Re: QM Measurement Problem

Source: http://sci.tech−archive.net/Archive/sci.physics.research/2008−03/msg00000.html

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- *Date*: Sat, 1 Mar 2008 16:38:32 +0000 (UTC)

In article <c15007a2−346c−4b96−a0ed−5678332bb59d@xxxxxxxxxxxxxxxxxxxxxxxxxxxxx>, dougsweetser@xxxxxxxxx says...

> Hello Gerry:
> You wrote:
>
>> A particular atom, say the one creating the top serif of the 'D', can consistently be observed to be in the same place, and it is not moving anywhere. There is a real sense in which its position is known exactly, and its momentum is zero. It is living in the classical world, precisely because of its entanglement with the other atoms.
>
> One certainly can do a series of experiments where the atoms are proven by observation to be sitting right on top of the 'D'. One could do another series of experiments to show that the momentum is zero. One cannot do a single experiment to show that in a measurable sense, "its position is known exactly, and its momentum is zero" without violating the uncertainty principle, the variation of the measurement of the position x times the variation in the measurement of the momentum px must be greater than the super tiny hbar.

Indeed. But why would you need to do any measurements when you know exactly where it is at all times? For many purposes, the uncertainty principle is irrelevant when it comes to this atom. As I was saying, for these purposes it's living in the classical world.

> This was an instructive comment:
>
>> The atoms in the solid are strongly entangled with others in their environment − the electrons in your vaguely−described 'cloud', presumably, are not.

> The cloud is both very precise and reproducible. There are many systems that with their superposition of states have a location where there is zero probability to find the atom. An experiment can be set up to measure the probability distribution of the system over space, and we find that there are places with zero probability. We label this quantum interference. Unfortunately, we bring with us the notion of classical interference, where one thing gets together with another thing destructively. That is not the way quantum systems work − everything is independent.

I'm not sure what you are getting at here. Our usual model of quantum interference is based on the same equations as the interference of idealised classical waves. (The interactions of classical waves such as ripples in water are never completely linear, of course.) In this model the positions where the probability of finding an atom is zero are those where the wave functions associated with possible states/transitions of the system interfere destructively.

>> You could semi−plausibly have a superposition state that looked like a cat that you could not tell was alive or dead. It would instantly collapse into one or the other, or more likely into a very sick cat.

> ..

>> So you are taking the classical results observed after opening each box, and superimposing them. Just what I said. No picture of an observed superposition state. No indication of interference between dead and alive states.

> This indicates we are not communicating so well on these issues, which is not uncommon. There is no need for a sick cat state. Nor is there a need to show interference between the dead and alive states. As soon as I discuss making a measurement of anything, you slap the label "classical result", a behavior I find mystifying. The CCD camera at the end of a two slit interference experiment would appear to fit this notion of classical result since the signals are either on or off.

Yes − the photograph of an interference pattern in a two−slit experiment is entirely classical. But the picture shows an interference pattern − something that is not present in your picture of Schrodinger's cat. The latter picture could be drawn by somebody who has never heard of quantum mechanics.

> So here is your definition:

> > Classical result = what you get when you open the box and see a dead cat or a live cat. Nothing more.

> Unfortunately, I don't get what you mean. For me, what classical physics is about is our ability to watch a system, say a live cat, evolve in time. We can watch a cat go from alive to sick to dead over a period of observation.

But the period required for decoherence in a cat is so short that the smallest instant you could watch it for is more than long enough!

> The SSCE I described ("Simplified Schrodinger's Cat Experiment"),

Hey, that was my phrase, describing a different experiment :−)

> there is no observation you can ever do with the cat transitioning in time from live to dead. One gets one or the other. The best we can do to summarize the results is a picture like I provided.

Which means that there is no quantum mechanics to see in the summary of the results.

> Neat, I see a connection to quantum interference. Earlier I had said there is no "sick cat" state. That is a state the classical physicist would expect to see, part of the transition in time from live to dead. In the precise, repeatable system I set up with a thousand cat clones, not a single one was sick. It is the omission of expected states that many find troubling about quantum mechanics.

Again, this omission is purely classical. If you repeat the experiment enough times, the proportion of sick cats will be the (approximately) same as the proportion of (non−poisoned) cats you would classically have expected to fall ill. There is no constructive or destructive interference − just classically additive probabilities.

The transition from live to dead in the case of the cats for whom the poison bottle was broken will be observed to have occurred before the box was opened, in all of the boxes where the bottle was broken. Traces of it will be detectable if the cat is autopsied.

> > "Unambiguously live and dead"? What do you mean by that?

> The cats in the system are never sick. It is also vital to emphasize
> I am talking about _many_ cats, not a single cat. Issues in quantum
> theory cannot be understood by reflecting on a solitary cat. One
> needs a great many of them, all identical. This is not a multiverse.
> It is a system constructed out of lots of cats, half of them standing,
> prancing, and playing, the other half stone cold dead.

But none exhibiting any real quantum mechanical behaviour.

> I wish to
> collect all my data together of what I can expect to find, and that is
> the superposition of live and dead cats, never sick, unambiguously
> live and dead.

As I pointed out above, the sick state (a transition state between live and dead) will be observable via autopsy or perhaps other signs in all of the cases where the cat is found dead. It will be observed to have occurred before the box was opened.

None of this is in any way surprising, given that the purpose of Scrodinger's thought experiment was to point out the oddness of quantum theory, and ask how we should interpret it − not to demonstrate its truth. For the latter, the two−slit experiment, experiments with entangled photon pairs, etc., are best. A nineteenth−century physicist would have correctly predicted the results that would be obtained from the Schrodinger Cat experiment, because the predictions of quantum theory and classical theory are the same for it.

− Gerry Quinn

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