Sketch of the design of the Hilbert Book Model

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Introduction

The Hilbert Book Model is a simple, largely deduced model of the lower levels of quantum physics that is strictly based on quantum logic.

A sturdy and well accepted foundation like quantum logic is selected because the rest of the model is fully deduced and cannot be supported by experimental verification. By using this basis and further relying on trustworthy deduction the researcher can penetrate deeper in the lower layers of the foundations of physics than when only observable facts may be assumed and yet avoid that fantasy strikes rampantly.

Quantum logic differs in one of its ~25 axioms from classical logic. Quantum logic has a weaker version of the modular law. As a consequence also the distributive law no longer holds. Due to this small difference in the axioms the structure of quantum logic is far more complicated than the structure of classical logic.

One of the most remarkable achievements of early quantum physics was the result obtained by the duo John von Neumann and Garret Birkhoff who discovered that the set of propositions in a quantum logical system is lattice isomorphic to the set of closed subspaces of an infinite dimensional separable Hilbert space. With other words, in this way two nearly equivalent models are available that can act as foundation for quantum physics.

Quantum logic is accepted as nature's logic by most researchers of the foundations of quantum physics. See: http://en.wikipedia.org/wiki/Quantum_logic

The Hilbert Book Model project shows that quantum logic and its lattice related companion, the Hilbert space, can both be used as foundation of physics. The selected base can be extended. First the problem must be solved that both quantum logic and the Hilbert space can only represent a static status quo.

By extending the selected base, it is possible to generate step by step a full blown model of the lowest levels of physics that ranges from space and progression, via fields and elementary particles up to simple composites.

Many of the features that play a role in the deduced model cannot be observed. However, in the resulting model potentials, photons, and elementary particles play their "normal" role.

Extension of the foundation

Neither quantum logic, nor its lattice isomorphic companion, the set of subspaces of the separable Hilbert space, has natural means to implement dynamics. Thus, the first extension step is to construct a dynamic model by taking an ordered sequence of these static sub-models as a base for the dynamic model.

This model resembles a book in which every page describes a static status quo of the universe. The page number acts as a progression parameter. The progression step size can be taken to be fixed and in that case it corresponds to a super-high frequency which represents the progression tick.

The second extension step is the refinement of quantum logic by restricting the propositions to propositions that can be characterized by a numeric value, which can play the role of a relevance characteristic and can also act as a coefficient in linear combinations. This results in a Hilbert logic system that has a greater correspondence to the Hilbert space than quantum logic has. For this logic, propositions correspond to Hilbert vectors, while for quantum logic, propositions correspond to Hilbert subspaces.

Hierarchy

Now we have created a threefold hierarchy. Hilbert vectors span Hilbert subspaces and Hilbert logic propositions span quantum logic propositions. These hierarchies correspond to constituents that configure building blocks.

If the building blocks are interpreted as elementary particles, then these particles have constituents! Elementary particles are often interpreted as point-like objects. So, what are these constituents?

If the Hilbert vectors that span the building block subspace are eigenvectors, then the eigenvalues enumerate the constituents of the building block. Now the question shifts to what the enumerators are. If the corresponding operator is an allocation operator then these enumerators are positions of the building block. In that case the building block can still be a point-like object.

Building blocks

The building block cannot be at multiple positions at the same instance. However, it can walk along these locations. Thus at every progression step the building block arrives at a new eigenvalue of the allocation operator. The reserved locations are not ordered. Thus the walk goes along a stochastic micro-path.

The building block can be interpreted as a point-like object that is represented by a coherent set of reserved locations. These reserved locations are the (virtual) constituents of the building block.

The reserved locations can be described by a continuous density distribution. If the locations are distributed as a 3D normal distribution (or something like such a distribution), then the density distribution can be interpreted as a probability density distribution. In that case it conforms in its functionality to the squared modulus of the quantum state function (wave function) of the particle. Thus some extra mechanism must exist that takes care that the distribution of reserved locations can be interpreted as a probability density distribution. That mechanism does not house in the logic systems and it does not house in the Hilbert space. It is an "external" mechanism!

Continuity

The above sketch is only a part of the full story. For example the choice for modeling a dynamic system by an ordered sequence of static sub-models asks for measures that keep sufficient coherence between the members of the sequence, otherwise only dynamic chaos will result. On the other hand the coherence must not be too stiff otherwise no actual dynamics will take place. The stochastic blur of the location of the building blocks can take care of this last point. The fact that the form of this blur is such that it acts as a probability density function serves the first point.

