Essentials of the Hilbert Book Model

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Abstract

In order to support clear discussions, a simple self- consistent model of fundamental physics is constructed. It is strictly based on the axioms of traditional quantum logic and uses the isomorphism of the set of propositions of this logic system with the set of closed subspaces of a quaternionic separable Hilbert space. This primitive model cannot represent dynamics and does not include a representation of fields. For that reason the model also uses the Gelfand triple of the Hilbert space and a set of links that connect the eigenvectors of a particle location operator in the Hilbert space with the continuum eigenspace of a corresponding location operator in the Gelfand triple. These links are quaternionic probability amplitude distributions (QPAD's) that will act as the quantum state functions of the particles. The combination of a quaternionic Hilbert space, its Gelfand triple and the set of linking QPAD's still can only represent a static status quo of the universe. However, a dynamic model may consist of an ordered sequence of such sandwiches. The subsequent sandwiches form the pages of a book that we will call the Hilbert Book Model.

The flat quaternionic derivative of a QPAD leads to a continuity equation that describes how the flat derivative is coupled to its source. When the strength of the coupling is made explicit, then the resemblance with linear equations of motion becomes apparent.

This interpretation extends conventional quantum physics with quantum fluid dynamics. It throws an unprecedented view on the undercrofts of fundamental physics.

The logic model

Lattice structure

In the beginning quantum physics was done by quantization of the equations of classical mechanics. Schrödinger and Heisenberg each found a different way to perform this act. Dirac was able to prove that these ways are in fact two different views of the same methodology. John von Neumann and Garret

Birkhoff were able to formulate the fundamental reason why quantum physics differs from classical physics. They found that physics cheats with classical logic and instead obeys a more weakly structured logic, which was called quantum logic. They also proved that the set of propositions of quantum logic is lattice isomorphic with the set of closed subspaces of a separable Hilbert space. Later Constantin Piron proved that the number system in which the inner product of the Hilbert space is specified must be taken from a division ring. Only three suitable division rings exist: the real numbers, the complex numbers and the quaternions. Selecting the quaternions leads to a generalized quaternionic separable Hilbert space. This is the choice that will be applied in the Hilbert Book Model. For historic information see [1], Piron's theorem and reference [15] in that paper

Extension

We now have a double model. Besides a pure logic model we have a lattice isomorphic model that uses a quaternionic Hilbert space, which is far more suitable for the mathematical formulation of the physical laws. However, these models are still very primitive. They do not support fields and they do not implement dynamics. The separable Hilbert space only supports countable operator eigenspaces and it does not support an operator that offers time as a continuous eigenvalue. With other words this primitive model must be extended.

First we add fields. We do this (in a unorthodox way) by adding the Gelfand triple of the Hilbert space and constructing a set of links between the eigenvectors of the particle location operator that resides in the separable Hilbert space and the continuum eigenspace of a corresponding location operator that resides in the Gelfand triple. The link has the form of a quaternionic probability amplitude distribution (QPAD) [1]. It will act as the quantum state function of the particle. It defines the probability of detecting the particle at the location that corresponds to the parameter of the QPAD[2].

Since we did not obstruct the lattice isomorphism between the Hilbert space and quantum logic, we can construct a similar extension to quantum logic. It adds fuzzy (=blurred) observations to the logic.

Dynamics

The Schrödinger picture and the Heisenberg picture both use the representation in a Hilbert space. In the Schrödinger picture the states depend on time and the operators including their eigenvectors are static. In the Heisenberg picture the operators are time dependent and the states are static. Both pictures are valid, but in combination they represent a discrepancy. In fact only the movement of the states relative to the eigenvectors is important. The discrepancy can be resolved by assuming that progression is a global parameter of the Hilbert space. But in that case the whole Hilbert space represents a static status quo.

Thus, the sandwich consisting of Hilbert space, Gelfand triple and set of QPAD's can only represent a static status quo of the universe.

[1] Adding a restricted degree of fuzziness to the observations is a measure that is commonly applied when an over-determined set of linear equations that relate these observations to the results must be solved.

[2] It is possible to first construct a quaternionic Hilbert space from a set of measurable QPAD's and then embed that Hilbert space as a subspace inside an infinite dimensional quaternionic Hilbert space.

