Quaternionic Quantum Physics

By Ir J.A.J. van Leunen

Retired physicist & software researcher

Location: Asten, the Netherlands

Website: http://www.crypts-of-physics.eu/

Communicate your comments to info at that site.

Last version: April 5, 2012

Abstract

This paper presents a reason for the existence of the wave function. Most physicist use a complex wave function as the representative of a quantum physical item without further thinking about why that choice is made.

A slightly different choice for the wave function throws a completely new light on fundamental physics. For example, a quaternionic wave function converts each linear equation of motion into a balance equation and turns fundamental physics into a space streaming problem.

The fact that such a slight change has such deep and unexpected effects shows that the fundaments of physics are still not well comprehended.

This paper introduces the notion of the HBM Palestra, which is the playground for all activity that takes place in universe. The paper also introduces Quantum Fluid Dynamics (QFD).

Wave functions

It is a mathematical fact that both the real numbers and the rational numbers contain an infinite amount of elements. It is possible to devise a procedure that assigns a label containing a different natural number to every rational number. This is not possible for the real numbers. Technically this means that the set of real numbers has a higher cardinality than the set of rational numbers. In simple words it means that there are far more real numbers than there are rational numbers. Still both sets can densely cover a selected continuum, such as a line. However, the rational numbers leave open places, because infinite many real numbers fit between each pair of rational numbers.

Complex numbers and quaternions have the same cardinality as the real numbers. They all form a continuum. Rational numbers have the same cardinality as the integers and the natural numbers. They all form (infinite) countable sets.

Now take the fact that the set of observations covers a continuum and presume that the observed objects form a countable set. This poses a problem when the proper observation must be attached to a selected observed object. The problem is usually over-determined and in general it is inconsistent. The problem can only be solved when a little inaccuracy is allowed in the value of the observations.

In quantum physics this inaccuracy is represented by the wave function, which is a probability amplitude distribution. It renders the inaccuracy stochastic.

According to analyzes in 1936 of John von Neumann[1] and Garret Birkhoff[2], quantum physics uses separable Hilbert spaces as the realm in which it does its mathematics. A separable Hilbert space has only a countable set of dimensions. So, a particle location-operator can only have a countable set of eigenvectors. Each eigenvector represents a location. As a consequence, only a countable set of relevant locations exists. That is why wave functions must solve the problems that are posed by the availability of a too large variety of observations.

In the Hilbert Book Model[3] this argument is used in order to explain why quantum physics contains wave functions and from the existence of wave functions the existence of physical fields is derived, thus this argument has far reaching consequences. One could apply non-separable Hilbert spaces, such as a rigged Hilbert space, but that takes the argument away why quantum physics must contain wave functions. It would also deprive quantum mechanics from its fundament; quantum logic.

---

[1] http://en.wikipedia.org/wiki/John_von_Neumann#Quantum_logics
[2] http://en.wikipedia.org/wiki/John_von_Neumann#Lattice_theory
[3] See the corresponding section

Probability amplitude distributions

The wave function of physical particles is a typical example of a probability amplitude distribution. Most physicists use a complex probability amplitude distribution (CPAD) for that purpose. The squared modulus of a CPAD can be interpreted as the distribution of the probability density of the presence of the carrier of the properties of the particle. However, it is equally well possible to use a quaternionic probability amplitude distribution (QPAD) instead of a CPAD. This option has several advantages. A static QPAD can be considered as the combination of a real charge density distribution and an imaginary current density distribution. What these charges and currents are can be left to later investigation. It is appropriate to interpret the charge as the ensemble of the properties of the carrier of the charge. As with the CPAD, the squared modulus of a QPAD can still be interpreted as the distribution of the probability density of the presence of the carrier of the properties of the particle. The main difference is that with QPAD's fundamental physics can be interpreted as a streaming problem.

This can be taken one step further. This occurs by deliberating about the carriers. What can they be? What is moving across the parameter space of the QPAD? A daring and at the same time promising choice would be that they are tiny patches of the parameter space of the QPAD. The parameter space can be seen as the imaginary part of a quaternionic distribution. By transporting tiny patches that originate of that space to another location in that space the space can be locally compressed and may decompress at other locations. In this way a kind of space-atmosphere is created.

This daring interpretation immediately gives an explanation for the existence of space curvature in the neighborhood of particles.

QPAD versus CPAD

The choice for QPAD versus CPAD is a purely mathematical decision. It does not influence physical reality. It only changes the view that human's may have on physics. It appears that the choice for QPAD's turns the theory about fundamental physics into a streaming theory. In this quaternion oriented theory the usefulness of the toolkit of complex number oriented physics will reduce to special one-dimensional cases. It means that tricks that work in complex QED and complex QCD will in general not work for QPAD's.