Space

The mechanism that installs the coherence of the blur uses the fact that the locations are embedded in a continuum. It is a known fact that this continuum is curved. Thus the best choice is to implement this continuum in the model as a field. The continuum must somehow be coupled to the separable Hilbert space. That Hilbert space has no natural means to support a continuum. Its operators have countable eigenspaces. However, each separable Hilbert space possesses a Gelfand triple, which provides operators that have a continuum as their eigenspace. Thus, the background field that will act as the representation of the curved space that we experience as our living room can be taken from the Gelfand triple. This also means that the external mechanism not only must recreate the eigenspaces of allocation operators in the Hilbert space, but it must also recreate the eigenspaces of operators in the Gelfand triple.

Potentials

It is well known that massive particles curve the continuum in which they are embedded. This curvature is described by the gravitation potential of the particle. Besides of this gravitation potential, particles can also feature an electrostatic potential.

Since particles move and can be generated and annihilated, the generation of these potentials is a dynamic affair. Since the whole universe appears to be regenerated at every progression step this also holds for the background field and for the potentials.

So we must find an explanation how this occurs.

Step stones and super-high frequency waves

As shown above nature's building blocks can be represented by a coherent set of step stones. The step stones form a stochastic micro-path and even at rest the building block walks along this micro-path.

At every arrival at a step stone the building block emits information about its presence and its properties. This information is transported via a wave front that slightly folds and thus curves the embedding continuum. This is the mechanism that transports the information and at the same time it is the mechanism that curves the background field. The phenomenon is the origin of space curvature and can be described by the gravitation potential of the particle.

The wave fronts are generated at slightly different locations. At small scales they interfere. Already at a small distance the wave fronts seem to come from a rather stationary location that serves as the location of the building block. Together the wave fronts form super-high frequency waves. This frequency is so high that the waves themselves cannot be observed. However, their influences are noticeable in the form of potentials and these waves act as carrier waves for photons, which appear as modulations of these carrier waves when the emitter suddenly decreases its energy.

Regenerating universe

Further the wave fronts that are emitted by all massive particles in universe superpose (interfere) to form the background field that acts as (curved) embedding continuum.

The Hilbert Book Model gets its name from the fact that in this model universe proceeds with universe wide steps from one static status quo to the next. In universe a single universe wide (proper) time clock ticks. It corresponds with a super-high frequency.

At each progression step the whole universe is recreated. The propagation of waves is governed by Huygens principle, which renews the wave fronts of the super-high frequency waves at every progression step. As a consequence also the background field that is constituted by all wave fronts that were emitted by massive particles and that acts as our curved space will be regenerated at every progression step.

Each page of the book describes only the spatial picture. Dynamics is implemented by the ordered sequence of these pictures. Inside a page no interaction takes place. Interaction occurs only between pages and subsequent pages. The direction of these interaction is from lower page numbers to higher page numbers.

Correlation vehicle

An external mechanism guards sufficient coherence between subsequent pages. Without this mechanism space and progression are completely decoupled.

The mechanism controls both the regeneration of the elementary particles and the regeneration of the wave fronts. In this way also the potentials and the background field that acts as an embedding continuum are regenerated.

The particle regenerator can be implemented by a blurred allocation function $\mathcal{P}$. That function is a convolution of a sharp continuous allocation function $\wp$ and a stochastic spatial spread function $\mathcal{S}$. The stochastic spatial spread function is implemented by the combination of a Poisson process and a binomial process. The binomial process is implemented by a 3D spread function.

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

$\mathcal{P}$ has a flat parameter space that is spanned by a quaternionic number system. The stochastic spatial spread function $\mathcal{S}$ generates a planned step stone distribution that can be described by a continuous quaternionic object density distribution ψ.

Since the stochastic spatial spread function houses the generator of space curvature and the sharp continuous allocation function describes local curvature, these two parts must be in concordance with each other.

The propagation and regeneration of the wave fronts is controlled by the Huygens principle. Indirectly this controls the potentials and the background field. Also this part of the correlation vehicle must be in concordance with the other parts.

The differential $d\wp$ of the sharp continuous allocation function defines a local metric ds, which describes the local curvature of the background field .

$$ds(x) = ds^{\nu}(x)e_{\nu} = d\wp = \sum_{\mu=0\ldots3} \frac{\partial \wp}{\partial x_{\mu}} dx_{\mu} = q^{\mu}(x)dx_{\mu} \tag{2}$$

$$= \sum_{\mu=0\ldots3} \sum_{\nu=0,\ldots3} e_\nu \frac{\partial \wp_\nu}{\partial x_\mu} dx_\mu = \sum_{\mu=0\ldots3} \sum_{\nu=0,\ldots3} e_\nu q_\nu^\mu dx_\mu$$

This quaternionic metric is a linear combination of 16 partial derivatives q_ν^μ. This leads to a quaternionic curvature theory.

Some tasks are completed before the correlation vehicle stops with the current job. For example a micro-walk is completed before the generator stops generating new step stones. Some related jobs behave similarly. For example the emission or absorption of photons also finish their task after completion of the job.

