Young and old photons

The cause of red-shift

Abstract

If the duration of the emission, the duration of the passage and the duration of the absorption of photons depend on the progression value, then the consequence of the observation of red-shift for old photons will be that space is compressing rather than expanding.

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This paper uses a completely deduced model in which messengers play a role that is similar to the role that photons play in physical reality.

Contents

1 The underlying model

We use a paginated space progression model that emerges from a skeleton relational structure. This structure can mathematically be characterized as an orthocomplemented weakly modular lattice[1]. Another name for this lattice is orthomodular lattice. Quantum logic has this lattice structure. Classical logic has a slightly different lattice structure. It is an orthocomplemented modular lattice. For our purpose it is better to interpret the elements of the orthomodular lattice as construction elements rather than as propositions.

The set of closed subspaces of an infinite dimensional separable Hilbert space is also an orthomodular lattice. The Hilbert space adds extra functionality to this orthomodular lattice. This extra functionality concerns the superposition principle and the possibility to store data in eigenspaces of normal operators. In the form of Hilbert vectors the Hilbert space features a finer structure than the orthomodular lattice has.

The Hilbert space can only handle members of a division ring for specifying superposition coefficients, for the eigenvalues of its operators and for the values of its inner products. Only three suitable division rings exist: the real numbers, the complex numbers and the quaternions. Quaternions enable the storage of 1+3D data that have an Euclidean geometric structure.

Thus, selecting a skeleton relational structure that is an orthomodular lattice as the foundation of the model already puts significant restrictions to the model. On the other hand, this choice promotes modular construction and in this way it significantly reduces the relational complexity of the final model.

This primitive model does not provide means to control dynamics and it does not support the representation of continuums.

Dynamics can be added by using an ordered sequence of the models that can represent a static status quo. This choice makes the model paginated. The model proceeds with model-wide progression steps. All discrete objects in the model can be considered to be regenerated at every progression step.

With this decision, an extra mechanism must be added that ensures sufficient coherence between subsequent elements of the sequence. The coherence must not be too stiff, otherwise no dynamics occurs. On the other hand it must be sufficient restrictive, otherwise the result is dynamical chaos.

This mechanism shares many aspects with a real time operating system. The RTOS schedules subtasks and it ensures that these subs-tasks occur in sync.

Continuums can be supported by adding the Gelfand triple to the Hilbert space. The Gelfand triple can be used to check the coherence. This is done by embedding the subsequent Hilbert spaces into a common Gelfand triple. As a consequence progression steps along the Hilbert spaces and it flows inside the Gelfand triple. This allows the embedding process to control the dynamic as well as the spatial coherence.

Thus, if the orthomodular lattice is considered as the foundation of the model, then the separable Hilbert space is the next level of extension of the model. The foundation can be considered as part of a recipe for modular construction. What is missing are the binding mechanism and a way to hide part

[1] See the appendix

of the relations that exist inside the modules from the outside of the modules. These ingredients are delivered by the superposition principle and by the embedding mechanism.

2 Embedding the most elementary objects

At every progression instant, each discrete construct in this model is supposed to expose the skeleton relational structure that is defined as an orthomodular lattice.

At each progression instant, every discrete construct in this model can be represented by a closed subspace of a single separable Hilbert space

The embedding process gives every elementary building block an actual location. At the next progression step that location will differ. At each progression step the elementary building block will hop to the next location.

Other elementary objects exist that have an exact location at a series of progression steps. Also these objects hop from the current location to the next location. The location and the hop form a dual.

At each progression instant, every discrete building block in this model owns an exact hopping value and an exact location that together form a dual. Both members of the dual share the same real part, which stores the progression value. The next location is not known in advance. It is determined by a stochastic process.

The duals form the most elementary objects in the model. On themselves they do not have any other characteristic than their quaternionic value. Only as sets these duals become extra significance. Extra data are obtained from the statistics of the set or from the symmetry properties of the set. The hops form a path and this path adds its own characteristics.

The set can have one of three forms:

- A coherent swarm
- A closed path
- An open path string

The swarm differs from the two other forms in the fact that it can be characterized by a density distribution. The swarm is a coherent set. Two interpretations are possible:

- The swarm is generated by an ongoing stochastic process. After a while the statistic characteristics of the swarm stabilize.
- The swarm is prepared in advance. Its elements are used one by one. The currently active element is obtained by random selection of the not yet used elements. When all elements are used, then the swarm is regenerated.

Here we take the second interpretation. We do this because it is easier to understand. It means that the swarm is generated by a cyclic stochastic process. The swarm contains a huge number of elements. The swarm can be described by a normalized continuous location density distribution[2]. This continuous distribution has a Fourier transform. As a consequence the swarm owns a displacement generator. Thus, at first approximation the swarm moves as one unit.

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[2] The normalized continuous location density distribution corresponds to the squared modulus of the wave function that characterizes elementary particles in contemporary physics.

The swarm includes a closed path. We suppose that the statistics of the planned swarm are stable. Under the mentioned conditions, the swarm is at rest. It means that the sum of all hops equals zero. In this condition the swarm has a fixed number of elements.

Adding extra duals to the swarm causes a movement of the extended set. Adding particular sets of hops may cause an oscillation of the swarm. This occurs in typical oscillation modes. These extra sets form cycles. They are closed path objects. Adding or retrieving such sets must be done in sync with the swarm regeneration process. The sets that leave the oscillating swarm are open path strings. Such open path strings can also enter the free swarm or an already oscillating swarm. In principle the oscillations keep the swarm on average at the same location.