However, when we arrange the subsequent sandwiches in a sequence, then a new model is formed in which the sandwiches become the pages in a book. This leads to the Hilbert Book Model. The HBM represents a simple dynamic model of physics that comprises its fields in the set of linking QPAD's.

It means that according to this model, nature moves with universe wide steps. The page number of the book acts as a progression parameter. The progression step is a model invariant.

Discrete symmetries

The quaternionic number system exists in sixteen discrete symmetry sets (sign flavors). When the real part is ignored, then eight different symmetry sets result. The values of a continuous distribution all belong to the same symmetry set. The parameter space of the distribution may belong to a different symmetry set.

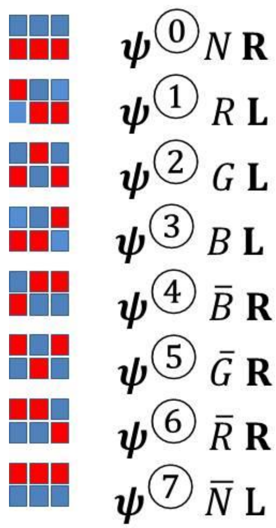

Figure 1: Sign flavors

Eight sign flavors

(discrete symmetries)

Colors N, R, G, B, $\overline{\mathrm{R}}$, $\overline{\mathrm{G}}$, $\overline{\mathrm{B}}$, W

Right or Left handedness R,L

Quaternionic probability amplitude distributions

QPAD's are quaternionic distributions. Quaternions are afflicted with eight different sign selections, which are combinations of four independent sign selections. One of them is the quaternionic conjugation. It changes the sign of the imaginary part. The three other independent sign selections are reflections, one for each imaginary base direction. In continuous quaternionic distributions the sign selections do not change. Thus, continuous distributions exist in eight different sign flavors. They correspond to eight different discrete symmetries. This applies to QPAD's and as a consequence it applies to quantum state functions.

A QPAD contains a scalar field in its real part and a vector field in its imaginary part. The scalar field can be interpreted as to represent a charge density distribution. The vector field can be interpreted as to represent a corresponding current density distribution.

Differentials, continuity equations and coupling equations

Derivative

The flat differential[3] of a quaternionic distribution has a real and an imaginary part.

$$g(q) = g_0(q) + \boldsymbol{g}(q) = \nabla f(q) \tag{1}$$

$$= \nabla_0 f_0(q) \mp \langle \boldsymbol{\nabla}, \boldsymbol{f}(q) \rangle$$

$$\pm \nabla_0 \boldsymbol{f}(q) + \boldsymbol{\nabla} f_0(q) \pm \left(\pm \boldsymbol{\nabla} \times \boldsymbol{f}(q) \right)$$

The blue colored $\mp$ and $\pm$ signs refer to the influence of conjugation of $f(q)$ on quaternionic multiplication. The red $\pm$sign refers to the influence of reflection of $f(q)$. It represents the handedness.

Continuity equation

If the function f(q) is a QPAD then an understanding reader might recognize the real part as a continuity equation (also called balance equation).

$$\nabla_0 f_0(q) = \pm \langle \boldsymbol{\nabla}, \boldsymbol{f}(q) \rangle + g_0(q) \tag{2}$$

Here f_0 plays the role of a charge density and $\boldsymbol{f} = f_0\, \mathbf{v}$ plays the role of current density. Thus in quaternionic terms the full equation is also a continuity equation and the QPAD f combines a charge density distribution f_0 and a current density distribution $\boldsymbol{f}$.

$$\nabla f(q) = g(q) \tag{3}$$

Coupling equation

Now write the differential as a coupling equation

$$\nabla f(q) = m\, h(q) \tag{4}$$

where m is interpreted as a coupling strength. Here two QPAD's $\{f, h\}$ are coupled with strength m.

[3] The nabla ∇ represents a flat derivative in which curvature of the parameter space is ignored. The full derivative is used with the distance function (see Flat Physics)

This equation resembles the Dirac equation and the Majorana equation when the gamma matrices are removed.

