Re: Download a new book on quantum mechanics and relativity.

Source: http://sci.tech−archive.net/Archive/sci.physics.relativity/2004−12/0699.html

---

From: Eugene Stefanovich (*eugenev_at_synopsys.com*)
Date: 11/24/04

```
Date: Wed, 24 Nov 2004 10:39:11 −0800
```

Bilge wrote:
> *Eugene Stefanovich:*
> *>Bilge wrote:*
>
> *>> That's also completely ridiculous. By definition, a force changes*
> *>> an intial state into another state, so how can it be diagnolizable?*
> *>> If you diagnolized it, all of its eigenvalues would be zero, otherwise,*
> *>> you would have the rather strange situation where a force acts on a*
> *>> particle and doesn't change its momentum or energy. You confuse the*
> *>> time dependence of an expectation value of an operator, with an actual*
> *>> operator.*
> >
> *>I define force acting on particle i as commutator of the particle's*
> *>momentum with the total Hamiltonian*
> >
> *>f_i = i[p_i, H]*
>
> *Do you read what you write?*
>
> *f_i \psi_n = a_n \psi_n = i[p_i, H] \psi_n*
>
> *= i a_n (p_i H − H p_i) \psi_n*
>
> *You have two possibilities:*
>
> *(1) \psi is simultaneously an eigenvector of p_i and H, in which*
> *case, f_i is identically zero.*
>
>
> *(2) \psi is either an eigenvector of either p_i or H but not both,*
> *or an eigenvector of neither p_i nor H, in which case, you can't*
> *define all three operators, f_i, p_i and H simultaneously as*
> *observables for your system.*
>
> *Take your pick of any two of the three operators.*

I do not understand your concerns here. Surely, f_i, p_i, and H do not
commute with each other (in the general case). Both three are good
quantum observables, but they cannot be measured simultaneously. So
what? Most pairs of observables in QM are not commuting and not
simultaneously measurable (like x and p). That's what QM is about.

>
> >This is a Hermitian operator, and it is certainly an observable in the
> >classical limit.
>
> So are p and x, but they can't both be observables in a set of operators
> defined for a system.

Yes, p and x cannot belong to the same set of mutually commuting
operators. They certainly belong to different sets. You can describe
system in the momentum representation or in the position representation
(or in the energy representation, or whatever). These descriptions are
complementary. This does not make x (or p, or f) less "observable" than
any other physical quantity.

I do not think we disagree here (in such a case one of us completely
misunderstands quantum mechanics, which I do not believe is the case).
I think we are simply using different terminology, that's all.

>
> >f_i(t) = d/dt p_i(t)
>
> Wrong. f_i is d<p_i>/dt. The derivative of an expectation value of an
> operator is not the same thing as an operator.

I wrote this formula for the classical limit of the observable "force".
Correct quantum expression is

<f_i(t)> = d/dt <p_i(t)>

>
> >I wouldn't trust such vague statements as "force changes an initial
> >state into another state" for figuring out the structure of the
> >operator of force. You have the mathematical definition (above).
> >The rest is a matter of simple math.
>
> I did the math above for you and proved that you can't both define
> a force operator and have good states of momentum and energy. Hence,
> if your states are good momentum abd energy states, f_i cannot
> also be one of your observables. Period. This is not negotiable,
> and if you object, read any introductory quantum mechanics text
> or cite an online reference.

I disagree. Observables (Hermitian operators) and states (unit vectors
in the Hilbert space) are independent quantities. Your state could
be an eigenstate of an operator F. Then each measurement of observable F

in this state will yield the same value. If the state is not an
eigenstate of F, then different measurements of the observable F in
this state
will yield different values. The probabilities of outcomes are
determined by the squares of the values of the wave function in the
"F representation". For F to be or not to be an observable does not
depend on the state.

