On the hierarchy of objects

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Abstract

The objects that occur in nature can be categorized in several levels. In this collection every level except the first level is built from lower level objects. This collection represents a simple model of nature. The model exploits the possibilities that mathematical concepts provide. Also typical physical ingredients will be used.

The paper splits the hierarchy of objects in a logic model and a geometric model. These two hierarchies partly overlap.

No model of Physics can change physical reality.

Any view on physical reality involves a model

Drastically different models can still be consistent in themselves.

The Hilbert Book Model is a simple self-consistent model of physics.

This model steps with universe-wide progression steps from one sub-model to the next one. Each of these sub-models represents a static status quo of the universe. The sub-models are strictly based on traditional quantum logic

The HBM is a pure quaternion based model. Conventional Physics is spacetime based. When both models are compared, then the progression quantity (which represents the page number in the Hilbert Book model) corresponds to proper time in conventional physics.

The length of a smallest quaternionic space-progression step in the HBM corresponds with an "infinitesimal" coordinate time step in conventional physics.

Contents

1 Introduction

I present you my personal view on the hierarchy of objects that occur in nature. Only the lowest levels are extensively treated. Composite particle objects are treated in a more general way. Cosmology is touched.

The paper is founded on three starting points:

- A sub-model in the form of traditional quantum logic that represents a static status quo.
- A correlation vehicle that establishes cohesion between subsequent members of a sequence of such sub-models.
- The cosmological principle.

Further it uses three hypotheses. It turns out that the cosmological principle is already a corollary of the first two points.

This hierarchy model is in concordance with the Hilbert Book Model[1]. Since the HBM is strictly based on the axioms of traditional quantum logic, the same will be the case for the logic part of the object hierarchy model. The Hilbert Book Model gets its name from the fact that traditional quantum logic can only represent a static status quo and for that reason dynamics must be represented by an ordered sequence of these static models. The similarity with a sequence of pages and a book is obvious.

The object hierarchy model adds two fundamental starting points. First, a correlation vehicle must provide the cohesion between the subsequent members of the sequence. Second, the model must obey the cosmological principle.

The cosmological principle means that at large scales, universe looks the same for whomever and wherever you are. One of the consequences is that at larger scales universe possesses no preferred directions. It is ***quasi-isotropic*** (on average isotropic).

This paper is part of the ongoing HBM project.

The paper explains[2] all features of fundamental physics that are encountered in the discussed hierarchy which ranges from propositions about physical objects until elementary particles. Amongst them are the cosmological principle, the existence of quantum physics, the existence of a maximum speed of information transfer, the existence of physical fields, the origin of curvature, the origin of inertia, the dynamics of gravity, the existence of elementary particles, the existence of generations of elementary particles and the existence of the Pauli principle.

[1] http://vixra.org/abs/1209.0047

[2] Or it indicates a possible explanation

2 The logic model

2.1 Static status quo

2.1.1 Quantum logic

The most basic level of objects in nature is formed by the propositions that can be made about the objects that occur in nature. The relations between these propositions are restricted by the axioms of traditional quantum logic. This set of related propositions can only describe a static status quo.

In mathematical terminology the propositions whose relations are described by traditional quantum logic form a lattice. More particular, they form an orthomodular lattice that contains a countable infinite set of atomic (=mutually independent) propositions. Within the same quantum logic system multiple versions of sets of these mutually independent atoms exist. In this phase of the model the content of the propositions is totally unimportant. As a consequence these atoms form principally an unordered set[3]. Only the interrelations between the propositions count.

Traditional quantum logic shows narrow similarity with classical logic, however the modular law, which is one of the about 25 axioms that define the classical logic, is weakened in quantum logic. This is the cause of the fact that the structure of quantum logic is significantly more complicated than the structure of classical logic.

2.2 Dynamic model

A dynamic model can be constructed from an ordered sequence of the above static sub- models. Care must be taken to keep sufficient coherence between subsequent static models. However, some deviation must be tolerated, because otherwise, nothing dynamical will happen in this new dynamic model. The cohesion is established by a suitable correlation vehicle.

2.2.1 Correlation vehicle

The correlation vehicle uses a toolkit consisting of an enumerator generator, a reference continuum and a continuous function that maps the enumerators onto the continuum. The function is a continuous function of both the sequence number of the sub-models and the enumerators that are attached to a member of the selected set of atomic propositions. The enumeration is artificial and is not allowed to add extra characteristics or functionality to the attached proposition. For example, if the enumeration takes the form of a coordinate system, then this coordinate system cannot have an origin and it is not allowed to introduce preferred directions. The omission of the origin leads to an affine space. The avoidance of preferred directions produces problems in multidimensional coordinate systems. In case of a multidimensional coordinate system the correlation vehicle must use a smooth touch. At very small scales the coordinate system must get blurred. This means that the guarantee for coherence between subsequent sub-models cannot be made super hard. Instead coherence is reached with an acceptable tolerance.

[3] This fact will prove to be the underpinning of the cosmologic principle.

2.2.2 Isomorphic model

The natural form of the enumeration system can be derived from the lattice isomorphic companion of the quantum logic sub-model.

In the third and fourth decade of the twentieth century Garret Birkhoff and John von Neumann[4] were able to prove that for the set of propositions in the traditional quantum logic model a mathematical lattice isomorphic model exists in the form of the set of the closed subspaces of an infinite dimensional separable Hilbert space. The Hilbert space is a linear vector space that features an inner vector product. It offers a mathematical environment that is far better suited for the formulation of physical laws than what the purely logic model can provide.

Some decades later Constantin Piron[5] proved that the only number systems that can be used to construct the inner products of the Hilbert vectors must be division rings. The only suitable division rings are the real numbers, the complex numbers and the quaternions[6]. Quaternions can be seen as combinations of a real scalar and a 3D (real) vector. The number system of the quaternions represent a dynamic 3D coordinate system.

Since the set of real numbers is multiple times contained in the set of complex numbers and the set of complex numbers is multiple times contained in the set of quaternions, the most extensive isomorphic model is contained in an infinite dimensional quaternionic separable Hilbert space. For our final model we will choose the quaternionic Hilbert space, but first we study what the real Hilbert space model and the complex Hilbert space model provide.

The set of closed subspaces of the Hilbert space represents the set of propositions that forms the static quantum logic system. The set of mutually independent atoms in the logic model corresponds to a set of base vectors that together span the whole Hilbert space. Like the sets of mutually independent atoms in the quantum logic system, multiple sets of orthonormal base vectors exist in the Hilbert space. The base vectors do not form an ordered set. However, a so called normal operator will have a set of eigenvectors that form a complete orthonormal base. The corresponding eigenvalues may provide a means for enumeration and thus for ordering these base vectors. An arbitrary normal operator does not fit. Its eigenvalues introduce an origin and in the case of a multidimensional eigenspace they may produce preferred directions. The represented atoms do not have such properties. Still, many suitable enumeration operators exist. However, several things can already be said about the eigenspace of the enumeration operator. This space is countable. It has no origin. It does not show preferred directions. It can be embedded in a corresponding reference continuum.

As part of the corresponding Gelfand triple[7] the separable Hilbert space forms a sandwich that features uncountable orthonormal bases and (compact) normal operators with eigenspaces that form a

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[4] http://en.wikipedia.org/wiki/John_von_Neumann#Quantum_logics

[5] C. Piron 1964; _Axiomatique quantique_

[6] Bi-quaternions have complex coordinate values and do not form a division ring.

[7] See http://vixra.org/abs/1210.0111 for more details on the Hilbert space and the Gelfand triple. See the paragraph on the Gelfand triple.

continuum. The reference continuum can be taken as the eigenspace of the corresponding enumeration operator that resides in the Gelfand triple of a reference Hilbert space.

Together with the pure quantum logic model, we now have a dual model that is significantly better suited for use with calculable mathematics. Both models represent a static status quo.

The Hilbert space model suits as part of the toolkit that is used by the correlation vehicle.

As a consequence***, an ordered sequence of infinite dimensional quaternionic separable Hilbert spaces forms the isomorphic model of the dynamic logical model***.

2.3 Affine space

The set of mutually independent atomic propositions is represented by an orthonormal set of base vectors in Hilbert space. Both sets span the whole of the corresponding structure. An arbitrary orthonormal base is not an ordered set. However, these base vectors can be enumerated. The installation of the correlation vehicle requests the introduction of enumerators. The enumeration may introduce an ordering. In that case the attachment of the numerical values of the enumerators to the Hilbert base vectors defines a corresponding operator. It must be remembered that the selection of the enumerators and therefore the corresponding ordering is kind of artificial. The eigenspace of the enumeration operator has no unique origin and is has no preferred directions. Thus it has no axes. It can only indicate the distance between two or more locations. For multidimensional enumerators the distance is not precise. It represents a blurred coordinate system. Both in the Hilbert space and in its Gelfand triple, the enumeration can be represented by a normal enumeration operator.

2.4 Continuity

2.4.1 Arranging dynamics

Embedding the enumerators in a continuum highlights the interspacing between the enumerators. Having a sequence of static sub-models is no guarantee that anything happens in the dynamic model. A fixed (everywhere equal) interspacing will effectively lame any dynamics. A more effective dynamics can be arranged by playing with the sizes of the interspacing. This is the task of ***a continuous distance function***.

2.4.2 Establishing coherence

The coherence between subsequent static models can be established by embedding each of the countable sets in a single reference continuum. For example the Hilbert space can be embedded in its Gelfand triple. The enumerators of the base vectors of the separable Hilbert space can also be embedded in a corresponding continuum. That continuum is formed by the values of the enumerators that enumerate an orthonormal base of the Gelfand triple. We will reuse the same (reference) Gelfand triple for all members of the sequence of Hilbert spaces. The reference Gelfand triple is taken from a selected[8] member of the sequence. Next a correlation vehicle is established by introducing a continuous distance function that controls the coherence between subsequent members of the sequence of static

[8] The selection criterion is that around this member the scaling of the imaginary space is a symmetric function of progression.

models. It does that by defining the interspacing in the countable set of the enumerators that act in the separable Hilbert space by mapping them to the reference continuum. In fact the differential of the distance function is used to specify the "infinitesimal" interspacing[9].

The equivalence of this action for the logic model is that the enumerators of the atomic propositions are embedded in a continuum that is used by an appropriate correlation vehicle.