The Dirac equation for the electron runs

$$\nabla f(q) = m\, f^{*}(q) \tag{5}$$

Thus here the QPAD $h(q)$ is a sign flavor variant of $f(q)$.

The Majorana equation uses a different sign flavor variant.

Particles and waves

If we restrict to sign flavor variants then equation (4), apart from possible variants of m, offers 64 variants of $\{f, h\}$. The combinations $\{f, f\}$ will become zero coupling strength $(m = 0)$. They must be zero or they must oscillate. Thus 56 different particle types result. The sign flavors determine the properties (electric charge, color charge and spin).

The free (= uncoupled) QPAD's oscillate. They represent the waves. Eight different waves exist.

The HBM does not recognize generations (different versions of m for the same particle type).

The result is a striking correspondence with the standard model, but also strange differences exist.

See the table[4].

Inertia and space curvature

Quantum fluid dynamics

The continuity equation extends quantum physics with quantum fluid dynamics. Quantum fluid dynamics differs from conventional fluid dynamics in the nature of the moving objects. The moving objects are carriers of properties. In conventional fluid dynamics the moving objects are elements of a gas or a liquid. In quantum fluid dynamics the moving objects are tiny patches of the parameter space of the charge and current density distributions. The coupling of QPAD's affects the local density of the carriers. As a consequence it affects the curvature in the environment of this coupling. This explains the origin of gravitation.

Inertia

The QPAD $h(q)$ that acts as a source in the coupling equation is coupled to the quantum state function $f(q)$ of the particle. It is formed by the local superposition of the tails of the quantum state functions of distant particles. Apart from the fact that they superpose, the quantum state functions influence each other. This is due to the fact that the coupling affects the (local) curvature with long distance effects. This influence decreases with distance. However, the number of particles that contribute to the influence increases with distance. This second effect wins. The result is a huge uniform background potential at every location in universe. Now field theory tells that the acceleration of a local particle goes together with the existence of an extra field that counteracts the acceleration. This effect is called inertia.

Palestra

All quantum state functions share their parameter space as affine spaces. Due to the fact that the coupling of QPAD's affect the parameter space, this shared space is curved. The curvature is not static. With other words patches in the parameter space move and densities in the distribution of these patches change. Due to the particular properties of this space it deserves a special name. it is called ***Palestra***. It is the place where everything happens. The Palestra comprises the whole universe.

Spacetime metric

The Palestra is defined with respect to a flat parameter space, which is spanned by the ***rational*** quaternions[4]. The specification is performed by a continuous quaternionic distribution $\wp(x)$ that acts as a distance function. This distance function defines a quaternionic infinitesimal interval ds. On its turn this definition defines a metric[5].

$$ds(x) = ds^{\nu}(x)e_{\nu} = d\wp = \sum_{\mu=0\dots3} \frac{\partial\wp}{\partial x_{\mu}} dx_{\mu} = q^{\mu}(x)dx_{\mu} \tag{1}$$

The base e_{ν} and the coordinates x_{μ} are taken from the **flat** parameter space of $\wp(x)$. That parameter space is spanned by the quaternions. The definition of the quaternionic metric uses a full derivative $d\wp$ of the distance function $\wp(x)$. This full derivative differs from the quaternionic nabla ∇, which ignores the curvature of the parameter space.

The distance function $\wp(x)$ may include an isotropic scaling function $a(\tau)$ that only depends on progression τ. It defines the expansion/compression of the Palestra.

ds is the infinitesimal quaternionic step that results from the combined real valued infinitesimal dx_{μ} steps that are taken along the e_{μ} base axes in the (flat) parameter space of $\wp(x)$.

$dx_0 = c\ d\tau$ plays the role of the infinitesimal space time interval ds_{st}[6]. It is a physical invariant. $d\tau$ plays the role of the proper time interval and it equals the infinitesimal progression interval. The progression step is an HBM invariant. Without curvature, dt in $\|ds\| = c\ dt$ plays the role of the infinitesimal coordinate time interval.

$$c^2\ dt^2 = ds\ ds^* = dx_0^2 + dx_1^2 + dx_2^2 + dx_3^2 \tag{2}$$

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[4] http://en.wikipedia.org/wiki/Quaternion_algebra#Quaternion_algebras_over_the_rational_numbers
[5] Mendel Sachs takes a similar approach.
[6] Notice the difference between the quaternionic interval ds and the spacetime interval ds_{st}

$$dx_0^2 = {ds_{st}}^2 = c^2\, dt^2 - \, dx_1^2 - dx_2^2 - dx_3^2 \tag{3}$$

dx_0^2 is used to define the local spacetime metric tensor. With that metric the Palestra is a pseudo-Riemannian manifold that has a Minkowski signature. When the metric is based on ds^2, then the Palestra is a Riemannian manifold with a Euclidean signature. The Palestra comprises the whole universe. It is the arena where everything happens.