[...]
>
> [...]
> >> >Particle spin is obtained naturally in Wigner's theory of irreducible
> >> >unitary representations of the Poincare group (1939). A good reference
> >> >is section 2.5 in Weinberg's book vol. 1.
> >>
> >> While that might be a good reference, that reference certainly
> >> contradicts just about everything you are claiming. For example, does
> >> weinberg suggest that anything moves faster than `c' based upon what he
> >> writes?
> >
> >He doesn't suggest that. But he doesn't calculate the speed of
> >propagation of interaction either. I remind you that QED (and
> >standard model, in general) only tells about the S−matrix.
>
> Don't be ridiculous. QED contains a great deal of information that is
> not directly related to any scattering question, by virtue of how it is
> derived and the form of the equation. It simply is not possible to have
> the interaction propagate at a speed different from `c' without giving the
> photon a mass and without additional terms in the interaction (i.e., a
> higgs field), giving up charge conservation.

I disagree, because I have a theory in which photon has zero mass,
charge is conserved, there are no Higg's particles, and interaction
propagates instantaneously.

> Furthermore, any
> approximation I derive from qed is still qed. So, for example, if you look
> at the chapters throughout bjorken & drell starting with the very first
> chapter, where the write the canonical momentum as p_u −> p_u − eA^u,
> you'll note that you have precisely the terms in the qed lagrangian that
> correspond to:
>
> __
> \psi(\gamma^u p^u − m)\psi − j_u A^u
>
> _
> If you also note that j_u A^u = \psi A/ \psi (A/slash), you'll
> find that written all over bjorken and drell. I have no idea why you
> say that qed is limited to the S−matrix. Bjorken and Drell explicitly
> use the terms I wrote down to calculate lots of things.

Name just one thing which is not described by the S−matrix and
calculated in QED. Name just one time−dependent process described by
QED. I bet you cannot do that.

[...]

> >> *Does weinberg say that gauge invariance is irrelevant because of*
> >> *poincare invariance?*
> >
> >*I never said that gauge invariance is irrelevant.*
>
> *I beg to differ. If you want to maintain that position, I'll go and*
> *find the message−id's in which you did say that.*

I said many times that gauge invariance is a part of mathematical trick
(also called canonical quantization) which is very helpful in deriving
Poincare invariant interacting Hamiltonians. Nobody can do such
derivations in QED or in standard model without invoking the gauge
invariance idea. I always said that gauge invariance and fields in
general are just parts of this trick, and they have no relationship
to any observation. Once the Hamiltonian was derived, we can forget
about fields and gauge invariance (they become completely irrelevant
at this point) and perform all calculations just as in usual
quantum mechanics, without fields and gauges.

>
> *[...]*
> >*consequences. My point was that in doing that there is no no need to*
> >*invoke gauges and fields. All information required to obtain the time*
> >*evolution and bound states is already contained in the Hamiltonian.*
>
> *Apparently there is, since you can't have instantaneous propagation of*
> *any observable in a relativistic theory much less in a gauge invariant*
> *theory.*

I heard this statement from you many times, but I haven't heard a proof
yet. Relativistic theory can have instantaneous interaction. There is
entire branch of quantum physics initiated by Dirac in
"Forms of relativistic dynamics" Rev. Mod. Phys. 21 (1949), 392,
and continued by
B. Bakamjian, L.H. Thomas "Relativistic particle dynamics, II"
Phys. Rev. 92 (1953), 1300 and many others including Foldy, Sokolov,
Coester, Polyzou, Klink, etc. In this approach, relativistic
direct (=instantaneous) interactions in many−particle systems are
constructed. In my book I basically generalized this approach to the
case when the number of particles is not conserved.