The distance function uses a combination of progression and the enumerator id as its parameter value. The value of the progression might be included in the value of the id. Apart from their relation via the distance function, the enumerators and the embedding continuum are mutually independent[10]. For the selected correlation vehicle it is useful to use numbers as the value of the enumerators. The type of the numbers will be taken equal to the number type that is used for specifying the inner product of the corresponding Hilbert space and Gelfand triple. The danger is then that a direct relation between the value of the enumerator of the Hilbert base vectors and the embedding continuum is suggested. So, here a warning is at its place. Without the distance function there is no relation between the value of the enumerators and corresponding values in the embedding continuum. However, there is a well-defined relation between the images[11] produced by the distance function and the embedding continuum that is formed by the corresponding enumerators in the Gelfand triple.[12]

The relation between the members of a countable set and the members of a continuum raises a serious one-to-many problem. That problem can easily be resolved for real Hilbert spaces and complex Hilbert spaces, but it requires a special solution for quaternionic Hilbert spaces.

Together with the reference continuum and the Hilbert base enumeration set the distance function defines the ***evolution*** of the model.

2.5 Hilbert spaces

2.5.1 Real Hilbert space model

When a real separable Hilbert space is used to represent the static quantum logic, then it is sensible to use a countable set of real numbers for the enumeration. A possible selection is formed by the natural numbers. Within the real numbers the natural numbers have a fixed interspacing. Since the rational number system has the same cardinality as the natural number system, the rational numbers can also be used as enumerators. In that case it is sensible to specify ***a (fixed) smallest rational number*** as the enumeration step size. In this way the notion of interspacing is preserved and can the distance function do its scaling task[13]. In the realm of the real Hilbert space model, the continuum that embeds the enumerators is formed by the real numbers. The values of the enumerators of the Hilbert base vectors are used as parameters for the distance function. The value that is produced by the distance function

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[9] The differential defines a local metric.
[10] This is not the case for the reference Hilbert space in the sequence. There a direct relation exists.
[11] Later these images will be called Qpatches
[12] We will take the reference continuum from the Gelfand triple of the reference Hilbert space in the sequence. Thus, in the reference member of the sequence a clear relation between the two enumeration sets exist.
[13] Later, in the quaternionic Hilbert space model, this freedom is used to introduce space curvature and it is used for resolving the one to many problem.

determines the target location for the corresponding enumerator in the embedding continuum. The interspacing freedom is used in order to introduce dynamics in which something happens.

In fact what we do is defining an enumeration operator that has the enumeration numbers as its eigenvalues. The corresponding eigenvectors of this operator are the target of the enumerator.

With respect to the logic model, what we do is enumerate a previously unordered set of atomic propositions that together span the quantum logic system and next we embed the numerators in a continuum. The correlation vehicle takes care of the cohesion between subsequent quantum logical systems.

While the progression step is fixed, the (otherwise fixed) space step might scale with progression.

Instead of using a fixed smallest rational number as the enumeration step size and a map into a reference continuum we could also have chosen for a model in which the rational numbered step size varies with the index of the enumerator.

2.5.2 Gelfand triple

The Gelfand triple of a real separable Hilbert space can be understood via the corresponding enumeration model of the real separable Hilbert space. Let the smallest enumeration value of the rational enumerators approach zero. Even when zero is reached, then still the set of enumerators is countable. Now add all limits of converging rows of rational enumerators to the enumeration set. After this operation the enumeration set has become a continuum and has the same cardinality as the set of the real numbers. It means that also every orthonormal base of the Gelfand triple has that cardinality. It also means that linear operators in this space have eigenspaces that are continuums and have the cardinality of the real numbers[14].

2.5.3 Complex Hilbert space model

When a complex separable Hilbert space is used to represent quantum logic, then it is sensible to use rational complex numbers for the enumeration. Again a smallest enumeration step size is introduced. However, the imaginary fixed enumeration step size may differ from the real fixed enumeration step size. The otherwise fixed imaginary enumeration step may be scaled as a function of progression. In the complex Hilbert space model, the continuum that embeds the enumerators of the Hilbert base vectors is formed by the system of the complex numbers. This continuum belongs as eigenspace to the enumerator operator that resides in the Gelfand triple. It is sensible to let the real part of the Hilbert base enumerators represent progression. The same will happen to the real axis of the embedding continuum. On the real axis of the embedding continuum the interspacing can be kept fixed. Instead, it is possible to let the distance function control the interspacing in the imaginary axis of the embedding continuum. The values of the rational complex enumerators are used as parameters for the distance function. The complex value of the distance function determines the target location for the corresponding enumerator in the continuum. The distance function establishes the necessary coherence between the subsequent Hilbert spaces in the sequence. The difference with the real Hilbert space model is, that now the progression is included into the values of the enumerators. The result of these

[14] This story also applies to the complex and the quaternionic Hilbert spaces and their Gelfand triples.

choices is that the whole model steps with (very small, say practically infinitesimal) fixed progression steps.

In the model that uses complex Hilbert spaces, the enumeration operator has rational complex numbers as its eigenvalues. In the complex Hilbert space model, the fixed enumeration real step size and the fixed enumeration imaginary step size define ***a maximum speed***. The fixed imaginary step size may scale as a function of progression. The same will then happen with the maximum speed, defined as space step divided by progression step. However, if information steps one step per progression step, then the information transfer speed will be constant. Progression plays the role of proper time. Now define a new concept that takes the length of the complex path step as the step value. Call this concept the coordinate time step. Define a new speed as the space step divided by the coordinate time step. This new ***maximum speed is a model constant***. Proper time is the time that ticks in the reference frame of the observed item. Coordinate time is the time that ticks in the reference frame of the observer[15]. Coordinate time is our conventional notion of time.

Again the eigenvectors of the (complex enumeration) operator are the targets of the enumerator whose value corresponds to the complex eigenvalue.

If we ignore the case of negative progression, then the complex Hilbert model exist in two forms, one in which the interspacing appears to expand and one in which the interspacing decreases with progression[16].

2.5.4 Quaternionic Hilbert space model

When a quaternionic separable Hilbert space is used to model the static quantum logic, then it is sensible to use rational quaternions for the enumeration. Again the fixed enumeration step sizes are applied for the real part of the enumerators and again the real parts of the enumerators represent progression. The continuum that embeds the enumerators is formed by the number system of the quaternions. The scaling distance function of the complex Hilbert space translates into an isotropic scaling function in the quaternionic Hilbert space. However, we may instead use a full 3D distance function that incorporates the isotropic scaling function. This new distance function may act differently in different spatial dimensions. However, when this happens at very large scales, then it conflicts with the cosmological principle. At those scales the distance function must be quasi isotropic. The distance function is not allowed to create preferred distances.

Now the enumeration operator of the Hilbert space has rational quaternions as its eigenvalues. The relation between eigenvalues, eigenvectors and enumerators is the same as in the case of the complex Hilbert space. Again the whole model steps with fixed progression steps.

2.5.4.1 Curvature and fundamental fuzziness

The spatially fixed interspacing that is used with complex Hilbert spaces poses problems with quaternionic Hilbert spaces. Any regular spatial interspacing pattern will introduce preferred directions.

[15] In fact coordinate time is a mixture of progression and space. See paragraph on spacetime metric.
[16] The situation that expands from the point of view of the countable enumeration set, will contract from the point of view of the embedding continuum of enumerators.

Preferred directions are not observed in nature[17] and the model must not create them. A solution is formed by the ***randomization of the interspacing***. Thus instead of a fixed imaginary interspacing we get an average interspacing. This problem does not play on the real axis. On the real axis we can still use a fixed interspacing. The result is an ***average maximum speed***. This speed is measured as space step per coordinate time step, where the coordinate time step is given by the length of the 1+3D quaternionic path step. Further, the actual location of the enumerators in the embedding continuum will be determined by the combination of a sharp distance function and a Quaternionic Probability Amplitude Distribution (QPAD) that specifies the local blur. The form factor of the blur may differ in each direction and is set by the differential of the sharp distance function. The total effect is given by the convolution of the sharp distance function and a non-deformed QPAD. The result is a blurred distance function.

The requirement that the cosmological principle must be obeyed is the cause of a fundamental fuzziness of the quaternionic Hilbert model. It is the reason of existence of quantum physics.

An important observation is that the blur mainly occurs locally.

At larger distances the freedom that is tolerated by the distance function causes ***curvature of observed space***. However, as explained before, at very large scales the distance function must be quasi isotropic[18]. The local curvature is described by the differential of the sharp part of the distance function.

This picture only tells that space curvature might exist. It does not describe the origin of space curvature. For more detailed explanation, please see the paragraph on the enumeration process.

2.5.4.2 Discrete symmetry sets

Quaternionic number systems exist in 16 forms (sign flavors[19]) that differ in their discrete symmetry sets. The same holds for sets of rational quaternionic enumerators. Four members of the set represent isotropic expansion or isotropic contraction of the imaginary interspacing. At large scales two of them are symmetric functions of progression. The other two are at large scales anti-symmetric functions of progression. We will take the symmetrical member that expands with positive progression as the ***reference rational quaternionic enumerator set***. Each member of the set corresponds with a quaternionic Hilbert space model. Thus apart from a reference continuum we now have a reference rational quaternionic enumerator set. Both reference sets meet at the reference Hilbert space. Even at the instance of the reference Hilbert space, the distance function must be a continuous function of progression.

A similar split in quaternionic sign flavors occurs with continuous quaternionic functions. For each discrete symmetry set of their parameter space, the function values of the continuous quaternionic distribution exist in 16 versions that differ in their discrete symmetry set. Within the target domain of the quaternionic distribution the symmetry set will stay constant.

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[17] Preffered directions are in conflict with the cosmological principle.
[18] Quasi-isotropic = on average isoropic.
[19] See paragraph on Qpattern coupling

2.5.4.3 Generations and Qpatterns

During the progression step the generator of enumerators can depending on its efficiency only generate a certain amount of randomized enumerators. If generators with different efficiency exist, then several generations[20] of local QPAD's exist. For a selected generation the following holds:

Apart from the adaptation of the form factor that is determined by the local curvature and apart from the discrete symmetry set of the QPAD, the QPAD's are everywhere in the model the same.

Therefore we will call this basic form of the selected QPAD generation a ***Qpattern.*** For each generation, *Qpatterns exist in 16 versions that differ in their* discrete symmetry set.

The paper does not reveal how much lower order objects are contained in a Qpattern. These objects are generated in a single progression step.

2.6 The reference Hilbert space

The reference Hilbert space is taken as the member of the sequence of Hilbert spaces at the progression instance where the distance function is a symmetric function of progression that expands in directions that depart from the progression value of the reference Hilbert space.

At large and medium scales the reference member of the sequence of quaternionic Hilbert spaces is supposed to have a quasi-uniform[21] distribution of the enumerators in the embedding continuum. This is realized by requiring that the eigenspace of the enumeration operator that acts in the Gelfand triple of the zero progression value Hilbert space represents the reference embedding continuum. With other words, at this instance of progression, the rational quaternionic enumeration space is ***flat***. This member of the sequence still features a stochastic interspacing in the imaginary part of the embedding quaternionic continuum. For the reference Hilbert space the isotropic scaling function is symmetric at zero progression value. Thus for the reference Hilbert space at the reference progression instance the distribution of the enumerators will realize a ***densest packaging***[22].