For the distance function holds

$$\frac{\partial^2 \wp}{\partial x_\mu \partial x_\nu} = \frac{\partial^2 \wp}{\partial x_\nu \partial x_\mu} \tag{5}$$

And similarly for higher-order derivatives. Due to the spatial continuity of the distance function $\wp(x)$, the quaternionic metric as it is defined above is far more restrictive than the metric tensor that that is used in General Relativity:

$$ds^2 = g_{ik}\, dx^i\, dx^k \tag{4}$$

Still

$$g_{ik} = g_{ki} \tag{5}$$

The Palestra step

When nature steps with universe (Palestra) wide steps during a progression step Δx_0, then in the Palestra a quaternionic step $\Delta s_\wp$ will be taken that differs from the corresponding flat step Δs_f

$$\Delta s_f = \Delta x_0 + \boldsymbol{i}\, \Delta x_1 + \boldsymbol{j}\, \Delta x_2 + \boldsymbol{k}\, \Delta x_3 \tag{1}$$

$$\Delta s_\wp = q^0 \Delta x_0 + q^1\, \Delta x_1 + q^2\, \Delta x_2 + q^3\, \Delta x_3 \tag{2}$$

The coefficients q^μ are quaternions. The Δx_μ are steps taken in the (flat) parameter space of the distance function $\wp$(x).

The flattened nabla

The quaternionic function g(ζ), which has a curved parameter space defined by $\zeta = \wp(x)$ corresponds to a new function h(x)= g($\wp$(x)), which has a flat parameter space. The flattened nabla $\breve{\nabla}$ is defined as:

$$\breve{\nabla} g = \sum_{\nu=0}^{3} e_\nu \frac{\partial g(\zeta)}{\partial x_\nu} = \sum_{\nu=0}^{3} e_\nu \sum_{\lambda=0}^{3} e_\lambda \frac{\partial g_\lambda(\zeta)}{\partial x_\nu} \tag{1}$$

$$= \sum_{\nu=0}^{3} e_\nu \sum_{\lambda=0}^{3} e_\lambda \sum_{\mu=0}^{3} \frac{\partial g_\lambda}{\partial \zeta_\mu} e_\mu \frac{\partial \zeta_\mu}{\partial x_\nu} = \sum_{\nu=0}^{3} \sum_{\lambda=0}^{3} \sum_{\mu=0}^{3} e_\nu e_\lambda e_\mu \frac{\partial g_\lambda}{\partial \zeta_\mu} \frac{\partial \wp_\mu}{\partial x_\nu}$$

In contrast, the “simple” quaternionic nabla, which ignores curvature, runs as:

$$\nabla = \sum_{\mu=0}^{3} e_\mu \nabla_\mu = \sum_{\mu=0}^{3} e_\mu \frac{\partial}{\partial x_\mu}; e = (1, \boldsymbol{i}, \boldsymbol{j}, \boldsymbol{k}) \quad (2)$$

$$\nabla f = \sum_{\mu=0}^{3} \sum_{\nu=0}^{3} e_\mu e_\nu \frac{\partial f_\nu}{\partial x_\mu} \quad (3)$$

Pacific space and black regions.

The parameter space of the distance function is a flat space that it is spanned by the number system of the quaternions. This parameter space gets the name “**Pacific space**”. If in a certain region of the Palestra no matter is present, then in that region the Palestra is hardly curved. It means that in this region the Palestra is nearly equal to the parameter space of the distance function.

The Pacific space has the advantage that when distributions are converted to this parameter space the Fourier transform of the converted distributions is not affected by curvature.

