimental arrangement which can detect interference
> of observers and live/dead cats would also be able to
> resurrect cats and alter memories, and would thus be such
> an invasive procedure that one could not afterwards
> say what had genuinely happened on the basis of
> what the observer remembered or whether the cat was
> found to be alive or dead.
>

No difference here. Coin−tossing and Geiger counters do the same quantum job.

...

>
> I don't fully understand what you are referring to when you
> say "epistemic perspective". Can you explain your point
> using just the normal concepts involved in standard
> quantum mechanics? It does appear to me that you are
> claiming to be able to do the impossible − namely,
> to be able to make three successive measurements, A, B, A,
> where B doesn't commute with A, in such a way that the
> last measurement of A is guaranteed to give the same
> result as the first measurement.

If you want you can replace Nick tossing a coin above with a Geiger counter. The same holds. You just have to add an automated flag−raising device, or if you prefer, red or white lights replacing the flags. The point I am making is that the information about the system's state is vehiculed by signals and that the information content of signals depends on the observer's knowledge about the system. You may apply that to spin−measurements too. Not all red lights vehicule the same information, right?

>
> The situation seems analogous to me to the following. Suppose
> there's a spin−half particle, and A is a measurement of the
> x−spin while B is a measurement of the z−spin. I make three
> measurements, A, B, and A again. Normal quantum mechanics
> would say that the chances of getting the same result for
> the first and last measurements of A is 50%. However, if
> I take what you say above and apply it to this case, you
> would appear to be saying that the chances of getting
> the same result the first and last times is 100%, because
> the information that I get from the first measurement
> of A changes my "epistemic perspective".

We are drifting apart here. I do not get your point, but I think the reason is that I did not make mine clear enough. This misunderstanding appears related to the objections you raise about my experimental procedure too, What I call "epistemic perpective" is the semantic framework that allows me to encode signals into knowledge about the system's state , i.e. into my state vector.

>
> In the Nick/cat case, A is checking to see whether the
> cat is alive and Nick knows that, or whether the cat
> is dead and Nick knows that. B is an observable
> which has |Nick seeing dead cat>+|Nick seeing live cat>
> as an eigenvector. I am saying that, since these don't
> commute, if you measure A, B and A again, then you
> will only have 50% chance of getting the same result
> for both measurements of A. You appear to be saying
> that my knowledge of the result of the first measurement
> of A somehow changes the eigenvectors of B, in such a
> way that B now commutes with A. That seems
> to me like saying that if I know the x−spin of a
> particle, then that changes the eigenvectors of the
> z−spin, so that the x and z Pauli matrices now commute.
>
> >> I can, for example, measure
> >> the position of an electron regardless of whether it starts
> >> off in one place or another. There's a single observable
> >> for position, rather than different observables for different
> >> positions. Similarly, in thise case, there is a single
> >> observable which has to be used when you want to detect
> >> superpositions, and it doesn't change just because the
> >> state of the system is different.
>
> >My epistemic perspective may change and that change the eigenvectors of
> >the system (which are just THE STATES IN WHICH I CAN EXPECT TO FIND
> >THE SYSTEM after measurement) . I know, based on my knowledge of the
> >experimental setting , that the system will stay in the |Nick seeing
> >cat dead> state.
>
> This is highly unclear to me. Firstly, linear operators have
> eigenvectors, while systems don't.

Sorry, obviously you are right. I meant "that changes the eigenvectors of the measurement operator I use" (i.e. the measurement operator itself). In other words, I know that, say, a red light vehicules different information in different experimental settings.

> Secondly, in quantum
> mechanics, the knowledge of the observer never changes

> the eigenvectors of an observable. An observer may
> know that the result of a particular measurement of x−spin
> will be up, say, because he measures it in advance before
> performing a second measurement. This, however, has
> nothing to do with changing the eigenvectors of any observable.
> The eigenvectors of the observable are always the same.
> The knowledge of the observer just affects the quantum
> state which he assigns to the system.
>

...

>
> >The only thing that I need to show is that the system yields different
> >response depending on how and when I extract information about the
> >cat's state. The observable changes, because the way your readings are
> >entangled with Nick's state changes.
>
> Now, you appear to me to be saying that if the system is
> prepared in a different initial state, say |Nick seeing dead cat>
> rather than |Nick seeing dead cat>+|Nick seeing live cat>, then
> that changes the observable which will subsequently be measured.

What I am saying is that it changes the way the measurement outcomes I observe are ENTANGLED with the system's state. That's simply because I know that the experimental setting is different.

>
> If you do actually believe that, then you wouldn't be able
> to have a control experiment. For a control experiment, you
> have to measure the same observable, but for a differently
> prepared system.

