Cracks of fundamental quantum physics

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Abstract

The fundaments of quantum physics are still not well established. This paper tries to find the cracks in these fundaments and suggests repair procedures. This leads to unconventional solutions.

Story

In its first years the development of quantum physics occurred violently. As a consequence some cracks sneaked into the fundaments of this branch of physics. A careful investigation brings these cracks to the foreground. The endeavor to repair these cracks delivers remarkable results.

In the early days of quantum physics much attention was given to equations of motion that were corrections of classical equations of motion. The Schrödinger approach was one and the Heisenberg approach was another. Schrödinger used a picture in which the state of a particle changes with time. Heisenberg uses a picture in which the operators change with time. For the observables this difference makes no difference. Later Garret Birkhoff, John von Neumann and Constantin Piron found a more solid foundation that was based on quantum logic. They showed that the set of propositions of this logic is isomorphic with the set of closed subspaces of an infinite dimensional separable Hilbert space, whose inner product is defined with the numbers taken from a division ring. The ring can be the real numbers, the complex numbers or the quaternions. Since then many physicists do their quantum physics in the realm of a Hilbert space.

However, these physicists quickly encountered the obstinate character of the separable Hilbert space. Its normal operators have granular eigenspaces. Most of these physicists resorted to the corresponding rigged Hilbert space, but in doing so they neglect that in this way the relation with quantum logic gets lost.

Further, it appears that the separable Hilbert space cannot represent physical fields and cannot represent dynamics. This is a severe drawback and it looks as if the switch to the rigged Hilbert space becomes mandatory. For example quantum field theory represents fields as operators that reside in this rigged Hilbert space.

On the other hand there are more and more signals that nature is fundamentally granular and rigged Hilbert spaces do not provide that feature. This guides backwards to the separable Hilbert space. But in that case we must learn to live with its granularity. In addition we must find other ways to represent fields.

The rigged Hilbert space gave similar problems with representing dynamics as the separable Hilbert space does. There is no place for time as an eigenvalue of an operator neither in separable Hilbert space nor in rigged Hilbert space. For that reason, it is better to accept that the separable Hilbert space can only represent a static status quo.

In contrast to the rigged Hilbert space, the separable Hilbert space cannot provide an operator that offers a dense coordinate system as its eigenspace. The densely packed granules would immediately generate unnatural preferred directions. In contrast to this, the rigged Hilbert space can deliver a helpful background coordinate system that is directly related to positions of field values. However, the equivalent operator in the separable Hilbert space must not be used in order to locate Hilbert vectors in a regular way. As signaled before, this will introduce anomalies.

It is possible to define a normal operator in separable Hilbert space whose eigenspace consists out of a set of chains that are put together from granules. In the chain the granules are ordered. In each chain one granule is exceptional. We call it the current granule. The part of the chain that ends just before the current granule is called the past sub-chain. The part that starts just after the current granule is the future sub-chain. Via the background coordinate system that is delivered by the rigged Hilbert space each granule gets its own position. That value becomes the eigenvalue of the Hilbert vector that corresponds with the granule.

The operator has an outer horizon. Outside this horizon its eigenspace does not contain chains. It might also have inner horizons such that inside these inner horizons no chains exist. The chains are closed or they start and end at a horizon. They may also reflect tangentially against a horizon. These chains have much in common with the strands in Schiller's strand theory. However, they are not exactly the same.

A probability amplitude distribution that is attached to the current granule takes care of the fact that the chain in the neighborhood of the current granule stays sufficiently smooth. This becomes important when dynamics is implemented because with each dynamic step the current granule either stays at its current position or it moves one place ahead in the chain.

The rest of the chain may be influenced by the probability distributions of the current granules of other chains. Taken over a sequence of dynamic steps, the chain appears to fluctuate. The fluctuation determines the probability distribution and vice versa.

Depending on its type, an elementary particle relates to one, two or three of these chains. In this way the current granules of these chains are related to the current section of the path of the particle.

The addition of probability amplitude distributions to the current granules extends the separable Hilbert space to a new construct. For that reason we call this construct an extended separable Hilbert space.

Dynamics is implemented by a model that consists of an ordered sequence of such extended Hilbert spaces. It corresponds to an equivalent sequence of extended quantum logics.

The probability amplitude distribution that is connected to the current granule is a basic field constituent. The superposition of all these basic constituents forms a covering field.

The static decomposition of the covering field into a rotation free part and one or two divergence free parts defines a local curvature. This curvature can be used to define a derived field. We will call this the curvature field. It has all aspects of the gravitation field. When split back into curvature fields that are private to the particles the private curvature field can be used to attach the property "mass" to the corresponding particle.

The main difference between my approach and Schiller's approach lays in the interpretation of the source of the observable data. The fundamental postulate of Schiller's strand theory is that the crossing switches of strands deliver the observable data. In my approach the cloud of quanta that corresponds with the moving and rotating probability amplitude distributions that are connected to the current granules carry the observable data. There must be no difference between the results of the two models.

Further, Schiller's strand theory derives fields of the tails of strand tangles. In my approach the fluctuation of the chains are controlled by fields.

The described concepts form the basis of a more consistent model. It delivers the proper equations of movement.

References:

A historic review of what happened can be found in: "Quantum Theory: von Neumann vs. Dirac"; http://www.illc.uva.nl/~seop/entries/qt-nvd/.

Christoph Schiller; Strand theory. www.motionmountain.net/research.html .

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