For all subsequent Hilbert spaces the embedding continuum will be taken from the Gelfand triple of the first reference Hilbert space.

[20] See paragraph on generations
[21] quasi-uniform = on average uniform.
[22] The densest packaging will also be realized locally when the geometry generates black regions.

2.7 The cosmological principle revisited

The enumeration process attaches an artificial content to the each of the members in the unordered set of atomic propositions. The unrestricted enumeration with rational quaternions generates an artificial origin and it generates artificial preferred directions that are not present in the original set of atomic propositions. The correlation vehicle is not allowed to attach this extra functionality to the original propositions. However, the vehicle must still perform its task to establish cohesion between subsequent sub-models. One measure is to turn the enumeration space into an affine space. An affine space has no origin. The next measure is to randomize the enumeration process sufficiently such that an acceptable degree of cohesion is reached and at the same time a quasi-isotropy of this affine space is established. This measure requires the freedom of some interspacing, which is obtained by assigning a lowest rational number. In principle, a lowest rational number can be chosen for the real part and a different smallest base number can be chosen for the imaginary part. This choice defines a basic notion of speed. The resulting (imaginary) space is on average isotropic. The randomization results in a local blur of the continuous function that regulates the enumeration process.

The result of these measures is that the cosmologic principle is installed. Thus, in fact ***the cosmological principle is a corollary of the other two starting points***.

3 The enumeration process

It is not yet clear how Qpatterns will be shaped. This information can be derived from the requirements that are set for the correlation vehicle. We will start with an assumption for the enumeration process that for this vehicle will lead to the wanted functionality.

Hypothesis I: At small scales the enumeration process is governed by a Poisson process.

The lateral spread that goes together with the low scale randomization of the interspacing plays the role of a binomial process. The combination of a Poisson process and a binomial process is again a Poisson process, but locally it has a lower efficiency than the original Poisson process. For a large number of enumerator generations the resulting Poisson distribution resembles a Gaussian distribution[23]. If the generated enumerators are considered as charge carriers, then the corresponding potential has the shape of an Error function divided by r. Already at a short distance from its center location the potential function starts decreasing with distance r as a $1/r$ function.

If there is a static spherically symmetric Gaussian charge density

$$\rho_f(r) = \frac{Q}{\sigma^3\sqrt{2\pi}^3}\exp(\frac{-r^2}{2\sigma^2})$$

where Q is the total charge, then the solution $\varphi(r)$ of Poisson's equation,

$$\nabla^2\varphi = -\frac{\rho_f}{\varepsilon}$$

is given by

$$\varphi(r) = \frac{Q}{4\pi\varepsilon r}\operatorname{erf}(\frac{r}{\sqrt{2}\sigma})$$

where $erf(x)$ is the error function.

Note that, for r much greater than σ, the erf function approaches unity and the potential $\varphi\ (r)$ approaches the point charge potential

$$\varphi(r) \approx \frac{Q}{4\pi\varepsilon r}$$

as one would expect. Furthermore the erf function approaches 1 extremely quickly as its argument increases; in practice for $r\ >\ 3\sigma$ the relative error is smaller than one part in a thousand.

[23] http://en.wikipedia.org/wiki/Poisson's_equation#Potential_of_a_Gaussian_charge_density

Now we remember Bertrand’s theorem.[24] :

Bertrand's theorem states that only two types of central force potentials produce stable, closed orbits:

(1) an inverse-square central force such as the gravitational or electrostatic potential

$$V(r) = \frac{-k}{r} \tag{1}$$

and

(2) the radial harmonic oscillator potential

$$V(r) = ½\, k\, r^2 \tag{2}$$

With other words the assumption that the enumerators are generated by a Poisson process produces the proper cohesion requirements for the correlation vehicle.

According to this investigation it becomes acceptable to assume that the undisturbed shape of the Qpatterns can be characterized as Gaussian distributions[25]. Since this distribution produces the correct shape of the gravitation potential***, it would explain the origin of curvature***.

[24] http://en.wikipedia.org/wiki/Bertrand's_theorem.

[25] It might be clear that in this way an explanation is given for the effect of a Qpattern on local curvature.

4 Geometric model

The geometric model applies the quaternionic Hilbert space model. From now on the complex Hilbert space model and the real Hilbert space model are considered to be abstractions of the quaternionic model. It means that the special features of the quaternionic model bubble down to the complex and real models. For example both lower dimensional enumeration spaces will show blur at small enumeration scales. Further, both models will show a simulation of the discrete symmetry sets that quaternionic systems and functions possess. This can be achieved with spinors and Dirac matrices or with the combination of Clifford algebras, Grassmann algebras and Jordan algebras..

At large scales the model can properly be described by the complex Hilbert space model. At very large scales the quaternionic model is quasi isotropic.

We will place the reference Hilbert space at zero progression value.

Quaternionic numbers exist in 16 discrete symmetry sets. When used as enumerators, half of this set corresponds with ***negative progression and will not be used in this geometric model.***

As a consequence we will call the Hilbert space at zero progression value the ***start*** of the model.

This model does not start with a Big Bang. Instead it starts in a state that is characterized by densest packaging of the Qpatches.

4.1 RQE's

RQE stands for Rational Quaternionic Enumerator. This lowest geometrical level is formed by the enumerators of a selected base of a selected member of the sequence of Hilbert spaces. In this level, the embedding continuum is not included. The sequence number corresponds with the progression value in the real part of the value of the RQE. In principle the enumerators enumerate a previously unordered set.

The ordering and the corresponding origin of space become relevant when an observer object considers one or more observed objects. The real part of the enumerators defines progression. In physics progression conforms to proper time. As a consequence according to our model, the equivalent of proper time steps with a fixed step.

HYPOTHESIS II : At its start nature used only one discrete symmetry set for its lowest level of geometrical objects. This discrete symmetry set is the same set that characterizes the reference continuum. This situation stays throughout the history of the model. This set corresponds with the reference quaternionic Hilbert space model.

Due to this restriction the RQE-space is not afflicted with splits and ramifications[26].

[26] http://en.wikipedia.org/wiki/Quaternion_algebra#Quaternion_algebras_over_the_rational_numbers

4.2 Palestra

The second geometric level is a curved space, called Palestra. As ingredients, it consists of an embedding continuum, the embedded RQE set and a sharp continuous quaternionic distance function. The local curvature is defined via the differential of the continuous (sharp) quaternionic distance function. The parameter space of the distance function is formed by the RQE-set. Thus since the RQE-set is countable, the Palestra contains a countable set of images of the sharp distance function. We will call these images "Qpatches". The distance function may include an isotropic scaling function. The differential of the distance function defines an infinitesimal quaternionic step. In physical terms 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[27]. Like the first geometric level, this level represents an affine space. The enumeration process adds an arbitrary origin. The origin and the axes only become relevant when the distance between locations must be handled. Like all continuous quaternionic functions, for each discrete symmetry set of its parameter space, the distance function exists in 16 different discrete symmetry sets for its function values. This means that also 16 different embedding continuums exist. As a consequence, there are 16 different versions of the Palestra. However, these versions may superpose. 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. One of the 16 Palestras acts as reference Palestra. The corresponding distance function and thus this reference Palestra has the same sign flavor[28] as the reference set that is formed by the lowest level of the geometrical objects.

4.3 Qpatches

The third level of geometrical objects consists of a countable set of space patches that occupy the Palestra. We already called them Qpatches. They are images of the RQE's that house in the first geometric object level. The set of RQE's is used as parameter space for the distance function. Apart from the rational quaternionic value of the corresponding RQE, 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 of the ***regions***[29] where next level objects can be detected. The name Qpatch stands 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. However, we already established that the value of the enumerator is also contained in the property set that forms the Qsymm charge.

The enumeration problems that come with the quaternionic Hilbert space model indicate that the Qpatches are in fact centers of a fuzzy environment that houses the potential locations where the actual RQE image can be found. ***A Qpatch is a non-blurred image of a RQE***.

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[27] See the paragraph on the spacetime metric.
[28] We will use sign flavors and discrete symmetry sets interchangeably.
[29] Not the exact locations.

4.4 QPAD's

The fuzziness in the correlated sampling of the enumerators and their images in the reference continuum is described by a ***quaternionic probability amplitude distribution*** (QPAD). The squared modulus of the QPAD represents the probability that an image of an RQE will be detected on the exact location that is specified by the value of the parameter of the blurred distance function. The ***QPAD's that act as Qpatterns have a flat parameter space in the form of a quaternionic continuum.*** The QPAD adds blur to the sharp distance function. The blurred distance function is formed by the ***convolution*** of the sharp distance function with the Qpattern. In this way the local form of the QPAD becomes a deformed Qpattern. The adaptation concerns the form factor of the QPAD. The form factor may differ in each direction. It is determined by the differential of the sharp distance function. On detection the image produced by the blurred distance function is a ***Qtarget***.

Qtargets only exist when a corresponding detection (interaction) is performed.

QPAD's are quaternionic distributions that contain a scalar potential in their real part that describes a density distribution of ***potential*** Qtargets. Further they contain a 3D vector potential in their imaginary part that describes the associated current density distribution of potential Qtargets. Continuous quaternionic distributions exist in eight different discrete spatial symmetry sets. However, the QPAD's inherit the discrete symmetry of their connected sharp distance function. The QPAD's superpose. Together they form a global QPAD. 16 different global QPAD's exist.

4.5 Blurred distance functions

The blurred distance function $\mathcal{P}$ has a flat parameter space that is formed by rational quaternions. It is the convolution of the sharp distance function $\wp$ with a Qpattern ψ.

$$\mathcal{P} = \wp \circ \psi \tag{1}$$

$\wp$ describes the long range variation and ψ describes the short range variation. Due to this separation it is possible to describe the effect of the convolution on the local QPAD as a deformed Qpattern, where the form factor is controlled by the differential $d\wp$ of the sharp distance function.

Fourier transforms cannot be defined properly for functions with a curved parameter space, however, the blurred distance function $\mathcal{P}$ has a well-defined Fourier transform $\tilde{\mathcal{P}}$, which is the product of the Fourier transform $\tilde{\wp}$ of the sharp distance function and the Fourier transform $\tilde{\psi}$ of the Qpattern.

$$\tilde{\mathcal{P}} = \tilde{\wp} \times \tilde{\psi} \tag{2}$$

The Fourier transform pairs and the corresponding canonical conjugated parameter spaces form a double-hierarchy model.

