Re: The time it takes to emit one photon

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- *From*: nightlight <nightlight@xxxxxxxxxxxxx>
- *Date*: Mon, 15 Aug 2005 13:14:28 +0000 (UTC)

> Correct mathematical description of quantum dynamics of particles
> (and fields) is provided by vectors and operators in infinite−dimensional
> Hilbert (or Fock) spaces.

The abstract Hilbert space aspects of the QM/QED are only a part of the story. To connect with the experiment, which is accomplished by the operational rules of QM/QED, you do need, among other steps, to go to the space−time representation of the abstract Hilbert space elements. The particular separation line in the QM/QED between the formalism and the operational rules is an arbitrary historical convention (due mostly to von Neumann's 1932 formalization), with no more fundamental content than that of an author's choice on how to separate the course material into chapters or lectures.

So, yes, in the _full_ model of physical phenomena, you can draw a line so that on the one side of the line you have formalism with no explicit 3D space and on the other side all the rest (called operational rules), where the explicit 3D space representation has to be used in order to map the predictions of the full model to the readouts of the instruments.

A different convention (such as Bohm's QM) may draw this line differently, so that some of the space−time description is on the formalism side of the line, as well as in the operational rules side.

Hence, your argument above is about conventions, not about substance. De gustibus non est disputandum.

> Only in rare occasions (e.g., the position−space wave−function
> of a single particle) this description can be visualized as a "cloud
> of probability" in the real 3D space.

The EM field operators in Heisenberg picture evolve in regular 3D space (e.g. via Maxwell equations, for vacuum or for linear optical elements).

The evolution in 3N dimensional (N>1) configuration space of regular multiparticle QM can be obtained, as shown by Barut, as a linearization

approximation of the 3D evolution of coupled classical Maxwell−Dirac fields. The 3N dimensional approximation (which is the N particle QM formalism) does differ experimentally from the exact Maxwell−Dirac solutions, and the experiment matches the self−fields ED predictions, not those of the N particle QM. More specifically:

> I am not sure if you can abandon the linearity of quantum mechanics
> (the existence of linear superposition of states) so easily. The rules
> of quantum mechanics follow from the postulates of quantum logic.
> These postulates have very precise and (in principle) experimentally
> verifiable meaning.
>
> Any non−linear "generalization" of QM must violate some of these
> postulates, i.e., violate some fundamental properties of measurements.

Indeed, the Barut's self−fields predictions do deviate experimentally from the predictions of the multiparticle QM (which is obtained as a truncated linearization approximation of the Maxwell−Dirac coupled fields, hence they are certainly not equivalent). This difference, though, turns out to be precisely the radiative corrections, where the QM is wrong and the Barut's self−fields ED is right, and where QM needs to be superseded by QED to obain the experimentally correct results. Barut's self−fields ED agree with the experiments (and QED) here as far as he had carried out the computations (equivalent to the QED's alpha^5 order). So, the QM "works" in the sense of getting the numbers right, but only to the extent that the truncated linear approximation of Maxwell−Dirac dynamics (which is what the multiparticle QM formalism is) works.

>> Returning back to (A1)−(A3) −− that whole argument is in the model
>> space−time using the rules of the model (the QM, the unitary evolution
>> and the collapse). The model (the QM formalism) has time parameter,
>> too, and that is what the T1, T2,... refer to. ....
>
> Are these times T1, T2,... related to some observable events? I guess no.

A wrong guess. Of course, they are related to observable events. The T1, T2... operationally map to the most elemental experimental fact, the times of occurence of the "single results" on aparatus1 (which are here, in A1−A3, treated dynamically as the object2 consisting of object1 + aparatus1). While it is true that you can treat aparatus1 as the QM 'observer', in which case the "single result" on aparatus1 is the result of Born postulate, you can also treat the combined system object1+aparatus1 as an object2, evolving via unitary evolution. The Born postulate in this new object2−convention could be applied only to some hypothetical new aparatus2 (which could be a 2nd observer observing the 1st observer, aparatus1), but not to the aparatus1 any more.

Hence in the object2−convention aparatus1 cannot use Born postulate to allow you to declare that aparatus1 yields a "single result" in a

single try. Yet, if you treat the experiment in the object1−convention, the QM Measurement Theory tells you that there is a sequence of "single results", thus there is a member of that sequence, the "single result" for a given try (which is, obviously, also what the experiment shows).

