

## Re: Layman Q: wave funtion and measurement

**Source:** <http://sci.tech-archive.net/Archive/sci.physics/2004-09/6317.html>

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**From:** Edward Green (*spamspamspam3\_at\_netzero.com*)

**Date:** 09/15/04

Date: 14 Sep 2004 18:36:29 -0700

"Fernando Cacciola" <fernando\_cacciola@hotmail.com> wrote in message news:<2q60j4Fqog0qU1@uni-berlin.de>...

Hi, Fernando. Just in case you are still poking about here, waiting anxiously for my latest philosophical pronouncement. ;-)

> "Edward Green" <spamspamspam3@netzero.com> escribió en el mensaje  
> news:eca320d0.0409061734.49be01b9@posting.google.com...  
>> "Fernando Cacciola" <fernando\_cacciola@hotmail.com> wrote in message  
> news:<2q1b4fFqjseqU1@uni-berlin.de>...

<...>

>>> *If I got your right, the wave function says that a system is in a state  
>>> being a linear combination of eigenstates.*

Note that the state is expressible as a linear combination in *\_any\_* basis, and that in quantum mechanics, we are simply in the habit of taking the eigenstates of certain operators to form our bases.

>>> *But how can an objective entity be in a combined state?*  
>>  
>> *It happens all the time, even to the nicest classical entities. ;-)*  
>>  
>> *Say a classical particle at time t1 has velocity v1, east at 1 m/s.  
>> And say at time t2 this particle has velocity v2, north at 1 m/s.  
>> Finally at time t3 the particle has velocity v3, northeast at sqrt(2)  
>> m/s.*  
>>  
>> *Since  $v_3 = v_1 + v_2$ , I guess we have at t3 a "combined state"?*  
>>  
>> *To complete the quantum mechanical analogy, imagine that just after t3  
>> we pass the particle through a forked passage which ejects it moving  
>> either due east or due north, with probabilities 1/2, 1/2.*  
>>  
> *Very interesting analogy.*  
> *What puzzles me is the fact that upon observation we see either v1 or v2.*

Every theory has a "just the way it is" level. The fact that we only measure one of the eigenvalues of the observed variable is on this level. But QM tells us how to calculate the probabilities.

I think I know what you are thinking, though, and it is certainly a point of view abetted by popular accounts. If you stop thinking of superimposed states in a particular basis as some ghostly superposition of classically incompatible conditions and simply a definite physical state which happens to generate definite experimental outcomes according to some probabilistic rule, things will seem less weird.

- > *Perhaps it is as if we could view this system only through an orthogonal*
- > *window frame aligned with  $v_1$  and  $v_2$*
- > *so that we only see it moving in those directions while it is really moving*
- > *in both.*
- > *But my analogy breaks because in this setup we'll see some non-zero value*
- > *for  $v_1$  and some non-zero value for  $v_2$ ; no collapse here.*

The forked path idea comes closer to a quantum measurement: the system is forced into a particular eigenstate of the observable; it's not a passive observation, it's a physical process in which the measured system interacts with the experimental set-up.

- > *I can easily see that in the case of the 3D euclidean space, that we can*
- > *choose a basis for it doesn't mean that such basis cannot itself*
- > *be generated by some other (I can choose any 3 orthogonal unit vectors as a*
- > *basis). All vectors in our space are linearly dependent.*
- > *You're saying that the same happens with the "vectors" used to describe*
- > *states in QM.*

Mathematically the analogy is precise.

<...>

- > > *Let me emphasize again: in the minimalist interpretation (if we want*
- > > *to name the assumption free understanding of the formalism) the state*
- > > *of the system prior to the measurement determines*
- >
- > *I guess you meant "the wave function of a system..."*

Yes. State, state function, state vector, wave function; all mean the same thing.

- > *oh, well, let me try again:*
- >
- > *The "state" of a system is a magnitude*

It's an element of an abstract space. "Magnitude" is not quite the term of art.

- > *that expresses what is knowledgable about it.*
- > *It is not a direct account of the objective reality of the system but an*
- > *account for what is observable about it.*

Ah... QM does force one to review one's philosophy, does it not?

We don't have to be quite so global and absolutist. I don't know what is "knowable" about a physical system. But I do know within a particular formulation of quantum mechanics: the state vector. Even here, there is no "the" state vector: we may choose to ignore or include certain effects or interactions in our formulation, same as in other areas of physics. But, having chosen a particular model the state vector is indeed as complete a physical description as we can make of the system; under that model!

Tautological but self-consistent.

In this sense, the situation is no different from other physical theories: everything we can know about a region of vacuum as described by the classical theory of electromagnetism is embodied in a pointwise specification of the electric and magnetic fields. Everything we can know about a region of spacetime under the general theory of relativity is embodied in a specification of the metric.

I know something is made of an alleged qualitative difference between the quantum state description and other descriptions of physical states, but I would not make too much of it.

To get farther into your desire to distinguish the model from the really real system we'd have to digress farther into the philosophy of science than I have a taste for right now. But I suggest there is really no brave new world of QM which is unlike any other physical theory; it's more that QM forces us to examine unexamined assumptions, and put equally muddled but new unexamined assumptions in their place.  
;-)

- > *Given the characterization of "state" I made above, saying that the system*
- > *is "in a combined state" is merely telling something about what it will look*
- > *like if looked upon; but nothing about what really \_is\_ in itself.*

Something not entirely unlike that. But forgetting about any distinction between our model and the world, I was more strongly trying to suggest that the "superimposed" quality of quantum mechanical states is not weird at all.

Try to parse "superposition of states" like this:

|A state which returns result 1 with certainty> +

|A state which returns result 2 with certainty> =

|A state which returns result 1 or result 2 with probabilities  
1/2,1/2>

The final state is *not* a superimposition of results, but merely a new and definite state which is liable to return certain results under certain measurements with certain probabilities. Since you seem to want to give things a psychological cast, say that a happy man will react to a certain piece of news with laughter, a sad man with tears, and that pure laughter or tears are the only possible observations. A whimsical man will react to the same news with laughter or tears according to some probabilities, but this doesn't mean he is in a superimposed state of laughter and tears before receiving the news.

It happens that the precursor states of laughter and tears in our model are vectors in the same space and that the last state is a linear superimposition (combination) of these states, being a third distinct state in the given space. This use of "superimposition" in the space of precursor states which happen to live in a vector space confuses the unwary into thinking we are taking a superimposition of the outcome of various measurements applied to these states.

- > *Le me see: you say that we need the addition of the collapse*
- postulate to
- > *explain*
- > *why if we make another measure immediately we see the same outcome.*
- > *(without the postulate the system could rerandomize immediately)*
- > *Right?*

Things are not entirely unlike that.

I am uncomfortable making weighty absolute sounding pronouncements:  
but I perhaps can make things, if not entirely unweird, no weirder  
than necessary.