The Fourier transform of the blurred distance function equals the product of the Fourier transform of the sharp distance function and the Fourier transform of the Qpattern.

16 blurred distance function exist that together cover all Qpatches. One of the 16 blurred distance functions acts as reference. The corresponding sharp distance function and thus the corresponding QPAD have the same discrete symmetry set as the lowest level space.

The fact that the blur ψ mainly has a local effect makes it possible to treat $\wp$ and ψ seperately[30].

4.6 Local and global QPAD's

The model uses Qpatterns in order to implement the fuzziness of the local interspacing. After adaptation of the form factor to the differential of the sharp distance function a local QPAD is generated. The non-transformed local QPAD is a Qpattern. Each Qpattern possess a private inertial reference frame[31]. The superposition of all these local QPAD's, including the (deformed) higher generations of the Qpatterns, forms a global QPAD. Each of the 16 blurred distance functions corresponds to a global QPAD.

In principle each of the Qpatterns may extend over the whole RQE-space. However, the amplitude of these Qpatterns diminishes with the distance from their center point[32].

4.7 Generations

Photons and gluons correspond to a special generation of Qpatterns that have no lateral extension. Two photon Qpatterns and six[33] gluon Qpatterns exist[34].

Further, (at least) three generations of Qpatterns exist that have non-zero extension and that differ in their basic form factor.

The generator of enumerators is for a part a random number generator. That part is responsible for the generation of the Poisson distribution. During the progression step the generator of enumerators can depending on its efficiency only generate a certain amount of randomized enumerators. If generators with different efficiency exist, then several generations of Qpatterns exist.

4.8 Elementary particles

Elementary particles are constituted by the coupling of two Qpatterns that belong to the same generation. One of the Qpatterns is the quantum state function of the particle. The other Qpattern can be interpreted to implement inertia. Apart from their sign flavors these constituting Qpatterns form the same quaternionic distribution. However, the sign flavor must differ and their progression must have the same direction. This results in 32 elementary particle types, 32 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. The coupling affects the local curvature of the involved Palestras.

Qpatterns that belong to the same generation have the same shape. This is explained in the paragraph on the enumeration process. The difference between the coupling partners resides in the discrete

[30] ψ concerns quantum physics. $\wp$ concerns general relativaty.
[31] See the paragraph on inertial reference frames.
[32] See the paragraph on the enumeration process.
[33] In the Standard Model gluons appear as eight superpositions of the six base gluons.
[34] Bertrand's theorem indicates that under some conditions, the Qpatterns of photons and gluons might be described as radial harmonic oscillators.

symmetry sets. ***Thus the properties of the coupled pair are completely determined by the sign flavors of the partners.***

Coupling occurs because the two Qpatterns that constitute the coupling take the same location. Because they differ in their discrete symmetry they take part in a local oscillation where an outbound move is followed by a inbound move and vice versa[35].

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

The fact that for fermions the reference continuum and the reference enumerator set play a crucial role may indicate ***that the Pauli principle is based on this fact.***

This paper does not (yet) give an explanation for the influence on the spin of the particle that this connected to being a fermion or a boson.

Locally, the coupling of two Qpatterns is controlled by a coupling equation

$$\nabla\psi = \phi = m\,\varphi \tag{1}$$

Here ∇ is the quaternionic nabla. ψ and φ are normalized Qpatterns that belong to the same generation. ψ plays the role of quantum state function. The equation ignores the influence of the sharp distance function $\wp$. For elementary particles ψ and φ are different sign flavors of the same Qpattern:

$$\psi_0 = \varphi_0 \tag{2}$$

$$|\boldsymbol{\psi}| = |\boldsymbol{\varphi}| \tag{3}$$

$$\int_V |\psi|^2\, dV = \int_V |\varphi|^2\, dV = 1 \tag{4}$$

$$\int_V |\phi|^2\, dV = m^2 \tag{5}$$

This makes $|\phi|$ to the distribution of ***the local energy*** and m to the ***total energy*** of the quantum state function. The coupling equation can be split in a real equation and an imaginary equation.

$$\nabla_0\psi_0 - \langle \boldsymbol{\nabla}, \boldsymbol{\psi} \rangle = m_r\,\varphi_0 \tag{6}$$

$$\nabla_0\boldsymbol{\psi} + \boldsymbol{\nabla}\psi_0 + \boldsymbol{\nabla} \times \boldsymbol{\psi} = m_i\,\boldsymbol{\varphi} \tag{7}$$

Bold characters indicate imaginary quaternionic distributions and operators. Zero subscripts indicate real distributions and operators. If ψ and φ are different sign flavors of the same Qpattern, then m_r and m_i are equal.

[35] See: Coupling Qpatterns.

The quantum state function of a particle moving with uniform speed $\boldsymbol{v}$ is given by

$$\psi = \chi + \chi_0 \boldsymbol{v} \tag{8}$$

$$\chi_0 = \psi_0 \tag{9}$$

Here χ stands for quantum state function of the particle at rest.

We introduce new symbols. In order to indicate the difference with Maxwell's equations we use Gotic capitals:

$$\boldsymbol{\mathfrak{E}} = \nabla_0 \boldsymbol{\psi} + \boldsymbol{\nabla} \psi_0 \tag{10}$$

$$\boldsymbol{\mathfrak{B}} = \boldsymbol{\nabla} \times \boldsymbol{\psi} \tag{11}$$

The local field energy E is given by:

$$E = |\phi| = \sqrt{\phi_0 \phi_0 + \langle \boldsymbol{\phi}, \boldsymbol{\phi} \rangle} = \sqrt{\phi_0 \phi_0 + \langle \boldsymbol{\mathfrak{E}}, \boldsymbol{\mathfrak{E}} \rangle + \langle \boldsymbol{\mathfrak{B}}, \boldsymbol{\mathfrak{B}} \rangle + \boldsymbol{2} \langle \boldsymbol{\mathfrak{E}}, \boldsymbol{\mathfrak{B}} \rangle} \tag{12}$$

The total energy is given by the volume integral

$$E_{total} = \sqrt{\int_V |\phi|^2 \, dV} \tag{13}$$

In a static situation the local energy E reduces to

$$E_{static} = \sqrt{\langle \boldsymbol{\nabla}, \boldsymbol{\psi} \rangle^2 + \langle \boldsymbol{\mathfrak{E}}, \boldsymbol{\mathfrak{E}} \rangle + \langle \boldsymbol{\mathfrak{B}}, \boldsymbol{\mathfrak{B}} \rangle} \tag{14}$$

Photons and gluons are not coupled.

In the standard model the eight gluons are constructed from superpositions of these six base gluons.

4.8.1 Fourier transform

In a region of little or no space curvature the Fourier transform of Qpatterns can be taken.

$$\nabla \psi = \phi = m\, \varphi \tag{1}$$

$$P \breve{\psi} = \breve{\phi} = m\, \breve{\varphi} \tag{2}$$

$$P_0 \breve{\psi}_0 - \langle \boldsymbol{P}, \breve{\boldsymbol{\psi}} \rangle = m\, \breve{\varphi}_0 \tag{3}$$

$$P_0 \breve{\boldsymbol{\psi}} + \boldsymbol{P} \breve{\psi}_0 + \boldsymbol{P} \times \breve{\boldsymbol{\psi}} = m\, \breve{\boldsymbol{\varphi}} \tag{4}$$

4.8.2 Inertial reference frames

Each Qpattern possesses an inertial reference frame that represents its current location, its orientation and its discrete symmetry. The reference frame corresponds with a Cartesian coordinate system that has a well-defined origin. Reference frames of different Qpatterns have a relative position. A Qpattern does not move with respect to its own reference frame. However, reference frames of different Qpatterns may move relative to each other. The reference frames reside in an affine space. Interaction can take place between reference frames that reside in different HBM pages and that are within the range of the interaction speed. Within the same HBM page no interaction is possible. Interaction runs from a reference frame to a frame that lays in the future of the sender.

Coupling into elementary particles puts the origins of the reference frames of the coupled Qpatterns at the same location. At the same location reference frames are parallel. That does not mean that the axes have the same sign.

4.8.3 Coupling Qpatterns

Qpatterns are not static. Instead they oscillate. The interpretation of this oscillation is that on the average the Qpattern keeps its location and it keeps its form. Thus an outbound move must be followed by an inbound move. The zero order temporal frequency of this oscillation is set by the progression step. In this light coupling means the synchronization of the involved Qpatterns. For fermions the oscillation can occur in three, two or one dimensions. Bosons may oscillate differently in different dimensions. The sharp distance function takes care of the stickier part of the dynamics. The synchronization can involve oscillations that are in-phase and oscillations that are in anti-phase. These criterions may act isotropic or they may hold in one or two dimensions.

The coupling uses pairs $\{\psi^x, \psi^y\}$ of two sign flavors. Thus the coupling equation runs:

$$\nabla\psi^x = m\,\psi^y \tag{1}$$

Corresponding anti-particles obey

$$(\nabla\psi^x)^* = m\,(\psi^y)^* \tag{2}$$

The anti-phase couplings must use different sign flavors. In the figure below $\psi^{⓪}$ acts as the reference sign flavor.

The coupling and its effect on local curvature can be understood from the background of Bertrand's theorem

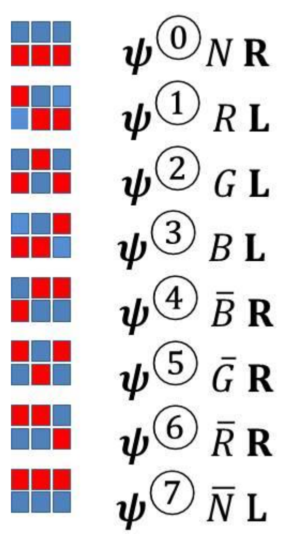

Figure 1: Sign flavors

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**

4.8.4 Elementary particle properties

Elementary particles retain their properties when they are contained in composite particles.

4.8.4.1 *Spin*

Spin relates to the fact whether the coupled Qpattern is the reference Qpattern. Each generation has its own reference Qpattern. Fermions couple to the reference Qpattern. Fermions have half integer spin. Bosons have integer spin. The spin of a composite equals the sum of the spins of its components.

4.8.4.2 *Electric charge*

Electric charge depends on the difference and direction of the base vectors for the Qpattern pair. Each sign difference stands for one third of a full electric charge. Further it depends on the fact whether the handedness differs. If the handedness differs then the sign of the count is changed as well.

The electric charge of a composite is the sum of the electric charge of its components.

4.8.4.3 *Color charge*

Color charge is related to the direction of the anisotropy of the considered Qpattern with respect to the reference Qpattern. The anisotropy lays in the discrete symmetry of the imaginary part. The color charge of the reference Qpattern is white. The corresponding anti-color is black. The color charge of the coupled pair is determined by the colors of its members. All composite particles are black or white.