In a region where the curvature is high, the Palestra step comes close to zero. At the end where the Palestra step reaches zero, an information horizon is established. For a distant observer, nothing can pass that horizon. The information horizon encloses a **black region**. Inside that region the quantum state functions are so densely packed that they lose their identity. However, they do not lose their sign flavor. The result is the formation of a single quantum state function that consists of the superposition of all contributing quantum state functions. The resulting black body has mass, electric charge and angular momentum. The quantum state function of a black hole is quantized. Due to the fact that no information can escape through the information horizon, it can be safely stated that the inside of that horizon is empty. It does not contain a singularity at its center. All characteristics of the black hole are contained in its quantum state function.

The existence of black holes indicates that the distance function has no inverse. However, outside these singular locations it can have a local inverse.

The distance function $\wp(x)$ is a continuous quaternionic distribution. Like all continuous quaternionic distributions it contains two fields. It is NOT a QPAD. It does not contain density distributions.

Start of the universe.

At the start of the universe the package density was so high that also in that condition only one mixed QPAD can exist. That QPAD was a superposition of QPAD’s that have different sign flavors. Only when the universe expanded enough, multiple individual QPAD's of the same sign flavor may have been generated. These QPAD's where photons and gluons.

Palestra information path

At any point in the Palestra and in any direction a path can be started.

In the Palestra the "length" of the quaternionic path is the coordinate time duration

$$s(t) = \int_0^{\tau_c} \|d\wp\| = \int_0^{\tau_c} \left\|\frac{d\wp}{d\tau}\right\| d\tau \tag{1}$$

τ_c is the duration in proper time ticks. τ is the progression parameter. It equals proper time. s is the coordinate time. We investigate constant speed curves in the imaginary Palestra.

$\boldsymbol{\mathcal{R}}$ is the imaginary part of $\wp$.

$$\boldsymbol{T} = \frac{Im\left(\frac{d\wp}{ds}\right)}{\left\|Im\left(\frac{d\wp}{ds}\right)\right\|} = \frac{\frac{d\boldsymbol{\mathcal{R}}}{ds}}{\left\|\frac{d\boldsymbol{\mathfrak{R}}}{ds}\right\|} \tag{2}$$

$$\boldsymbol{N} = \frac{\frac{d\boldsymbol{T}}{ds}}{\left\|\frac{d\boldsymbol{T}}{ds}\right\|} \tag{3}$$

Since $\|\boldsymbol{T}\| = 1$ are $\boldsymbol{N}$ and $\boldsymbol{T}$ perpendicular.

$$\boldsymbol{B} = \boldsymbol{T} \times \boldsymbol{N} \tag{4}$$

$$\frac{d\boldsymbol{T}}{ds} = \kappa\, \boldsymbol{N} \tag{5}$$

$$\frac{d\boldsymbol{N}}{ds} = -\kappa \boldsymbol{T} + \tau \boldsymbol{B} \tag{6}$$

$$\frac{d\boldsymbol{B}}{ds} = -\tau\boldsymbol{N} \tag{7}$$

$\boldsymbol{T}$ is the tantrix. $\boldsymbol{N}$ is the principle normal unit vector. $\boldsymbol{B}$ is the binormal unit vector[7].

κ is the curvature. τ is the torque.

Since massless information carriers, such as photons and gluons move with constant speed c, they travel along a constant speed curve. Here the speed is defined by using coordinate time rather than proper time.

Equation of motion

The gravitational equation of motion follows from a variance analysis of the duration in coordinate time of a path

$$s(t) = \int_0^{\tau_c} \|d\wp\| = \int_0^{\tau_c} \left\|\frac{d\wp}{d\tau}\right\| d\tau = \int_0^{\tau_c} L\, d\tau \tag{1}$$

$$L = \left|\frac{d\wp}{d\tau}\right| = \left|\sum_{\mu=0\ldots3}\sum_{\nu=0\ldots3} e_\nu \frac{\partial\wp_\nu}{\partial x_\mu}\frac{dx_\mu}{d\tau}\right| = \sqrt{\sum_{\nu=0\ldots3}\left(\sum_{\mu=0\ldots3}\frac{\partial\wp_\nu}{\partial x_\mu}\frac{dx_\mu}{d\tau}\right)^2} \tag{2}$$

$$L = \left|\frac{d\wp}{d\tau}\right| = L\,(x,\dot{x}) \tag{3}$$

$$\delta s = \delta \int_{\tau_1}^{\tau_2} L\,(x,\dot{x})\, d\tau = 0 \tag{4}$$

$$\frac{d}{d\tau}\frac{\partial L}{\partial \dot{x}^\mu} - \frac{\partial L}{\partial x^\mu} = 0 \tag{5}$$