[...]
>
> >> *In case it hasn't dawned on you yet, your clothing*
> >> *transformation dresses the electrons with the virtual photons you dislike.*

> >
> >Yes, that's one way to look at the dressing procedure: The dressed
> >Hamiltonian describes interactions of dressed electrons (bare electron +
> >its cloud of virtual particles). Another way to look at this procedure:
> >there are no "bare" electrons and "virtual" particles.
>
> In that case, you'll be struggling to describe any phenomena that isn't
> described by ordinary quantum mechanics. You have the following problem.
>
> The mass of the electron is 0.511 MeV. The classical radius of an
> electron with charge `e' is 2.82 x 10^−15 m. The known upper limit
> on the electron radius is < 10^−17 m. That gives a mass > 143 MeV.
> What precisely are you doing when renormalizing your theory (in
> physical terms)? Don't say that it's just a mathematical operation.
> That ``mathematical operation'' shows up as real data.

I do not have this simplistic view of the electron as a ball of
certain radius. Neither I am willing to calculate the mass of the
electron from the self−interaction of this ball. In my approach,
there is no self−interaction of particles, so electron's mass does
not have the electromagnetic origin.

[...]

> Therefore,
> you cannot choose operators obtained from all ten generators to
> be simultaneously observable. You have to choose. Life's a bitch.
>
> [...]
> >> I'm sorry, but (1) what are modifying if you modify the system without
> >> modifying anything in your system,
> >
> >I start from a non−interacting system in which generators of the
> >Poincare group take the form of the sum of 1−particle generators, i.e.
> >
> >P = P_0 = p_1 + p_2
> >H = H_0 = h_1 + h_2
> >J = J_0 = j_1 + j_2
> >K = K_0 = k_1 + k_2
> >
> >The interaction is introduced by adding interaction terms to these
> >generators. In the instant form, the interacting generators are
> >
> >P = P_0 = p_1 + p_2
> >H = h_1 + h_2 + V
> >J = J_0 = j_1 + j_2
> >K = k_1 + k_2 + Z
> >
> >where V and Z are functions of p_1,r_1,p_2, r_2 selected in such way
> >that commutation relations between generators P,H,J,K are not perturbed.
>

> *Since you cannot choose all of those to be simultaneously diagonal,*
> *they are not all observables.*

Disagreed. There are many observables even for a single particle:
x (position), p (momentum), j (angular momentum) s (spin), h (energy),
etc. Some pairs of these observables commute, some don't.
We can choose different sets of mutually commuting observables from this
list, and define different "representations". Operator represents an
observable even if it is not diagonal in the selected "representation".

>
> >*If you know any other way of describing a relativistic interaction in a*
> >*quantum system, please let me know.*
>
> *I'm not arguing with the technique. I'm arguing with your interpretation*
> *of what you've derived and the fact that you treat non−commuting operators*
> *as being simultaneously observable.*

Where did I say that?

>
> *[...]*
> >> *(2) how can an observer measure the individual particles when the*
> >> *particles are all have spacelike separations on a t = constant*
> >> *hyperplane without violating poincare invariance?*
> >
> >*That's easy. We can certainly synchronize all clocks in physical*
> >*laboratories on Earth (one can just listen to the Greenwich radio signal*
> >*and introduce correction R/c where R is the distance from ones place*
> >*to Greenwich and c is the speed of light; let us disregard such*
> >*subtleties as gravity and Earth's spherical shape and rotation).*
>
> *No, I'm sorry, you cannot do that.*

Why?

>
> >*Then we can measure positions of two electrons (one in Greenwich,*
> >*and another in California) at the same time instant. What's wrong*
> >*with that?*
>
> *You haven't measured the electrons at the same instant. You've*
> *measure one electron along the past light cone of the other. You*
> *are committing a common fallacy (at least common on this newsgroup).*
> *However, it's well known that _any_ two events with a spacelike*
> *separation can be made simultaneous, so two events which are simul−*
> *taneous have _no_ intrinsic time ordering.*

If these two events are not related to each other by interaction, then
I agree with you. However, if one (physical) event creates the other
(physical) event by means of instantaneous interaction

(for example, shaking of one charged particle induces the movement of
the other) then both events are simultaneous in all reference frames.
This idea is explained in my paper
"Is Minkowski
space−time compatible with
quantum mechanics?" Found. Phys. 32 (2002), 673.

and in section 12.3 of my book.

[...]