4.8.4.4 *Mass*

Mass is related to the number of involved Qpatches. It is more directly related to the square root of the volume integral of the square of the local field energy E. Any internal kinetic energy is included in E.

The same mass rule holds for composite particles. The fields of the composite particles are dynamic superpositions of the fields of their components.

4.8.5 Elementary object samples

With these ingredients we can look for agreements with the standard model. It appears that the coverage is complete. But the diversity of the HBM table appears to be not (yet) discernible.

4.8.5.1 Photons and gluons

Photons and gluons are not coupled. In the standard model the eight gluons are constructed from superpositions of these six base gluons.

type	s-type	e-charge	c-charge	Handedness	SM Name
$\{\psi^{⑦}\}$	boson	0	N	**R**	photon
$\{\psi^{⓪}\}$	boson	0	W	**L**	photon
$\{\psi^{⑥}\}$	boson	0	$\overline{\mathrm{R}}$	**R**	gluon
$\{\psi^{①}\}$	boson	0	R	**L**	gluon
$\{\psi^{⑤}\}$	boson	0	$\overline{\mathrm{G}}$	**R**	gluon
$\{\psi^{②}\}$	boson	0	G	**L**	gluon
$\{\psi^{④}\}$	boson	0	$\overline{\mathrm{B}}$	**R**	gluon
$\{\psi^{③}\}$	boson	0	B	**L**	gluon

4.8.5.2 Leptons and quarks

According to the Standard Model both leptons and quarks comprise three generations. They form 22 particles. Neutrinos will be treated separately.

4.8.5.2.1 Neutrinos

Neutrinos are boso-fermions and have zero electric charge. They are leptons, but they seem to belong to a separate low-weight family of (three) generations. They couple to a Qpattern that has the same sign-flavor. The Qpatterns oscillate synchronous. The lowest generation has a very small rest mass.

type	s-type	e-charge	c-charge	Handedness	SM Name
$\{\psi^{⑦},\psi^{⑦}\}$	fermion	0	NN	**RR**	neutrino
$\{\psi^{⓪},\psi^{⓪}\}$	Anti-fermion	0	WW	**LL**	neutrino
$\{\psi^{⑥},\psi^{⑥}\}$	boson?	0	$\overline{\mathrm{R}}\overline{\mathrm{R}}$	**RR**	neutrino
$\{\psi^{①},\psi^{①}\}$	Anti- boson?	0	RR	**LL**	neutrino
$\{\psi^{⑤},\psi^{⑤}\}$	boson?	0	$\overline{\mathrm{G}}\overline{\mathrm{G}}$	**RR**	neutrino
$\{\psi^{②},\psi^{②}\}$	Anti- boson?	0	GG	**LL**	neutrino
$\{\psi^{④},\psi^{④}\}$	boson?	0	$\overline{\mathrm{B}}\overline{\mathrm{B}}$	**RR**	neutrino
$\{\psi^{③},\psi^{③}\}$	Anti- boson?	0	BB	**LL**	neutrino

4.8.5.2.2 Leptons

Pair	s-type	e-charge	c-charge	Handedness	SM Name
$\{\psi^{⑦},\psi^{⓪}\}$	fermion	-1	N	**LR**	electron
$\{\psi^{⓪},\psi^{⑦}\}$	Anti-fermion	+1	W	**RL**	positron

The generations contain the muon and tau generations of the electrons. The Qpatterns oscillate asynchronous in three dimensions.

4.8.5.2.3 Quarks

Pair	s-type	e-charge	c-charge	Handedness	SM Name
$\{\psi^{①},\psi^{⓪}\}$	fermion	-1/3	R	**LR**	down-quark
$\{\psi^{⑥},\psi^{⑦}\}$	Anti-fermion	+1/3	$\overline{\mathrm{R}}$	**RL**	Anti-down-quark
$\{\psi^{②},\psi^{⓪}\}$	fermion	-1/3	G	**LR**	down-quark
$\{\psi^{⑤},\psi^{⑦}\}$	Anti-fermion	+1/3	$\overline{\mathrm{G}}$	**RL**	Anti-down-quark
$\{\psi^{③},\psi^{⓪}\}$	fermion	-1/3	B	**LR**	down-quark
$\{\psi^{④},\psi^{⑦}\}$	Anti-fermion	+1/3	$\overline{\mathrm{B}}$	**RL**	Anti-down-quark
$\{\psi^{④},\psi^{⓪}\}$	fermion	+2/3	$\overline{\mathrm{B}}$	**RR**	up-quark
$\{\psi^{③},\psi^{⑦}\}$	Anti-fermion	-2/3	B	**LL**	Anti-up-quark
$\{\psi^{⑤},\psi^{⓪}\}$	fermion	+2/3	$\overline{\mathrm{G}}$	**RR**	up-quark
$\{\psi^{②},\psi^{⑦}\}$	Anti-fermion	-2/3	G	**LL**	Anti-up-quark
$\{\psi^{⑥},\psi^{⓪}\}$	fermion	+2/3	$\overline{\mathrm{R}}$	**RR**	up-quark
$\{\psi^{①},\psi^{⑦}\}$	Anti-fermion	-2/3	R	**LL**	Anti-up-quark

The generations contain the charm and top versions of the up-quark and the strange and bottom versions of the down-quark. The Qpatterns oscillate asynchronous in one or two dimensions.

4.8.5.2.4 Reverse quarks

Pair	s-type	e-charge	c-charge	Handedness	SM Name
$\{\psi^{⓪},\psi^{①}\}$	fermion	+1/3	R	**RL**	down-r-quark
$\{\psi^{⑦},\psi^{⑥}\}$	Anti-fermion	-1/3	$\overline{\mathrm{R}}$	**LR**	Anti-down-r-quark
$\{\psi^{⓪},\psi^{②}\}$	fermion	+1/3	G	**RL**	down-r-quark
$\{\psi^{⑦},\psi^{⑤}\}$	Anti-fermion	-1/3	$\overline{\mathrm{G}}$	**LR**	Anti-down-r-quark
$\{\psi^{⓪},\psi^{③}\}$	fermion	+1/3	B	**RL**	down-r-quark
$\{\psi^{⑦},\psi^{④}\}$	Anti-fermion	-1/3	$\overline{\mathrm{B}}$	**LR**	Anti-down-r_quark
$\{\psi^{⓪},\psi^{④}\}$	fermion	-2/3	$\overline{\mathrm{B}}$	**RR**	up-r-quark
$\{\psi^{⑦},\psi^{③}\}$	Anti-fermion	+2/3	B	**LL**	Anti-up-r-quark
$\{\psi^{⓪},\psi^{⑤}\}$	fermion	-2/3	$\overline{\mathrm{G}}$	**RR**	up-r-quark
$\{\psi^{⑦},\psi^{②}\}$	Anti-fermion	+2/3	G	**LL**	Anti-up-r-quark
$\{\psi^{⓪},\psi^{⑥}\}$	fermion	-2/3	$\overline{\mathrm{R}}$	**RR**	up-r-quark
$\{\psi^{⑦},\psi^{①}\}$	Anti-fermion	+2/3	R	**LL**	Anti-up-r-quark

The generations contain the charm and top versions of the up-r-quark and the strange and bottom versions of the down-r-quark. The Qpatterns oscillate asynchronous in one or two dimensions.

4.8.5.3 *W-particles*

The 18 W-particles have indiscernible color mix. $W_{+}$and W_{-} are each other's anti-particle.

Pair	s-type	e-charge	c-charge	Handedness	SM Name
$\{\psi^{\textcircled{6}},\psi^{\textcircled{1}}\}$	boson	-1	$\overline{\mathrm{R}}\mathrm{R}$	**RL**	W_{-}
$\{\psi^{\textcircled{1}},\psi^{\textcircled{6}}\}$	Anti-boson	+1	$\mathrm{R}\overline{\mathrm{R}}$	**LR**	W_{+}
$\{\psi^{\textcircled{6}},\psi^{\textcircled{2}}\}$	boson	-1	$\overline{\mathrm{R}}\mathrm{G}$	**RL**	W_{-}
$\{\psi^{\textcircled{2}},\psi^{\textcircled{6}}\}$	Anti-boson	+1	$\mathrm{G}\overline{\mathrm{R}}$	**LR**	W_{+}
$\{\psi^{\textcircled{6}},\psi^{\textcircled{3}}\}$	boson	-1	$\overline{\mathrm{R}}\mathrm{B}$	**RL**	W_{-}
$\{\psi^{\textcircled{3}},\psi^{\textcircled{6}}\}$	Anti-boson	+1	$\mathrm{B}\overline{\mathrm{R}}$	**LR**	W_{+}
$\{\psi^{\textcircled{5}},\psi^{\textcircled{1}}\}$	boson	-1	$\overline{\mathrm{G}}\mathrm{G}$	**RL**	W_{-}
$\{\psi^{\textcircled{1}},\psi^{\textcircled{5}}\}$	Anti-boson	+1	$\mathrm{G}\overline{\mathrm{G}}$	**LR**	W_{+}
$\{\psi^{\textcircled{5}},\psi^{\textcircled{2}}\}$	boson	-1	$\overline{\mathrm{G}}\mathrm{G}$	**RL**	W_{-}
$\{\psi^{\textcircled{2}},\psi^{\textcircled{5}}\}$	Anti-boson	+1	$\mathrm{G}\overline{\mathrm{G}}$	**LR**	W_{+}
$\{\psi^{\textcircled{5}},\psi^{\textcircled{3}}\}$	boson	-1	$\overline{\mathrm{G}}\mathrm{B}$	**RL**	W_{-}
$\{\psi^{\textcircled{3}},\psi^{\textcircled{5}}\}$	Anti-boson	+1	$\mathrm{B}\overline{\mathrm{G}}$	**LR**	W_{+}
$\{\psi^{\textcircled{4}},\psi^{\textcircled{1}}\}$	boson	-1	$\overline{\mathrm{B}}\mathrm{R}$	**RL**	W_{-}
$\{\psi^{\textcircled{1}},\psi^{\textcircled{4}}\}$	Anti-boson	+1	$\mathrm{R}\overline{\mathrm{B}}$	**LR**	W_{+}
$\{\psi^{\textcircled{4}},\psi^{\textcircled{2}}\}$	boson	-1	$\overline{\mathrm{B}}\mathrm{G}$	**RL**	W_{-}
$\{\psi^{\textcircled{2}},\psi^{\textcircled{4}}\}$	Anti-boson	+1	$\mathrm{G}\overline{\mathrm{B}}$	**LR**	W_{+}
$\{\psi^{\textcircled{4}},\psi^{\textcircled{3}}\}$	boson	-1	$\overline{\mathrm{B}}\mathrm{B}$	**RL**	W_{-}
$\{\psi^{\textcircled{3}},\psi^{\textcircled{4}}\}$	Anti-boson	+1	$\mathrm{B}\overline{\mathrm{B}}$	**LR**	W_{+}

The Qpatterns oscillate differently in multiple dimensions.