Note: With respect to the conventional approach, the procedure is the same, but the ingredients are slightly different. In this procedure the HBM uses coordinate time where usually proper time is used and it uses proper time instead of coordinate time.

[7] These vectors define the Frenet-Serret frame.

Second derivative

The Palestra information path investigates curvature that is connected to a selected direction. However, at a given location curvature can exist in multiple directions. This is revealed by investigating the second derivative of the distance function. We start with the first derivative.

$$\frac{d\wp}{d\tau} = \sum_{\nu=0\ldots3} e_\nu \sum_{\mu=0\ldots3} \frac{\partial\wp_\nu}{\partial x_\mu}\frac{dx_\mu}{d\tau} \tag{1}$$

$$\frac{d^2\wp}{d\tau^2} = \sum_{\nu=0\ldots3} e_\nu \sum_{\mu=0\ldots3} \left\{\left(\sum_{\lambda=0\ldots3} \frac{\partial^2\wp_\nu}{\partial x_\mu \partial x_\lambda}\frac{dx_\mu}{d\tau}\frac{dx_\lambda}{d\tau}\right) + \frac{\partial\wp_\nu}{\partial x_\mu}\frac{d^2x_\mu}{d\tau^2}\right\} \qquad (2$$

Multidimensional torque is revealed in the third derivative.

Flat physics

The distance function $\wp(x)$ connects each location in the Pacific space to a corresponding point in the Palestra. This opens the possibility to convert each QPAD to a corresponding flat quaternionic probability amplitude distribution (FQPAD).

For the QPAD $\psi(q)$ and the corresponding FQPAD $\Phi(x)$ holds

$$\Phi(x) = \psi(\wp(x)) \tag{1}$$

If $\psi(q)$ is a quantum state function with a curved parameter space, then $\Phi(x)$ is also a quantum state function, but it has a flat parameter space. It is no longer a QPAD. It does not affect its parameter space like $\psi(q)$ can do.

Formula (1) unifies regular quantum physics with gravitation theory.

Lorentz invariant transformation

A transformation is Lorentz invariant when the difference in progression interval between the observer and the observed item stays the same.

Fields

The HBM considers several types of fields that are al derived from QPAD's.

First of all any continuous quaternionic distribution contains a scalar field in its real part and a vector field in its imaginary part. For quaternionic probability amplitude distributions (QPAD's) these fields become a special interpretation. The real scalar field can be interpreted as to correspond to a charge density distribution. The imaginary field can be interpreted as to correspond to a current density distribution. The charges are properties or ensembles of properties of their carriers. The carriers can be interpreted as tiny patches of the parameter space of the QPAD. With other words, the currents may affect the local density of the distribution of the carriers. They only do that at instances where QPAD's couple.

In the HBM elementary particles are constituted by the coupling of two QPAD's. This coupling can be characterized by a set of properties. These properties are the properties of the corresponding particle. These properties exert influence on the environment of the particle. This influence can be represented by a secondary type of fields. Each type of property corresponds to a type of secondary fields. Together with the objects that correspond to a zero coupling factor, these secondary fields are the physical fields that we are used to.

Complex and quaternionic quantum physics

Quaternionic probability amplitude distributions (QPAD's) extend the functionality of complex probability amplitude distributions (CPAD's). Their imaginary part is extended with two dimensions. On the other hand the product of two quaternionic distributions will in general not commute. This poses problems when differentiations of products of quaternionic distributions are treated. Then in general

$$\nabla(f\ g) \neq\ f\ \nabla\ g\ +\ (\nabla f)g$$

and similarly

$$d(f\ g) \neq\ f\ d\ g\ +\ (df)g$$

The switch from CPAD's to QPAD's does not affect physical reality. It only affects the view that we have at the undercrofts of fundamental physics.