Inside the parameter space of a QPAD occur features such as charge density distributions, current density distributions, sources, drains, compression regions and decompression regions. The QPAD describes these features. It is unthinkable that a CPAD describes this same set of features. It can only properly describe one-dimensional phenomena or spherical or rotational symmetric phenomena. For that reason the QPAD approach is far richer than the CPAD approach. Where wave function is an appropriate name for the CPAD type state function, the name flow function would be more appropriate for the QPAD type state function.

The QPAD approach is also richer than the GRT approach. It offers a much more detailed analysis of what happens in the undercrofts of physics.

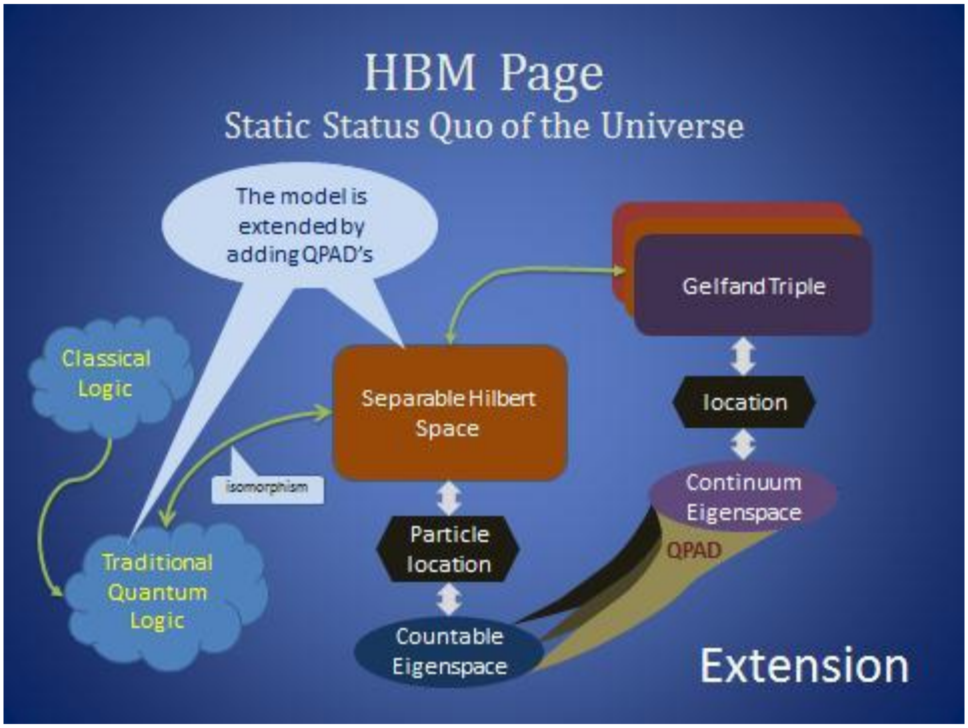
The fact that such a small change in strategy has such great and unexpected impact signals that the fundamentals of physics are still not well understood.

Sign flavors

QPAD's have still another advantage above CPAD's. Quaternions have two independent sign selections, where complex numbers have only one. One of the sign selections works isotropic. It is called conjugation and switches the sign of all three imaginary base vectors. The other is a reflection and exists in three independent directions. As a consequence eight different sign selections exist. This fact is hardly known. Still the fact is applied in physics, but it is encoded in an obscure way in the combination of spinors and gamma matrices.

Quaternionic distributions keep the same sign selection through all of their values. Thus quaternionic distributions exist in eight different sign flavors. Usually their parameter is a quaternion or the imaginary part of it. Thus the parameter space is itself a quaternionic distribution. This opens the possibility to use the parameter space as the reference for the characterization of the sign flavor of the quaternionic distribution.

The Hilbert Book Model



The Hilbert Book Model (HBM) is a simple Higgsless and self-consistent model of fundamental physics that is strictly based on the axioms of traditional quantum logic. It uses a sequence of instances of an extension of a quaternionic separable Hilbert space that each represents a static status quo of the whole universe. It widely uses the opportunities that are offered by QPAD's. The HBM uses the sign flavors of coupled QPAD's in order to construct all known elementary particles that occur in the standard model.

Due to its reliance on QPAD's rather than on CPAD's its methodology is unconventional and rather controversial. Methods that work in QDE and QCD cannot all be applied in the HBM. However, the HBM offers circumventions for this dilemma. It treats linear equations of motion such as the Dirac equation as balance equations. It treats fundamental physics as a space streaming problem.