4.8.5.4 *Z-candidates*

The 12 Z-particles have indiscernible color mix.

Pair	s-type	e-charge	c-charge	Handedness	SM Name
$\{\psi^{\textcircled{2}},\psi^{\textcircled{1}}\}$	boson	0	GR	**LL**	Z
$\{\psi^{\textcircled{5}},\psi^{\textcircled{6}}\}$	Anti-boson	0	$\overline{\mathrm{G}}\overline{\mathrm{R}}$	**RR**	Z
$\{\psi^{\textcircled{3}},\psi^{\textcircled{1}}\}$	boson	0	BR	**LL**	Z
$\{\psi^{\textcircled{4}},\psi^{\textcircled{6}}\}$	Anti-boson	0	$\overline{\mathrm{R}}\overline{\mathrm{B}}$	**RR**	Z
$\{\psi^{\textcircled{3}},\psi^{\textcircled{2}}\}$	boson	0	BR	**LL**	Z
$\{\psi^{\textcircled{4}},\psi^{\textcircled{5}}\}$	Anti-boson	0	$\overline{\mathrm{R}}\overline{\mathrm{B}}$	**RR**	Z
$\{\psi^{\textcircled{1}},\psi^{\textcircled{2}}\}$	boson	0	RG	**LL**	Z
$\{\psi^{\textcircled{6}},\psi^{\textcircled{5}}\}$	Anti-boson	0	$\overline{\mathrm{R}}\overline{\mathrm{G}}$	**RR**	Z
$\{\psi^{\textcircled{1}},\psi^{\textcircled{3}}\}$	boson	0	RB	**LL**	Z
$\{\psi^{\textcircled{6}},\psi^{\textcircled{4}}\}$	Anti-boson	0	$\overline{\mathrm{R}}\overline{\mathrm{B}}$	**RR**	Z
$\{\psi^{\textcircled{2}},\psi^{\textcircled{3}}\}$	boson	0	RB	**LL**	Z
$\{\psi^{\textcircled{5}},\psi^{\textcircled{4}}\}$	Anti-boson	0	$\overline{\mathrm{R}}\overline{\mathrm{B}}$	**RR**	Z

The Qpatterns oscillate differently in multiple dimensions.

4.9 Physical fields

Elementary particles conserve their properties in higher level bindings. These properties are sources to new fields. Besides the photons and the gluons these fields are the physical fields that we know. These new fields can be described by quaternionic distributions and when they cover large numbers of particles they can be described with quaternionic distributions that contain density distributions like the QPAD's described above. However, their charge carriers are particles and not Qpatches and their charge is a property of the corresponding particle. One of the physical fields, the gravitation field describes the local curvature of the reference Palestra.

4.10 Continuity equation

4.10.1 From coupling equation to continuity equation

Locally, the coupling of two Qpatterns is controlled by a coupling equation

$$\nabla\psi = m\,\varphi \qquad (1)$$

The coupling equation is equivalent is equivalent to a quaternionic differential equation.

$$\phi = \nabla\psi \qquad (2)$$

The coupling equation is also equivalent to a quaternionic differential continuity equation.

$$\nabla\psi = \phi \qquad (3)$$

This is best comprehended when the corresponding integral equation is investigated.

4.10.2 The differential and integral continuity equations

Let us approach the balance equation from the integral variety of the balance equation.

When $\rho_0(q)$ is interpreted as a charge density distribution, then the conservation of the corresponding charge[36] is given by the continuity equation:

Total change within *V* = flow into *V* + production inside *V* (1)

In formula this means:

$$\frac{d}{d\tau}\int_V \rho_0\, dV = \oint_S \hat{\boldsymbol{n}}\rho_0 \frac{\boldsymbol{v}}{c}\, dS + \int_V s_0\, dV \qquad (2)$$

$$\int_V \nabla_0\rho_0\, dV = \int_V \langle \boldsymbol{\nabla}, \boldsymbol{\rho}\rangle\, dV + \int_V s_0\, dV \qquad (3)$$

The conversion from formula (2) to formula (3) uses the Gauss theorem[37]. Here $\hat{\boldsymbol{n}}$ is the normal vector pointing outward the surrounding surface *S*, $\boldsymbol{v}(\tau, \boldsymbol{q})$ is the velocity at which the charge density $\rho_0(\tau, \boldsymbol{q})$ enters volume *V* and s_0 is the source density inside *V*. In the above formula $\boldsymbol{\rho}$ stands for

[36] Also see Noether's laws: http://en.wikipedia.org/wiki/Noether%27s_theorem

[37] http://en.wikipedia.org/wiki/Divergence_theorem

$$\boldsymbol{\rho} = \rho_0 \boldsymbol{v}/c \tag{4}$$

It is the flux (flow per unit area and unit time) of ρ_0 .

The combination of $\rho_0(\tau, \boldsymbol{q})$ and $\boldsymbol{\rho}(\tau, \boldsymbol{q})$ is a quaternionic skew field $\rho(\tau, \boldsymbol{q})$ and can be seen as a probability amplitude distribution (QPAD).

$$\rho \stackrel{\text{def}}{=} \rho_0 + \boldsymbol{\rho} \tag{5}$$

$\rho(\tau, \boldsymbol{q})\rho^*(\tau, \boldsymbol{q})$ can be seen as an overall probability density distribution of the presence of the carrier of the charge. $\rho_0(\tau, \boldsymbol{q})$ is a charge density distribution. $\boldsymbol{\rho}(\tau, \boldsymbol{q})$ is the current density distribution.

This results in the law of charge conservation:

$$s_0(\tau, \boldsymbol{q}) = \nabla_0 \rho_0(\tau, \boldsymbol{q}) \mp \langle \boldsymbol{\nabla}, \big(\rho_0(\tau, \boldsymbol{q}) \boldsymbol{v}(\tau, \boldsymbol{q}) + \boldsymbol{\nabla} \times \boldsymbol{a}(\tau, \boldsymbol{q})\big)\rangle \tag{6}$$

$$= \nabla_0 \rho_0(\tau, \boldsymbol{q}) \mp \langle \boldsymbol{\nabla}, \boldsymbol{\rho}(\tau, \boldsymbol{q}) + \boldsymbol{A}(\tau, \boldsymbol{q})\rangle$$

$$= \nabla_0 \rho_0(\tau, \boldsymbol{q}) \mp \langle \boldsymbol{v}(\tau, \boldsymbol{q}), \boldsymbol{\nabla} \rho_0(\tau, \boldsymbol{q})\rangle \mp \langle \boldsymbol{\nabla}, \boldsymbol{v}(\tau, \boldsymbol{q})\rangle\, \rho_0(\tau, \boldsymbol{q})$$

$$\mp \langle \boldsymbol{\nabla}, \boldsymbol{A}(\tau, \boldsymbol{q})\rangle$$

The blue colored ± indicates quaternionic sign selection through conjugation of the field $\rho(\tau, \boldsymbol{q})$. The field $\boldsymbol{a}(\tau, \boldsymbol{q})$ is an arbitrary differentiable vector function.

$$\langle \boldsymbol{\nabla}, \boldsymbol{\nabla} \times \boldsymbol{a}(\tau, \boldsymbol{q})\rangle = 0 \tag{7}$$

$\boldsymbol{A}(\tau, \boldsymbol{q}) \stackrel{\text{def}}{=} \boldsymbol{\nabla} \times \boldsymbol{a}(\tau, \boldsymbol{q})$ is always divergence free. In the following we will neglect $\boldsymbol{A}(\tau, \boldsymbol{q})$.

Equation (6) represents a balance equation for charge density. What this charge actually is, will be left in the middle. It can be one of the properties of the carrier or it can represent the full ensemble of the properties of the carrier.

Up to this point the investigation only treats the real part of the full equation. The full continuity equation runs:

$$s(\tau,\boldsymbol{q}) = \nabla\rho(\tau,\boldsymbol{q}) = s_0(\tau,\boldsymbol{q}) + \boldsymbol{s}(\tau,\boldsymbol{q}) \tag{8}$$

$$= \nabla_0\rho_0(\tau,\boldsymbol{q}) \mp \langle\boldsymbol{\nabla},\boldsymbol{\rho}(\tau,\boldsymbol{q})\rangle \pm \nabla_0\boldsymbol{\rho}(\tau,\boldsymbol{q}) + \boldsymbol{\nabla}\rho_0(\tau,\boldsymbol{q}) \pm \left(\pm\boldsymbol{\nabla}\times\boldsymbol{\rho}(\tau,\boldsymbol{q})\right)$$

$$= \nabla_0\rho_0(\tau,\boldsymbol{q}) \mp \langle\boldsymbol{v}(\tau,\boldsymbol{q}),\boldsymbol{\nabla}\rho_0(\tau,\boldsymbol{q})\rangle \mp \langle\boldsymbol{\nabla},\boldsymbol{v}(\tau,\boldsymbol{q})\rangle\,\rho_0(\tau,\boldsymbol{q})$$

$$\pm\nabla_0\boldsymbol{v}(\tau,\boldsymbol{q}) + \nabla_0\rho_0(\tau,\boldsymbol{q}) + \boldsymbol{\nabla}\rho_0(\tau,\boldsymbol{q})$$

$$\pm\left(\pm(\rho_0(\tau,\boldsymbol{q})\,\boldsymbol{\nabla}\times\boldsymbol{v}(\tau,\boldsymbol{q}) - \boldsymbol{v}(\tau,\boldsymbol{q})\times\boldsymbol{\nabla}\rho_0(\tau,\boldsymbol{q})\right)$$

$$s_0(\tau,\boldsymbol{q}) = 2\nabla_0\rho_0(\tau,\boldsymbol{q}) \mp \langle\boldsymbol{v}(q),\boldsymbol{\nabla}\rho_0(\tau,\boldsymbol{q})\rangle \mp \langle\boldsymbol{\nabla},\boldsymbol{v}(\tau,\boldsymbol{q})\rangle\,\rho_0(\tau,\boldsymbol{q}) \tag{9}$$

$$\boldsymbol{s}(\tau,\boldsymbol{q}) = \pm\nabla_0\boldsymbol{v}(\tau,\boldsymbol{q}) \pm \boldsymbol{\nabla}\rho_0(\tau,\boldsymbol{q}) \tag{10}$$

$$\pm\left(\pm\left(\rho_0(\tau,\boldsymbol{q})\,\boldsymbol{\nabla}\times\boldsymbol{v}(\tau,\boldsymbol{q}) - \boldsymbol{v}(\tau,\boldsymbol{q})\times\boldsymbol{\nabla}\rho_0(\tau,\boldsymbol{q})\right)\right)$$

The red sign selection indicates a change of handedness by changing the sign of one of the imaginary base vectors. Conjugation also causes a switch of handedness. It changes the sign of all three imaginary base vectors.