{ Note that the "single result" discussed here, besides being the most elemental experimental fact, is an absolutely essential ingredient of the QM Measurement Theory, since without it you can't even begin to define the operational mapping for the QM probabilities occurring in the Born postulate (the probabilities are operationally mapped to the normalized counts of the "single results"). For example, you can't coherently claim that there is no "single result", while claiming there is a count of single results, or ratios of limits of such counts.}

Now, the unitary (call it type−1) evolution of object1+aparatus1 cannot produce anything that, in the object2−convention, operationally maps to the "single result" at T1 on aparatus1, which the object1−convention claims (and the experiment shows) to exist. Therefore, von Neumann had to introduce the type−2 evolution of state, the collapse of state, which allows object2−convention to have the operational mapping for the "single result" on the aparatus1. The time T1 corresponds to the time when the "single result" occurs in a given try (they are obviously experimentally accessible values at least approximately e.g. by wiring a timer to a photo−detector, where timer+detector are components of the aparatus1), i.e. to the time when type−1 evolution is replaced by the type−2 evolution. The time T2 (where T2>=T1), corresponds to the time when the type−2 evolution yields controls of the state back to the type−1 evolution. As explained in A1−A3, if you have two _mutually exclusive_ types of state change/evolution, then these times T1 and T2 must exist. The fundamental QM defect is that it has no algorithm to compute numbers T1 or T2 (not even in principle) which the logical consistency requirement implies to exist.

Of course, if the logical consistency isn't a requirement (as in the "pedagogical" expositions, where the teacher's authority combined with the students' confusion will allow any number of incoherent components of a theory to coexist "harmoniously"), you have "no problem." For example, teacher can make go−away our first step above, by declaring: in object2−convention you're not allowed (`cause I say so) to demand an operational mapping for "single result" on aparatus1. What is then the time T1, student asks, which the attached timer within aparatus1 has recorded? Well, the teacher says, the T1 number isn't there until you, which is the aparatus2, reads the aparatus1. Yes, professor, but what if I was a part of that aparatus1 and I saw the T1 on the timer before you (the new aparatus2) had asked me what was the result. Listen kid, you think you saw it, but are you going to believe your lying eyes or what I am telling you is going on? You didn't see it, period. There was no T1 on that timer until I asked you, got it kid? Ok, well, you are right and I was wrong,... but what if you are also part of the aparatus1, and you just said T1 was there only after you asked me? Doesn't that mean that aparatus1 had T1 before some other aparatus2

measured it? Don't be dense kid, I said "after" but didn't say when is this "after" − if I am part of the aparatus1, then this "after" means (because I say so) that there is no T1 until after a third person asks me what did I hear from you. Thank you very much professor, I get it now, but what if there is no any other person, thus no aparatus2, let's say if aparatus1 is defined to be the entire universe? Well, then we get in some more universes... period. Anything goes and "works" just fine in this kind of word games.

Why go to all that trouble? What is the gain when a perfectly coherent theory exists, in which the current QM composite system formalism (the formal basis of the Measurement Theory, entanglement, etc) arises as merely a particular kind of linear approximation of the coupled classical fields, and where there is just one kind, non−linear, evolution (thus there is no collapse and no superposition of the object1+aparatus1 state and there is no entaglement of object1 and aparatus1)?

It is not as if there was ever an experiment which had excluded a purely local nonlinear field thery. Go ask experimenters −− there never was any such experiment. (Note that Barut's self−field ED predicts correctly all the radiative corrections, all of the crown jewels of the legendary QED accuracy, as far as his calculations were carried out, to the alpha^5 order.) There is only a wishful conjecture, a pipe dream with no actual design, that such an experiment (so−called "loophole free" Bell test, as this 'pipe dream' is euphemistically labeled) will be done some day when the technology has advanced enough. How that will be done, no one knows (note that the so−called "ideal detector" isn't a design, or any kind of how−to operational recipe, but just a pair of words written one after the other). I can see why someone selling investment opportunities in his Quantum Computing company would prefer to advocate "magical version" of QM. But why should the rest of us buy into all the nonsense and jump all these silly hoops? Some day, when our 'gender neutral physical science studies' become plain old 'physics' again, kids will laugh at our silly verbal acrobatics, wondering: Why? What possessed them?

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- ***Follow−Ups***:
  - ♦ ***Re: The time it takes to emit one photon***
    - ◊ *From:* Igor Khavkine
  - ♦ ***Re: The time it takes to emit one photon***
    - ◊ *From:* Eugene Stefanovich

- ***References***:
  - ♦ ***Re: The time it takes to emit one photon***
    - ◊ *From:* nightlight
  - ♦ ***Re: The time it takes to emit one photon***

◊ *From:* Eugene Stefanovich

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