See: http://vixra.org/abs/1112.0084 and http://vixra.org/abs/1202.0033

The HBM Palestra

We introduce a special kind of space. This space can curve. Its curvature can change. So, the space can move. It is space that moves with respect to a coordinate system. If you attach a separate coordinate system to the moving space, then you can describe what is happening. For example it can be described by a quaternionic distribution. Use only the imaginary part of the values and the imaginary part of the parameter. Now you have a distribution that describes your special space. You can use this space as the parameter space of still another function. For example you can use it as parameter space of a CPAD or a QPAD or any other field.

In the Hilbert Book Model all QPAD's and the fields that are derived from them or from their couplings, share the same parameter space. For that reason this common parameter space will be given a special name; ***the HBM Palestra***[4]. This shared parameter space spreads universe wide. It is the place where universe is located.

The HBM Palestra does not correspond to the historic notions of ether[5] that were used in physics. It is defined by the descriptions that are given in this section.

In general QPAD's are no more than special kinds of quaternionic distributions. In the HBM the primary QPAD's have a special interpretation as flow functions of elementary particles. In the HBM CPAD's will also use the HBM Palestra as their parameter space. They treat single variable features.

The parameter space of the QPAD can be interpreted as a quaternionic distribution. It has itself a parameter space, which is formed by a 3D continuum. This continuum is taken from the eigenspace of a location operator that resides in the Gelfand triple of the separable Hilbert space. Only the imaginary part of the quaternionic distribution is used. It can be considered as a 3D Riemannian manifold. The local metric defines the local curvature. What occurs in this manifold is described by the QPAD.

This space is the playground of all what happens in fundamental physics. It is governed by a special kind of fluid dynamics[6]. Things like charge density distributions, current density

[4] The name palestra is suggested by Henning Dekant's wive Sarah. It is a name from Greek antiquity. It is a public place for training or exercise in wrestling or athletics

[5] http://en.wikipedia.org/wiki/Aether_theories

[6] See Quantum Fluid Dynamics

distributions, sources, drains, compressed regions and decompressed regions occur in this space. The QPAD's are not the transporters. They only describe the transport process. The action takes place in their shared parameter space. That's how these QPADS's can influence each other.

The sources and drains are controlled by Poisson processes. The generated quanta take a probable track. The most probable track has preference. Thus the currents described by the QPAD's are corridors rather than actual paths. Similarly the locations of the charges in the density distributions are places where charges may exist with corresponding probability. It need not be the place where the charges are. The phrase "is governed by a special kind of fluid dynamics" must be interpreted in this view[7]. The transported quanta are sparsely present in the HBM Palestra.

Nevertheless this special space may be characterized by notions such as temperature and entropy. Both indicate a relation with information.

Two kinds of processes determine the dynamics in the parameter space. The first kind is formed by quantum generating or quantum annihilating Poisson processes. The second kind is caused by the coupling of QPAD's. It means that the dynamics in the parameter space can be described by a combination of fluid dynamics and statistical mechanics.

Since the HBM implements dynamics via a sequence of pages, each HBM page only shows the static status quo of the parameter space. The real part of the quaternionic distributions that define the HBM Palestra can be used to store the progression parameter.

The elementary coupling equation is a continuity equation. It describes primary couplings. The coupling can be characterized by a small set of properties. These properties are conserved. Most of these properties can be considered as sources of secondary QPAD's. These secondary QPAD's correspond to physical fields that are attached to the corresponding elementary particle.

The elementary coupling equation appears in 64 forms. Eight of these correspond to a zero coupling factor, thus these situations describe free QPAD's. It concerns photons and gluons. The 56 resulting cases concern specific elementary particles. Thus, there are 56 ways to constitute a primary coupling. This count neglects the antiparticle equation. Thus, a very large number of different primary couplings are possible.

After a coupling the resulting currents need not be exhausted completely. The properties of the coupling are conserved and the corresponding physical fields and the resulting currents can be exploited in higher order coupling. So what happens at these scales can become very complicated.

At some distance from the elementary particle the dynamics can be described as incompressible flow. However, close to the particle, thus close to the coupling the dynamics must be treated as compressible flow. It means that features like compression, entropy and temperature will start to play a role.

[7] See: Quantum Fluid Dynamics

In short; the HBM Palestra is the sparsely occupied internally moving space that is used as parameter space by all QPAD's that play a role in the HBM.

Quantum Fluid Dynamics

What happens in the HBM Palestra is controlled by Quantum Fluid Dynamics (QFD). QFD differs from conventional fluid dynamics in that in QFD the charge density distributions and current density distributions describe probable locations and paths in their own parameter space, while in conventional fluid dynamics these distributions describe actual locations and paths that occur in an considered medium such as a gas or liquid. That is why in QFD the charge density distributions and current density distributions are combined in quaternionic probability amplitude distributions, while in conventional fluid dynamics they are located in scalar and vector fields. These fields can also be combined in quaternionic distributions, but they are not probability amplitude distributions.