Some aspects of the model

The behavior of the deepest layers of physics can fairly clear be told in a pictorial way. The Hilbert Book Model gives a unique picture of these lower layers.

In the HBM nature's building blocks (elementary particles) are represented by coherent collections of what I call stepping stones. The stepping stones are temporary reserved locations where the building block can be found. The set of reserved locations are generated at random and are not ordered. This looks as if they are generated by a stochastic process. In fact the planned distribution looks like a 3D normal distribution.

At each progression instant only one step stone is used. It is never known beforehand which step stone is the next one. In this way the building block, even at rest, walks along a stochastic micro-path. At each arrival at a new step stone the building block emits a wave front that carries information about the presence and properties of the building block. This wave front moves with the greatest possible speed away from its source.

The wave fronts slightly fold and thus curve the continuum that embeds the particle. This is the way that the carried information is propagated. It is also the way that space curvature is created.

In the described way, the wave fronts are transmitted from slightly different locations. Already at a short distance the wave fronts seem to be generated at an super-high frequency by a source that has a fairly stationary location. In this way the particle does not represent a singularity for the gravitation potential. Instead of the 1/r dependence, the dependence looks more like Erf(r)/r. Already at a short distance r this function resembles closely the singular 1/r.

Together, the wave fronts that are emitted by the particle form a super-high frequency wave. The frequency of this wave is so high that in no way the wave itself can be observed. Only the consequences of the wave become visible.

On a small scale the wave fronts interfere. Together they form some fairly static potentials, each of which represent a typical average impact of the wave fronts. In theory a dedicated Green's function determines the contribution of the wave front to the potential. In this way the gravity potential and the electrostatic potential of the building block are formed.

The micro-path of a particle can be walked in two directions. This might relate to the sign of its spin.

Photons

A sudden change of the energy of the building block is accompanied by a temporary modulation of wave fronts. We know such modulations as photons. Since it is a modulation, its frequency can be much lower. The duration of the modulation is equal to the duration of a complete micro-walk.

Such events occur for electrons that move inside atoms. These electrons move along a micro-path, which is stretched along the path of a spherical harmonic oscillation.

As a result of this stochastic movement the electrons behave as if they are free. Only the stationary behavior is displayed. This means that the gravity potential and the electrostatic potential stay noticeable. Due to the additional movement, the mass of the electron seems to be slightly higher.

However, if due to the fact that the electron switches to a different oscillation mode, its energy level changes, then this goes along with the emission or absorption of a photon that corresponds with the energy jump.

The fact that the energy quantum is reflected in the frequency of the photon leads to the conclusion that the photon is created/destroyed in a fixed number of progressions steps. That number corresponds to the duration of a complete micro-walk. This conclusion also means that the building blocks all contain the same number of stepping stones.

At the beginning of quantum physics physicists were astonished by this phenomenon because instead they expected EM waves that match the spherical harmonic oscillation. This story shows that the turbulent stochastic behavior of the electron hides the oscillation.

Photons ride somewhere on the super-high frequency carrier wave. Its presence is described by an object density distribution that describes the probability for the photon of being at that location. Not the photons, but instead these object density distributions control the interference of multiple photons. The photon keeps its energy. At large distance, the probability of detecting the particle diminishes, but not its capability to trigger a suitable detector.

Chunks of energy

The fact that photons are energy quanta and encode their energy in their frequency leads to the suggestion that the energy quantum is divided in a discrete set of chunks. These chunks have a fixed size and are spread over the step stones that configure the micro-path. It means that in the simplest model in each micro-walk a participating step stone at the utmost can change its energy by a single energy chunk.

This also means that a lowest and a largest photon energy exist. Their ratio is given by the number of step stones that belong to a building block.

Inertia

The background field that forms the curved continuum that we experience as "our space" is formed by the superposition (or as you wish the interference) of the wave fronts that have been emitted by all massive elementary particles. According to field theory, a particle that moves uniformly in this field goes together with a vector field. When the particle accelerates this goes together with an extra field that counteracts the acceleration. This effect is known as inertia. (This is explained in "On the origin of inertia" by Denis Sciama)

Characteristics of the micro-path

The micro-path is a stochastic object and has corresponding characteristics.

A building block type has a fixed number (N_w) of step stones.

The sum of steps results in a building block step (S_b).

This defines the building block speed (S_b/N_w).

The step between subsequent step stones has an average length (l_s) and a step length variance (v_s).

Descriptors of the building block

Since the Hilbert Book Model applies proper time as its progression parameter it can use quaternions in order to model a flat 1+3D Euclidean parameter space that includes both progression and 3D space. In addition quaternionic functions are optimally suited for describing coherent distributions of discrete objects. Thus, quaternionic functions can be used as descriptors of building blocks.