All I have to show is that the experimental procedure yields different measurement outcomes depending on whether the shutter is in a superposition or not, but I think in this discussion we have been dragging along some confusion about what we mean by initial states. Note that I am actually conducting two different experiments. In the control exeriments I do not use the Geiger counter. What I test/show is that if you use a Geiger counter the results are different than if you close the shutter by hand half of the times before the experiment.

...

>
> >I've been articulating the description of my experimental model in more
> >detail as you've been raising your objections, which have provided this
> >exchange with a useful dialectic thread. You may have a look at [2]

> >to see what the experiment I have in mind actually looks like. Some of
> >the considerations in the paper are somewhat outdated, but the
> >experimental procedure described there is basically what I have been
> >referring to.
>
> The paper was:
> >[2] http://xxx.lanl.gov/abs/quant−ph/0007117
>
> In your paper you have a Mach−Zehnder interferometer, and there's
> a beam stopper which can be in either of two quantum states, |SA>
> and |SB>, or a superposition of these. In |SB> it blocks one arm
> of the interferometer and in |SA> it doesn't. When the stopper
> is in state |SA>, your detector never clicks, and if the
> stopper is in state |SB>, it clicks with probability 1/4.
> Overall, then, if there's a 50% chance that the beam stopper
> is in state |SA>, the probability of the detector clicking is
> 1/8.
>
> You prepare the beam stopper in the state (a|SA>+b|SB>)/sqrt(2),
> where |a^2|=1, and then claim that in this case the probability
> of the detector clicking is 3/8, and from this conclude that
> the experiment can detect the difference between the superposition
> (a|SA>+b|SB>)/sqrt(2) and the statistical mixture of 50% |SA> and
> 50% |SB>.
>
> The crucial step on which your calculation yielding 3/8 relies,
> however, appears to me to be incorrect. You say: "In this situation
> the photon crossing the superposed absorber undergoes a random phase
> change induced by the coupling between the photon's and the absorber's
> states." After this, I'm not sure what you do. Your
> expression for the final state of the photon doesn't appear
> to be normalised, and I think the analysis needs to be repeated
> taking into account the fact that the state of the photon is
> entangled with the state of the beam stopper.

I am confident that the calculations are correct. As for entanglement,
see below.

>
> As an example of something which has gone wrong, according to
> your expression for the final state of the photon, the probability
> that it has been absorbed by the beam stopper is 50%,

I cannot make sense of your point here. Please elaborate. There is
obviously the second beam−splitter that has to be taken into account.

> but in fact
> it should be 25% (as you say yourself at the bottom of page 5),
> since it is only if the photon goes along the upper path (half of the
> time) and if the beam stopper is blocking that path (half again),
> that the photon will be absorbed.

>
> Also, you say that the half photon which followed the lower
> path combines with the quarter photon which made it past
> the beam stopper on the other path. However, the quarter photon
> which made it past the beam stopper can only do so if
> the stopper is in the state |SA>, so its state is something
> like |SA>|photon state 1>, while the photon travelling along
> the other path doesn't care about the state of the stopper,
> so its state is something like (a|SA>+b|SB>)|photon state 2>/sqrt(2).
> So you can't just add |photon state 1> to |photon state 2>
> because they are multiplied by different beam stopper states.

This is indeed the crucial point.
When you say that the photon's states "are multiplied by different beam stopper states" you are falling into a misunderstanding that mars large chunks of current QM. Entanglement is an observer−dependent property of the measurement process ([3], cf.[4]). Roughly speaking, prior to measurement the photon is merely a ripple on the wave−function. When we say that a particle is entangled we are saying that some measurement outcomes entail certain constraints on other measurement outcomes. However, this is a property of the measurement process, not of the wave−function. As long as no information is extracted by the observer (i.e. as long as evolution is unitary) entanglement is an empty concept and all photons can be summed and subtracted, if you can track their phases.

>
> When I do the calculation, I find that, if the beam stopper
> is initially in the state (a|SA>+b|SB>)/sqrt(2), then the
> probability of the detector clicking is 1/8, exactly as it
> was when there was simply a 50% chance that the beam stopper's
> state was |SA>. That is, if my calculations are correct, this
> procedure can't be used to detect superpositions.

We'll see. Assuming I am right, people doing experimental work on "interaction−free" measurement are bound to stumble into the effect I am describing, if they haven't yet.

Cheers,

IV

[1] http://arxiv.org/abs/quant−ph/0206147
[2] http://physicsweb.org/articles/world/13/8/3
[3] I. Vecchi "Is entanglement observer−dependent?" at
http://xxx.lanl.gov/abs/quant−ph/0106003
[4] G. Ortiz, R. Somma, H. Barnum, E. Knill, L. Viola "Entanglement as an Observer−Dependent Concept ..." at

http://lanl.arxiv.org/abs/quant−ph/0403043

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- ***Follow−Ups***:
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        - *From:* rof

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