Already in 1927 Erwin Madelung[8] published a set of equations that treat quantum physics in the sense of QFD. The Dirac equation and the Majorana equation have a far simpler structure than the (second) Madelung equation. The first Madelung equation conforms to the real part of the elementary coupling equations.

Physical fields

In the HBM two categories of physical fields exist. The first category is formed by free primary QPAD's. These QPAD's oscillate. Depending on their sign flavor they are photons or gluons. Primary QPAD's are linked with an eigenvector of an operator in separable Hilbert space. For the free primary QPAD's this is the canonical conjugate of the locator operator.

The second category is formed by fields that represent the properties of the couplings of primary QPAD's that correspond to elementary particles. These properties are coupling factor, electric charge and spin. The wave functions of massive elementary particles are primary QPAD's that are linked with an eigenvector of the particle locator operator in separable Hilbert space. The corresponding physical fields are gravitation fields, electrostatic fields and magnetostatic fields. These fields move with the particles, but they do not oscillate like the first category does.

With other words, photons and gluons are fundamentally different from the second category of physical fields.

This may be the reason that photons cannot pass the event horizon of black holes, while the information of the BH's mass, electric charge and spin are available to the environment of the BH.

Conclusion

The fact that a rather small change in the methodology, such as a switch from CPAD's to QPAD's is capable of causing a drastic change in the view on the fundaments of physics, shows that these fundaments are still not well comprehended and are far from well established.

[8] See: http://en.wikipedia.org/wiki/Madelung_equations

What image intensifiers reveal

The author spent eighteen years in the development of image intensifier tubes. These devices ranged from goggles via driver scopes to fourteen inch wide X-ray image intensifiers.
They had one feature in common. They were all capable of turning the impingement of a quantum at their input screen into a visible light spot at their output screen. A hail storm of impinging quanta at the input resulted in a noisy film at the output[9][10][11].
The starlight scopes enable visibility of very low dose scenes under starlight conditions. They turned infrared and visible light quanta into light spots on a luminescent phosphor screen.
The X-ray image intensifiers were designed to deliver a perceptible image of an X-ray shadow picture at the lowest possible X-ray dose for the diagnosed patient.
What still astonishes me is that I never saw any indication of a wave entering the input of the image intensifiers. I only saw clouds of quanta. That does not say that these clouds cannot have the shape of waves, but the detected quanta did not show that relation.
With other words, what we can observe are the quanta. We cannot observe the envelop of the quantum clouds. We cannot observe the waves!
This is a significant experience. Light as a wave does not exist as a physically observable object. It only exists as a bunch of quanta. That quantum cloud may have the shape of a wave, but we cannot discern that wave. We can only detect interferences of these waves because the patterns of the detected quanta take that shape, but we cannot observe the interferences themselves.
What are then these quanta that impinge on the inputs of our detectors? They are tiny patches of something.

The Hilbert Book Model makes a very particular assumption about these quanta.
The HBM interprets the quanta as tiny patches of the parameter space of the wave function.
Further the HBM uses wave functions that are quaternionic probability amplitude distributions. This makes it possible to interpret the wave functions as combinations of charge density distributions and current density distributions. The wave functions may also contain sources, drains, compressed regions and decompressed regions. These features all occur in the parameter space of the wave function.
This daring interpretation explains why in the neighborhood of particles the parameter space appears to be compressed.

It appeared that the distribution of detected quanta can be characterized as a Poisson distribution. That indicated that the generators of the quanta can be considered as Poisson processes. It is well known that Poisson processes that are attenuated by subsequent binomial processes can be treated as a new less efficient Poisson process. Spatial and temporal spread can be interpreted as a binomial processes. It is also known that very efficient Poisson processes produce distributions that are close to Gaussian distributions.
When looked upon as a charge distribution the Gaussian distribution produces a potential that approaches an Error function. At some distance from the generator the Error function takes the form of a 1/r function. On its turn this corresponds with a single charge source.
Thus from a distance the generator looks as a (singular) single charge source. Of course the actual generator is not singular!
This gives a particular insight in radiation sources!

---

[9] See: http://en.wikipedia.org/wiki/File:Moon_in_x-rays.gif . Low dose X-ray image of the moon.
[10] See: http://www.youtube.com/watch?v=U7qZd2dG8uI ; Hail storm. Warning, this is NOT a video of an external object.
[11] Also see: http://en.wikipedia.org/wiki/Shot_noise