Re: Superposed observers (was No new Einstein)

Source: http://sci.tech−archive.net/Archive/sci.physics.research/2005−09/msg00342.html

- *From*: rof@xxxxxxxxxxxx
- *Date*: Mon, 19 Sep 2005 21:57:38 +0000 (UTC)

"I.Vecchi" <vecchi@xxxxxxxxxxxxx> writes:

>rof@xxxxxxxxxxxx ha scritto:

>> So you're saying that in some circumstances, a cat could be alive
>> relative to somebody and dead relative to somebody else? Can you
>> give an example of circumstances like those?

>I already did . In the experiment we have been discussing, the
>instances of Nick seeing the cat respectively dead and alive are the
>"somebody" and "somebody else" you are asking for. And we outside
>detect their interference patterns.

>> Isn't that many worlds?

>Arguably , but the observer−dependent nature of entanglement plays a
>crucial role in my model and I find it far easier to formulate it in an
>epistemic setting like RQM rather than in an ontological one like
>many−worlds.

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.

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?

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.

>>>> The reason that I say that he'll be put into the superposition
>>>> again is the following.
>>>>
>>>> 1. It is an axiom of quantum mechanics that after an observable has
>>>> been measured, the system is in an eigenstate of that observable.
>>>>
>>>> 2. To detect the superposition, you need to use an observable
>>>> which has |Nick seeing cat dead>+|Nick seeing cat alive> as
>>>> one of its eigenvectors.
>>>>
>>>> 3. If |Nick seeing cat dead>+|Nick seeing cat alive> is one
>>>> of its eigenvectors, then there is a determinate probability
>>>> that the system will be in that superposed state after
>>>> the measurement (namely after you have received information
>>>> from your thin channel).
>>>>
>>>> 4. The probability of finding |final state> is calculated by using the
>>>> formula
>>>> P(final state)=|<initial state|final state>|^2.
>>>>
>>>> 5. If the initial state is |Nick seeing cat dead>, then the probability
>>>> of finding the final state to be
>>>> (|Nick seeing cat dead>+|Nick seeing cat alive>)/sqrt(2) is 50%,
>>>> calculated by using the formula given in step 4.
>>>>
>>>> I think this is the crux of where we have been disagreeing.
>>>> Let me know which step of the above, if any, you disagree with.
>>>>
>>>

>IV:

>>>The point is that when you agree beforehand with Nick and tell him "Kill
>>>the cat" or "Put the coin head upwards" instead of "Let the Geiger do its

>>>job" or "Toss the coin" you are changing the experiment. You are changing
>>>your epistemic perspective and therefore the basis in which you extract
>>>information. Whatever the result of the measurement to detect superposed
>>>Nicks you will already know that the cat is dead or that the coin shows
>>>head and that firing a split photon through the box will not change that.
>>>You won't absorb/interpret information from the measurement readings in
>>>the same way.
>>>
>>>I can elaborate on this but I think it's pretty clear.

>RoF:

>> You are changing the initial state of the system, but not the
>> experimental arrangement used.

>We are not talking about measuring Nick's states directly, but through
>measurement outcomes that are entangled with them. The point I am
>making is based on the fact that entanglement, being observer−dependent
>, may change according to the observer's epistemic perspective.

>As a simple step towards understanding my point consider the situation
>where Nick is behind a wall and we agree before the experiment that if
>he tosses a coin and gets head, he'll raise a red flag, otherwise he'll
>raise a white flag. The white flag collapss me into the Nick−head
>branch, the red flag gets me into the Nick−tail branch. Now consider
>the situation where we agree before the experiment that if he tosses a
>coin and gets head, he'll raise a white flag, otherwise he'll raise a
>red flag. The white flag now collapses me into the
>Nick−tail branch, the red flag gets me into the Nick−head branch.

>In the two cases the same signals are entangled with different
>eigenvectors.

>In my full experiment you are not observing directly Nick or the cat,
>but an outcome which is entangled with it. Again, entanglement is
>observer−dependent. It depends on the epistemic perspective of the
>observer. When you know that the initial state of the system is |Nick
>seeing cat dead> you are changing the epistemic perspective, i.e, the
>way in which the measurement outcomes are entangled with Nick's states.

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.

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".

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. 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.

>> Let me try to explain it in a different way. You will
>> do one experiment to detect superposition of observers.
>> You will claim (correctly, if the experimental design
>> is good) that finding the light on 100% of the time
>> is evidence that a superposition is being detected.
>>
>> However, as in all such experiments, you need a control
>> experiment, to demonstrate that when there *isn't* a
>> superposition, you get different results.

>Obviously.

>> So you will
>> have to do the same procedure with a Nick/cat system
>> which isn't in a superposition. Now, when you do
>> this control experiment, you will (if all goes well)
>> find that the light goes on only 50% of the time.
>>
>> It is this control experiment, in which the observable
>> being measured is the same (and hence has the same
>> eigenvectors),

>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.

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. That is, if you prepare the system in
the state |l>+|d> and then do *something* and get *some result*,
then you need to do a control experiment with the system
prepared in a different state (|l> or |d>), and do
the same something and get a *different result*. You are
saying that you can't do the same something because changing
the initial state changes the observable.

>> but in which the initial state of the
>> system is different, which will resurrect cats and
>> alter Nick's memory, 50% of the time. The proof is
>> above, in steps 1−5.
>>
>> The crux is that you need to use an observable with

>> an eigenstate like |Nick seeing cat dead>+|Nick seeing cat alive>
>> if you want to detect superposition. If you have an
>> observable with an eigenstate like that, then when you
>> measure that observable, the system will sometimes
>> end up in exactly that state. You won't be able to
>> start with a system in the state |Nick seeing cat dead>,
>> and then measure the interference observable and still
>> leave the system in the |Nick seeing cat dead> state.
>> That would be like measuring the x−spin of a spin−half
>> particle without affecting the z−spin.
>>

>This is just different from what I am describing. I am talking about
>measurements outcomes which are entangled with Nick's states.
>Signs.

>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.

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%, 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.

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.

R.

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- ***Follow−Ups***:
    - ***Re: Superposed observers (was No new Einstein)***
        - *From:* I.Vecchi
- ***References***:
    - ***Re: Superposed observers (was No new Einstein)***
        - *From:* I.Vecchi
- Prev by Date: ***Spinors***
- Next by Date: ***Re: Gauge Transformations in Momentum Space?***
- Previous by thread: ***Re: Superposed observers (was No new Einstein)***
- Next by thread: ***Re: Superposed observers (was No new Einstein)***
- Index(es):
    - ***Date***
    - ***Thread***