Quaternions can be split into a scalar real part and a 3D imaginary part.

$$a \stackrel{\text{def}}{=} a_0 + \boldsymbol{a} \tag{1}$$

(2)

$$a^* \stackrel{\text{def}}{=} a_0 - \boldsymbol{a}$$

a^* is the quaternionic conjugate of a.

$$c = ab \tag{3a}$$

$$c_0 = a_0 b_0 - \langle \mathbf{a}, \boldsymbol{b} \rangle \tag{3b}$$

$$\boldsymbol{c} = a_0 \boldsymbol{b} + \boldsymbol{a} b_0 + \boldsymbol{a} \times \boldsymbol{b} \tag{3c}$$

Quaternionic functions can also be split into a real part and a 3D imaginary part. The real part can be interpreted as an object density distribution and the imaginary part can be interpreted as the associated current density distribution.

Quaternionic nabla

The quaternionic nabla stands for

$$\nabla \stackrel{\text{def}}{=} \left\{ \frac{\partial}{\partial \tau}, \frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z} \right\} = \{ \nabla_0, \boldsymbol{\nabla} \} \tag{1}$$

Here τ stands for the progression parameter.

The nabla operator acts on differentiable quaternionic functions.

$$\psi \stackrel{\text{def}}{=} \psi_0 + \boldsymbol{\psi} \tag{2}$$

Application of the nabla operator results in a quaternionic function. The equation can be split in a real part and an imaginary part.

$$\phi = \nabla\psi \tag{3a}$$

$$\phi_0 = \nabla_0\psi_0 - \langle \boldsymbol{\nabla}, \boldsymbol{\psi} \rangle \tag{3b}$$

$$\boldsymbol{\phi} = \nabla_0\boldsymbol{\psi} + \boldsymbol{\nabla}\psi_0 + \boldsymbol{\nabla} \times \boldsymbol{\psi} \tag{3c}$$

(3a) is the differential equation for continuous quaternionic distributions. Rearranging shows:

$$\nabla\psi = \phi \tag{4}$$

This is the differential continuity equation.

By normalizing the operands and the resulting quaternionic function a coupling equation results.

$$\langle \psi | \psi \rangle = \int_V |\psi|^2 \, dV = 1 \tag{5}$$

$$\nabla\psi = \phi \tag{6}$$

We also normalize a replacement φ for ϕ by dividing a by a real factor m

$$\phi = m\,\varphi \tag{7}$$

$$\langle \varphi | \varphi \rangle = \int_V |\varphi|^2 \, dV = 1 \tag{8}$$

This results in the coupling equation (7), which holds for coupled field pairs $\{\psi, \varphi\}$

$$\langle \phi | \phi \rangle = \int_V |\phi|^2 \, dV = m^2 \tag{9}$$

$$\langle \nabla\psi | \nabla\psi \rangle = \int_V |\nabla\psi|^2 \, dV = m^2 \tag{10}$$

This equation (10) only depends on ψ. Finally, the coupling equation reads:

$$\nabla\psi = m\,\varphi \tag{11}$$

This goes together with an anti-coupling equation

$$\nabla^*\varphi^* = m\psi^* \tag{12}$$

Due to the fact that the parameter space is not conjugated, equation (11) differs from equation (12).

The coupling factor m is directly related to the standard deviation of the step length $\sigma_s = \sqrt{v_s}$.[1]

The quaternionic format of the Dirac equation for the electron is a special form of the coupling equation.

$$\nabla\psi = m\,\psi^* \tag{13}$$

The coupling equation appears to hold for elementary particles and simple composite particles.

The quaternionic format of the Dirac equation for the positron is a special form of the coupling equation for anti-particles.

$$(\nabla\psi)^* = m\,\psi \tag{14}$$

Symmetries

Due to their four dimensions, quaternionic number systems exist in 16 versions that differ in their discrete symmetry properties. Their imaginary parts offer 8 symmetry versions.

Continuous quaternionic functions do not switch their symmetry in their target space. Thus for a given parameter space continuous quaternionic functions exist in 16 versions that only differ in their discrete symmetries. If the real part represents an object density distribution and the imaginary part represents the associated current density distribution, then the function exists in 8 versions that only differ in their discrete symmetries.

[1] The computation of the step length variance has much in common with the computation of Feynman's path integral.

In the Dirac equation two quaternionic functions appear that only differ in their discrete symmetry. The Hilbert Book Model assumes that elementary particles obey a coupling equation in which the two quaternionic functions only differ in their discrete symmetry set. This delivers a choice of $8\times8=64$ different elementary particles[2]. They must all have different properties, but these properties need not all be measurable. Mass, electric charge and spin are measurable, but color charge is not measurable.

The full story

The full story is much more complicated and takes a full e-book. For further details, please refer to: http://vixra.org/abs/1307.0106

[2] This diversity does not include the fact that elementary particles may exist in multiple genetations.