The HBM supports complex quantum physics as well as quaternionic quantum physics. Complex quantum physics suits better for one-dimensional or one-parametric applications. Moving along a path and linear oscillations corresponds to such conditions. Quaternionic quantum physics suits better for multidimensional applications, such as investigating the geometry of particles or with investigating the influence of curvature in cosmology..

The Hilbert Book Model

The HBM is treated in greater detail in "Features of the Hilbert Book Model". The corresponding free accessible manuscript can be found at [2] and in the author's e-print archive [3].

Hierarchy of objects

The objects that appear in nature can be ordered in a hierarchy of levels.

A-- The lowest level is space that is formed by the number system of the RATIONAL quaternions. However, better make it an affine space (a space without an origin). The real part of the quaternions defines progression. Progression conforms to proper time. As a consequence progression steps with a fixed step. Quaternionic numbers exist in 16 discrete symmetry sets

HYPOTHESIS: At its start nature used only one discrete symmetry set for its lowest level objects. This situation stays throughout the history of the model.

B-- The second level is a curved space, called Palestra. The local curvature is defined via the differential of a continuous quaternionic distance function. The parameter space of this function is the first level space (A). Thus the Palestra is a countable set. The distance function may include an isotropic scaling function. The differential of the distance function defines an infinitesimal quaternionic step. The length of this step is the infinitesimal coordinate time interval. The differential is a linear combination of sixteen partial derivatives. It defines a quaternionic metric. Like the first level, this level is an affine space. Like all continuous quaternionic functions the distance function exists in 16 different discrete symmetry sets. The symmetry set of the distance function values may differ from the symmetry set of the parameter space of the distance function. The distance function keeps its discrete symmetry set throughout its life.

C-- The third level consists of a countable set of space patches that occupy the Palestra. Let us call them Qpatches. They are images of the rational quaternions that house in the first level parameter space. Their charge is formed by the discrete symmetry set of the distance function. The curvature of the second level space relates directly to the density distribution of the Qpatches. The Qpatches represent the locations where next level objects can be detected. Since 16 different distance functions exist, there are 16 different versions of the Palestra. However, these versions may superpose. The name Qpatch stand for space patches with a quaternionic value. The charge of the Qpatches can be named Qsymm, Qsymm stands for discrete symmetry set of a quaternion.

D—Local quaternionic probability amplitude distributions (QPAD's) describe identifiable patterns of Qpatches. They are quaternionic distributions that contain a scalar potential in their real part that describes a Qpatch density distribution. Further they contain a 3D vector potential in their imaginary part that describes the associated current density distribution of Qpatches. Continuous quaternionic probability distributions exist in eight different discrete spatial symmetry sets (sign flavors). However, they inherit the discrete symmetry of their connected distance function. Photons and gluons are oscillating QPAD's. Two photon QPAD's and six gluon QPAD's exist.

E—16 integral QPAD’s exist that together cover all Qpatches. As far as a split is possible, will each of these QPAD’s split into a large number of local QPAD’s that each represent an identifiable pattern. One of the 16 integral QPAD’s acts as reference QPAD. The corresponding distance function and thus this reference QPAD has the same discrete symmetry set as the lowest level space.

F-- Elementary particles are constituted by the coupling of two (local) QPAD's. One of the QPAD's is the quantum state function of the particle. (The other QPAD implements inertia). Apart from their sign flavors these constituting QPAD's form the same quaternionic distribution. However, the sign flavor must differ and their progression must have the same direction. This results in 56 elementary particle types, 56 anti-particle types and 8 non-particle types. The coupling has a small set of observable properties: coupling strength, electric charge, color charge and spin.

HYPOTHESIS: If the quaternionic quantum state function of an elementary particle couples to a local piece of the reference integral QPAD, then the particle is a fermion. otherwise it is a boson. For anti-particles the quaternionic conjugate of the reference integral QPAD must be used. Non-coupled QPAD's are bosons.

G--Baryons are higher order constructs of elementary particles and free QPAD's. The same holds for mesons.