In its simplest form the full continuity equation runs:

$$s(\boldsymbol{q},\tau) = \nabla\rho(\boldsymbol{q},\tau)$$

Thus the full continuity equation specifies a quaternionic distribution s as a flat differential $\nabla\rho$.

When we go back to the integral balance equation, then holds for the imaginary parts:

$$\frac{d}{d\tau}\int_V \boldsymbol{\rho}\, dV = -\oint_S \widehat{\boldsymbol{n}}\rho_0\, dS - \oint_S \widehat{\boldsymbol{n}} \times \boldsymbol{\rho}\, dS + \int_V \boldsymbol{s}\, dV \tag{4}$$

$$\int_V \nabla_0\, \boldsymbol{\rho}\, dV = -\int_V \boldsymbol{\nabla}\rho_0\, dV - \int_V \boldsymbol{\nabla} \times \boldsymbol{\rho}\, dV + \int_V \boldsymbol{s}\, dV \tag{5}$$

For the full integral equation holds:

$$\frac{d}{d\tau}\int_V \rho\, dV + \oint_S \widehat{\boldsymbol{n}}\rho\, dS = \int_V s\, dV \tag{6}$$

$$\int_V \nabla\, \rho\, dV = \int_V s\, dV \tag{7}$$

Here $\widehat{\boldsymbol{n}}$ is the normal vector pointing outward the surrounding surface *S*, $\boldsymbol{v}(\tau,\boldsymbol{q})$ is the velocity at which the charge density $\rho_0(\tau,\boldsymbol{q})$ enters volume *V* and s_0 is the source density inside *V.* In the above formula ρ stands for

$$\rho = \rho_0 + \boldsymbol{\rho} = \rho_0 + \frac{\rho_0 \boldsymbol{v}}{c} \tag{8}$$

It is the flux (flow per unit of area and per unit of progression) of ρ_0 . t stands for progression (not coordinate time).

5 Inertia

We use the ideas of Denis Sciama[38][39][40]..

5.1 Inertia from coupling equation

In order to discuss inertia we must reformulate the coupling equation.

$$\nabla\psi = m\,\varphi \tag{1}$$

$$\nabla_0\psi_0 - \langle\nabla,\psi\rangle = m\,\varphi_0 \tag{2}$$

$$\nabla_0\psi + \nabla\psi_0 + \nabla\times\psi = \mathfrak{E} + \mathfrak{B} = m\,\varphi \tag{3}$$

We will write ψ as a superposition

$$\psi = \chi + \chi_0\,\boldsymbol{v} \tag{4}$$

$$\psi_0 = \chi_0 \tag{5}$$

$$\boldsymbol{\psi} = \boldsymbol{\chi} + \chi_0\,\boldsymbol{v}$$

χ represents the rest state of the object. With respect to progression, it is a constant.

$$\nabla_0\chi = 0 \tag{6}$$

For the elementary particles the coupled distributions { ψ , φ } have the same real part.

$$\psi_0 = \varphi_0 \tag{7}$$

$$\nabla_0\boldsymbol{\psi} = \chi_0\,\dot{\boldsymbol{v}} \tag{8}$$

Remember

$$\mathfrak{E} = \nabla_0\boldsymbol{\psi} + \boldsymbol{\nabla}\psi_0 \tag{9}$$

$$\chi_0\,\dot{\boldsymbol{v}} = \mathfrak{E} - \boldsymbol{\nabla}\psi_0 \tag{10}$$

In static conditions $\boldsymbol{v}$ represents a uniform speed of linear movement. However, if the uniform speed turns into acceleration $\dot{\boldsymbol{v}} \neq \boldsymbol{0}$, then an extra field of size $\chi_0\dot{\boldsymbol{v}}$ is generated that counteracts the acceleration. The Qpattern does not change, thus $\boldsymbol{\nabla}\psi_0$ does not change. Also $\mathfrak{B}$ does not change. This means that the acceleration of the particle corresponds to an extra $\mathfrak{E}$ field that counteracts the acceleration. On its turn it corresponds with a change of the coupling partner φ. That change involves the coupling strength m. The counteraction is felt as inertia.

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[38] http://arxiv.org/abs/physics/0609026v4.pdf

[39] http://www.adsabs.harvard.edu/abs/1953MNRAS.113...34S

[40] http://rmp.aps.org/abstract/RMP/v36/i1/p463_1

5.2 Background potential

The superposition of all real parts of Qpatterns of a given generation produces a uniform background potential. At a somewhat larger distance r these real Qpattern parts diminish in their amplitude as $1/r$. However, the number of involved Qpatterns increases with the covered volume. Further, on average the distribution of the Qpatterns is isotropic and uniform. The result is a huge (real) local potential Φ

$$\Phi = -\int_V \frac{\bar{\rho}_0}{r} dV = -\bar{\rho}_0 \int_V \frac{dV}{r} = 2\pi R^2 \bar{\rho}_0 \tag{1}$$

After averaging the Qpatterns reduce to their real parts.

$$\bar{\rho} = \bar{\rho}_0; \; \bar{\boldsymbol{\rho}} = \mathbf{0} \tag{2}$$

Apart from its dependence on the average value of $\bar{\rho}_0$, Φ is a huge constant. Sciama relates Φ to the gravitational constant G.

$$G = (-c^2) \,/\, \Phi \tag{3}$$

If the considered local particle moves relative to the universe with a uniform speed $\boldsymbol{v}$, then a vector potential $\boldsymbol{A}$ is generated.

$$\boldsymbol{A} = -\int_V \frac{\boldsymbol{v}\,\bar{\rho}_0}{c\,r} dV \tag{4}$$

Both $\bar{\rho}_0 \rho$ and **v** are independent of *r*. The product $\boldsymbol{v}\,\bar{\rho}_0$ represents a current. Together with the constant *c* they can be taken out of the integral. Thus

$$\boldsymbol{A} = \Phi\, \boldsymbol{v}/c \tag{5}$$

$$\mathfrak{E} = -\boldsymbol{\nabla\Phi} - \frac{\mathbf{1}}{\boldsymbol{c}} \cdot \dot{\boldsymbol{A}} \tag{6}$$

If we exclude the first term because it is negligible small, we get:

$$\mathfrak{E} = -\frac{\Phi}{c^2}\, \dot{\boldsymbol{v}} = G\, \dot{\boldsymbol{v}} \tag{7}$$

Like χ_0 and $\boldsymbol{\chi}$ forms a QPAD χ, the fields Φ and $\boldsymbol{A}$ together form a QPAD. However, this time the fields Φ and $\boldsymbol{A}$ do not represent parts of a Qpattern. The χ Qpattern differs fundamentally from the QPAD that is formed by Φ and $\boldsymbol{A}$. Instead these fields represent the distribution of the averages of the quantum state functions of distant particles and the distribution of the currents of these patterns.

5.3 Interpretation

As soon as an acceleration of the local item occurs, an extra component $\dot{\boldsymbol{A}}$ of field $\mathfrak{E}$ appears that corresponds to acceleration $\dot{\boldsymbol{v}}$.

In our setting the component $\boldsymbol{\nabla}\Phi$ of the field $\mathfrak{E}$ is negligible. With respect to this component the items compensate each other's influence. This means that if the influenced subject moves with uniform speed

$\boldsymbol{v}$, then $\mathfrak{E} \approx 0$. However, a vector potential $\boldsymbol{A}$ is present due to the movement of the considered item. Any acceleration of the considered local item goes together with an extra non-zero $\mathfrak{E}$ field. In this way the universe of particles causes inertia in the form of a force that acts upon the χ_0 distribution of the accelerating item.

If we compare this result with the previous analysis of inertia, then it becomes sensible to ***interpret the coupling partner of the quantum state function as the representation of the superposition of the tails of the quantum state functions of distant particles***.

The amplitude of Φ says something about the number of coupled Qpatterns of the selected generation that exist in universe. If it is constant and the average interspacing grows with progression, then the universe dilutes with increasing progression. Also the volume of the reference continuum over which the integration must be done will increase with progression. The total energy of these coupled Qpatterns that is contained in universe equals:

$$E_{total} = \sqrt{\int_V \left|\frac{\bar{\rho}_0}{r}\right|^2 dV}$$

5.4 Isotropic vector potential

The scalar background potential is accompanied by a similar background vector potential that is caused by the fact that the considered volume that was investigated in order to calculate the scalar background potential is enveloped by a surface that delivers a non-zero surface integral. The isotropic background potential corresponds to an isotropic scaling factor. This factor was already introduced in the first phases of the model.

6 Gravitation

The sharp distance function can act as the base of a quaternionic gravitation theory. The sharp distance function has sixteen partial derivatives that combine in a differential.

6.1 Palestra

All quantum state functions share their parameter space as affine spaces. Due to the fact that the coupling of Qpatterns affects this parameter space, the Palestra is curved. The curvature is not static. With other words the Qpatches in the parameter space move and densities in the distribution of these patches change. For potential observers, the Palestra is the place where everything classically happens. The Palestra comprises the whole universe.

6.1.1 Spacetime metric

The Palestra is defined with respect to a flat parameter space, which is spanned by the ***rational*** quaternions[41]. We already introduced the existence of a smallest rational number, which is used to arrange interspace freedom. The specification of the set of Qpatches is performed by a continuous

[41] http://en.wikipedia.org/wiki/Quaternion_algebra#Quaternion_algebras_over_the_rational_numbers

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[42].

$$ds(x) = ds^{\nu}(x)e_{\nu} = d\wp = \sum_{\mu=0\ldots3} \frac{\partial\wp}{\partial x_{\mu}} dx_{\mu} = q^{\mu}(x)dx_{\mu} \tag{1}$$

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. On its turn $d\wp$ ignores the blur of $\mathcal{P}$.

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}[43]. 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.

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

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

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

(4)

[42] The intervals that are constituted by the smallest rational numbers represent the infinitesimal steps. Probably the hair of mathematicians are raised when we treat the interspacing as an infinitesimal steps. I apologize for that.

[43] Notice the difference between the quaternionic interval ds and the spacetime interval ds_{st}

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

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:

$$ds^2 = g_{ik}\, dx^i\, dx^k \tag{5}$$

Still

$$g_{ik} = g_{ki} \tag{6}$$

6.1.2 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).

6.1.3 Pacific space and black regions.

If we treat the Palestra as a continuum, then 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**". This is the space where the RQE's live. 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 the smallest rational value, 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 region is quantized. Due to the fact that no information can escape through the information horizon, the inside of the horizon is obscure. No experiment can reveal its content. It does not contain a singularity at its center. All characteristics of the black region are contained in its quantum state function.

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.

6.1.4 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 expands enough, multiple individual Qpatterns may have been generated. In the beginning, these QPAD’s where uncoupled.

7 Modularization

A very powerful influencer is modularization. Together with the corresponding ***encapsulation*** it has a very healthy influence on the ***relational complexity*** of the ensemble of objects on which modularization works. The encapsulation takes care of the fact that most relations are kept internal to the module. When relations between modules are reduced to a few types, then the module becomes ***reusable***. The most Influential kind of modularization is achieved when modules can be ***configured from lower order modules***.

Elementary particles can be considered as the lowest level of modules. All composites are higher level modules.

When ***sufficient resources*** in the form of reusable modules are present, then modularization can reach enormous heights. On earth it was capable to generate ***intelligent species***.

7.1 Complexity

Potential complexity of a set of objects is a measure that is defined by the number of potential relations that exist between the members of that set.
If there are n elements in the set, then there exist n*(n-1) potential relations.

Actual complexity of a set of objects is a measure that is defined by the number of relevant relations that exist between the members of the set.

In human affairs it takes time and other resources to determine whether a relation is relevant or not. Only an expert has the knowledge that a given relation is relevant. Thus it is advantageous to have as little irrelevant potential relations as is possible, such that mainly relevant and preferably usable relations result.

Physics is based on relations. Quantum logic is a set of axioms that restrict the relations that exist between quantum logical propositions. Via its isomorphism with Hilbert spaces quantum logic forms a fundament for quantum physics. Classical logic is a similar set of restrictions that define how we can communicate logically. Like classical logic, quantum logic only describes static relations. Traditional quantum logic does not treat physical fields and it does not touch dynamics. However, the model that is based on traditional quantum logic can be extended such that physical fields are included as well and by assuming that dynamics is the travel along subsequent versions of extended quantum logics, also dynamics will be treated. The set of propositions of traditional quantum logic is isomorphic with the set of closed subspaces of a Hilbert space. This is a mathematical construct in which quantum physicists do their investigations and calculations. In this way fundamental physics can be constructed. Here holds very strongly that only relevant relations have significance.

7.2 Relationalcomplexity

We define ***relational complexity*** as the ratio of the number of actual relations divided by the number of potential relations.

7.3 Interfaces

Modules connect via interfaces. Interfaces are used by interactions. Interactions run via (relevant) relations. Relations that act within modules are lost to the outside world of the module. Thus interfaces are collections of relations that are used by interactions. Inbound interactions come from the past. Outbound interactions go to the future. Two-sided interactions are cyclic. They take at least two progression steps. They are either oscillations or rotations of the inter-actor.

7.4 Interface types

Apart from the fact that they are inbound, outbound or cyclic the interfaces can be categorized with respect to the type of relations that they represent. Each category corresponds to an interface type. An interface that possesses a type and that installs the possibility to couple the corresponding module to other modules is called a standard interface.

7.5 Modular subsystems

Modular subsystems consist of connected modules. They need not be modules. They become modules when they are encapsulated and offer standard interfaces that makes the encapsulated system a reusable object.

The cyclic interactions bind the corresponding modules together. Like the coupling factor of elementary particles characterizes the binding of the pair of Qpatterns will a similar characteristic characterize the binding of modules.

This binding characteristic directly relates to the total energy of the constituted sub-system. Let ψ represent the renormalized superposition of the involved distributions.

$$\nabla\psi = \phi = m\,\varphi \tag{1}$$

$$\int_V |\psi|^2\, dV = \int_V |\varphi|^2\, dV = 1 \tag{2}$$

$$\int_V |\phi|^2\, dV = m^2 \tag{3}$$

Here again m represents total energy.

The binding factor is the total energy of the sub-system minus the sum of the total energies of the separate constituents.

7.6 Modular actions

Subsystems that have the ability to choose their activity can choose to organize their actions in a modular way. As with static relational modularization the modular actions reduce complexity and for the decision maker it eases control.

7.7 Random design versus intelligent design

At lower levels of modularization nature design modular structures in a stochastic way. This renders the modularization process rather slow. It takes a huge amount of progression steps in order to achieve a relatively complicated structure. Still the complexity of that structure can be orders of magnitude less than the complexity of an equivalent monolith.

As soon as more intelligent sub-systems arrive, then these systems can design and construct modular systems in a more intelligent way. They use resources efficiently. This speeds the modularization process in an enormous way.

8 Cosmology

8.1 Cosmological view

Even when space was fully densely packed with matter (or another substance) then nothing dynamic would happen. Only when sufficient interspacing comes available dynamics becomes possible.

The Hilbert Book Model exploits this possibility. It sees black regions as local returns to the original condition.

8.2 Entropy

As a whole, universe expands. Locally regions exist where contraction overwhelms the global expansion. These regions are separated by inversion surfaces. The regions are characterized by their inversion surface. Within these regions the holographic principle resides. The fact that the universe as a whole expands means that the average size of the encapsulated regions increases.

The ***holographic principle*** says that the total entropy of the region equals the entropy of a black region that would contain all matter in the region. Black regions represent regions where entropy is optimally packed.

Thus entropy is directly related to the interspacing between enumerators. With other words, local entropy is related to local curvature.

8.3 The cosmological equations

The integral equations that describe cosmology are:

$$\frac{d}{d\tau}\int_V \rho\, dV + \oint_S \hat{\boldsymbol{n}}\rho\, dS = \int_V s\, dV \tag{1}$$

$$\int_V \nabla\, \rho\, dV = \int_V s\, dV \tag{2}$$

Here $\hat{\boldsymbol{n}}$ is the normal vector pointing outward the surrounding surface S, $\boldsymbol{v}(\tau,\boldsymbol{q})$ is the velocity at which the charge density $\rho_0(\tau,\boldsymbol{q})$ enters volume V and s_0 is the source density inside V. In the above formula ρ stands for

$$\rho = \rho_0 + \boldsymbol{\rho} = \rho_0 + \frac{\rho_0 \boldsymbol{v}}{c} \tag{3}$$

It is the flux (flow per unit of area and per unit of progression) of ρ_0 . t stands for progression (not coordinate time).

8.4 Inversion surfaces

An inversion surface S is characterized by:

$$\oint_S \hat{\boldsymbol{n}}\rho \, dS = 0 \tag{1}$$

8.5 Cosmological history

Think that these universe pockets contain matter that is on its way back to its natal state. If there is enough matter in the pocket this state forms a black region. The rest of the pocket is cleared from its mass content. Still the size of the pocket may increase. This represents the expansion of the universe. Inside the pocket the holographic principle governs. The black region represents the densest packaging mode of entropy.

The pockets may merge. Thus at last a very large part of the universe may return to its birth state, which is a state of densest packaging of entropy.

Then the resulting mass which is positioned at a huge distance will enforce a uniform attraction. This uniform attraction will install an isotropic extension of the central package. This will disturb the densest packaging quality of that package. The motor behind this is formed by the combination of the attraction through distant massive particles, which installs an isotropic expansion and the influence of the small scale random localization which is present even in the state of densest packaging.

This describes an eternal process that takes place in and between the pockets of an affine space.

9 Recapitulation

The model starts by taking quantum logic as its foundation. It could as well have started by taking an infinite dimensional separable Hilbert space as its foundation. However, in that case the special role of base vectors would not so easily have been brought to the front. It appears that the atoms of the logic system and the base vectors of the Hilbert space play a very crucial role in the model. They represent the lowest level of objects in nature that play the theater of our observation.

The atoms are only principally unordered at very small "distances". They have content. The Hilbert space offers built-in enumerator machinery that defines the distances and that specifies the content of the represented atoms.

The isotropic scaling factor that was assumed in the early phases of the model appears to relate to mass carrying particles that exist at huge distances.

The master of the enumeration process is the distance function $\mathcal{P}$. This function has a flat parameter space.

$$\mathcal{P} = \wp \circ \psi \tag{1}$$

At small scales this function becomes a spread function ψ that governs the quantum physics of the model. The whole function $\mathcal{P}$ is a convolution of a sharp part $\wp$ and the spread function ψ. The differential of $\wp$ delivers a local metric. The spread function appears to be generated by a Poisson generator which produces Qpatterns.

After a myriad of progression steps the original ordering of the natal state of the model is disturbed so much that the natal large and medium scale ordering is completely lost. However, this natal ordering is returning in the black regions that constitute pockets that surround them in universe. When the pockets merge into a huge black region, the history might restart enforced by the still existing low scale randomization and by the isotropic expansion factor, which is the consequence of the existence of massive particles at huge distances in this affine space.

The model uses a first part where elementary particles are formed by the representatives of the atomic propositions of the logic.

In a second part the formation of composites is described by a process called modularization. In that stage, in places where sufficient resources are present, the modularization process is capable of forming intelligent species.

This is the start of a new phase of evolution in which the intelligent species get involved in the modularization process and shift the mode from random design to intelligent design. Intelligent design runs much faster and uses its resources in a more efficient and conscientious way.

10 Conclusion

With respect to conventional physics, this simple model contains extra layers of individual objects. The most interesting addition is formed by the RQE's and the Qpatches. They represent the atoms of the quantum logic sub-model.

The model gives an acceptable explanation for the existence of an (average) maximum velocity of information transfer. The two prepositions:

- Atomic quantum logic fundament
- Correlation vehicle

Lead to the existence of fuzzy interspacing of enumerators of the Hilbert space base vectors and to dynamically varying space curvature when compared to a flat reference continuum.

Without the freedom that is introduced by the interspacing fuzziness and which is used by the dynamic curvature, no dynamic behavior would be observable in the Palestra.

In the generation of the model the enumeration process plays a crucial role, but we must keep in mind that the choice of the enumerators and therefore the choice of the type of correlation vehicle is to a large degree arbitrary. It means that the Palestra has no natural origin. It is an affine space.

Physicist that base their model of physics on an equivalent of the Gelfand triple which lacks a mechanism that creates the freedom that flexible interspaces provide, are using a model in which no natural curvature and fuzziness can occur. Such a model cannot feature dynamics.

Attaching a progression parameter to that model can only create the illusion of dynamics. However, that model cannot give a proper explanation of the existence of space curvature, space expansion, quantum physics or even the existence of a maximum speed of information transfer.

Please attack these statements with your criticism.