H--Nucleons are constructs of baryons, mesons and QPAD’s.

I--Atoms are constructs of nucleons, electrons and photons.

J--Molecules are constructs of atoms

K--All kinds of higher order constructs exist.

L--Planets and stars

M--Solar systems

N--Galaxies

O--Clusters of galaxies

Conclusion

This simple model contains extra layers of individual objects. The most interesting addition is formed by the Qpatches.

Every level except for the first two is controlled by fluid dynamics.

The coupling of QPAD's affects the local density of the Qpatches. Thus it affects the curvature of the Palestra. The reference Palestra is our universe. It consists of the shared affine versions of the parameter spaces of the local reference QPAD's. The coupling causes the exchange of Qpatches between the concerned local QPAD’s. The exchange of Qpatches appears to be governed by Poisson processes.

Black regions are regions where the density of coupled QPAD's becomes so high that the separate QPAD's lose their identity. The region is represented by a single QPAD pair. Its properties are mass, electric charge and angular momentum.

Black matter can be formed by non-uniformities in the spread of Qpatches.

Ziggs and Qpatches

Ziggs is a category name. The category consists of three types. The first two types are quantum fluctuations and virtual particles. The reason for their existence is the fact that the uncertainty principle forbids that energy is zero during a long period of time.

The third category are Qpatches, where the charge is Qsymm and the carriers are tiny patches of the curved space that is formed by sharing the affine versions of the parameter spaces of the quantum state functions of particles. The existence of these carriers does not fluctuate. However, the distribution of their density may move or even oscillate.

The carriers form the natural interpretation of the realization of the scalar potential field and the vector potential field that are contained in a quaternionic quantum state function. The potential fields result from density distributions of charge carriers. Fluctuations in the density distributions are quite similar to vacuum quantum fluctuations.

Ziggs form a condensate, which means that it does not make a difference whether a single Zigg is added to or removed from the condensate.

Note: Recently Leonard Susskind introduced the "ziggs" in his YouTube lecture "demystifying the Higgs boson with Leonard Susskind"

http://www.youtube.com/watch?v=JqNg819PiZY

In that lecture Susskind does not talk about ziggs as tiny patches of space.

The existence of the ziggs is proved by the Casimir effect, which explains the van der Waals forces. (See Wiki) An explanation of the existence of the carrier distribution is given by low radiation dose imaging that is produced by image intensifiers. Low dose imaging does not explain so much the existence of quantum fluctuations or virtual particles. (See http://www.scitech.nl/English/e_physics/#_What_image_intensifiers reveal)

The advantage of the third view that sees Qpatches as tiny space patches is that it can directly be related with space curvature. The relation with between quantum energy fluctuations or virtual particles with curvature is far more indirect.

The ziggs interpreted as tiny patches of space are carriers of properties (charges). According to Susskind the charge is zilch.

A QPAD may represent an identifiable collection of Qpatches (Qsymm carriers). These QPAD's describe the distribution of the Qpatches and the flow of Qpatches.

Elementary particles are constituted by the coupling of a pair of QPAD's.

The Qpatches condensate is no ether. It is a condensate of space patches.

HBM versus contemporary physics

The way that fields and dynamics are implemented in the HBM differs considerably from contemporary physics. In the HBM, nature steps with universe (Palestra) wide steps from one static status quo to the next. The corresponding progression step is considered a model invariant. In contemporary physics the infinitesimal spacetime interval is considered to be a physical invariant. Both models are Lorentz invariant.

Quantum electro dynamics and quantum chromo dynamics treat fields similarly as wave functions. The approach makes extensive use of canonical derivatives. The HBM uses QPAD's as quantum state functions and derives all fields directly or indirectly from these QPAD's.

The HBM is a quaternionic quantum physics that incorporates complex quantum physics as a specialization to one-dimensional or one-parametric applications. It extends complex quantum physics with quantum fluid dynamics. Conventional quantum physics sticks with complex numbers. It adapts to quaternionic behavior via spinors, matrices, Clifford algebras, Grassmann algebras, and Jordan algebras.

The usage of the distance function for the definition of the quaternionic metric causes a slight, but significant difference in the tackling of the information path and in the generation of the gravitational equation of motion.

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