Adding a more arbitrary set of duals or an open path string that does not fit for establishing an oscillation, will cause a translation of the possibly oscillating swarm. An entering string can be broken into one or more fitting open path string and a translation set. The translation set increases the kinetic energy of the composite.

3 Mathematical intermezzo

The equations in this intermezzo are based on application in a flat continuum. In practice this only holds under special conditions.

3.1 Functions as Hilbert space operators

By using bra-ket notation, operators that reside in the Hilbert space and correspond to continuous functions, can easily be defined starting from an orthogonal base of vectors.

Let $\{q_i\}$ be the set of rational quaternions and $\{|q_i\rangle\}$ be the set of corresponding base vectors.

$|q_i\rangle q_i\langle q_i|$ is the configuration parameter space operator.

Let $f(q)$ be a quaternionic function.

$|q_i\rangle f(q_i)\langle q_i|$ defines a new operator that is based on function $f(q)$.

In the Gelfand triple, the continuous function $f(q)$ can be defined between a continuum eigenspace that acts as target space and the eigenspace of the reference operator $|q\rangle q\langle q|$ *that* acts as parameter space.

In the Gelfand triple the dimension of a subspace loses its significance. Thus a function that is derived from the representation of a coherent swarm in Hilbert space has a dimension in Hilbert space, but loses that characteristic in its representation in the Gelfand triple.

3.2 Quaternion geometry and arithmetic

Quaternions can be considered as the combination of a real scalar and a 3D vector that has real coefficients. This vector forms the imaginary part of the quaternion. Quaternionic number systems are division rings.

Bi-quaternions exist whose parts exist of a complex scalar and a 3D vector that has complex coefficients. Bi-quaternions do not form division rings. This model does not use them.

3.2.1 Notation

We indicate the real part of quaternion a by the suffix a_0.

We indicate the imaginary part of quaternion a by bold face $\boldsymbol{a}$.

$$a = a_0 + \boldsymbol{a} \tag{1}$$

3.2.2 Sum

$$c = c_0 + \boldsymbol{c} = a + b \tag{1}$$

$$c_0 = a_0 + b_0 \tag{2}$$

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

3.2.3 Product

$$f = f_0 + \boldsymbol{f} = d\, e \tag{1}$$

$$f_0 = d_0 e_0 - \langle \boldsymbol{d}, \boldsymbol{e} \rangle \tag{2}$$

$$\boldsymbol{f} = d_0 \boldsymbol{e} + e_0 \boldsymbol{d} \pm \boldsymbol{d} \times \boldsymbol{e} \tag{3}$$

The $\pm$ sign indicates the influence of right or left handedness[3].

$\langle \boldsymbol{d}, \boldsymbol{e} \rangle$ is the inner product of $\boldsymbol{d}$ and $\boldsymbol{e}$.

$\boldsymbol{d} \times \boldsymbol{e}$ is the outer product of $\boldsymbol{d}$ and $\boldsymbol{e}$.

3.2.4 Norm

$$|a| = \sqrt{a_0 a_0 + \langle \boldsymbol{a}, \boldsymbol{a} \rangle} \tag{1}$$

3.2.5 Rotation

Quaternions are often used to represent rotations.

$$c = ab/a \tag{1}$$

[3] Quaternionic number systems exist in 16 symmetry flavors.

rotates the imaginary part of b that is perpendicular to the imaginary part of a[4].

3.3 Quaternionic functions

3.3.1 Norm

Square-integrable functions are normalizable. The norm is defined by:

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

$$= \int_V \{|\psi_0|^2 + \ |\boldsymbol{\psi}|^2 \,\} dV$$

$$= \|\psi_0\| + \|\boldsymbol{\psi}\|$$

3.3.2 Differentiation

If g is differentiable then the quaternionic nabla ∇g of g exists.

The quaternionic nabla ∇ is a shorthand for $\nabla_0 + \boldsymbol{\nabla}$

$$\nabla_0 = \frac{\partial}{\partial \tau} \tag{3}$$

$$\boldsymbol{\nabla} = \left\{\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z}\right\} \tag{4}$$

$$h = h_0 + \boldsymbol{h} = \nabla g \tag{4}$$

$$h_0 = \nabla_0 g_0 - \langle \boldsymbol{\nabla}, \boldsymbol{g} \rangle \tag{5}$$

$$\boldsymbol{h} = \nabla_0 \boldsymbol{g} + \boldsymbol{\nabla} g_0 \pm \boldsymbol{\nabla} \times \boldsymbol{g} \tag{6}$$

$$\phi = \nabla\psi \ \Rightarrow \phi^* = (\nabla\psi)^* \tag{7}$$

[4] See Q-FORMULÆ

$$(\nabla\psi)^* = \nabla_0\psi_0 - \langle\boldsymbol{\nabla},\boldsymbol{\psi}\rangle - \nabla_0\boldsymbol{\psi} - \boldsymbol{\nabla}\psi_0 \mp \boldsymbol{\nabla}\times\boldsymbol{\psi} \tag{8}$$

$$\nabla^*\psi^* = \nabla_0\psi_0 - \langle\boldsymbol{\nabla},\boldsymbol{\psi}\rangle - \nabla_0\boldsymbol{\psi} - \boldsymbol{\nabla}\psi_0 \pm \boldsymbol{\nabla}\times\boldsymbol{\psi} \tag{9}$$

3.3.3 Gauge transformation

For a function χ that obeys

$$\nabla^*\nabla\chi = \nabla_0\nabla_0\chi + \langle\boldsymbol{\nabla},\boldsymbol{\nabla}\chi\rangle = 0 \tag{1}$$

the value of ϕ in

$$\phi = \nabla\psi \tag{2}$$

does not change after the transformation

$$\psi \to \psi + \xi = \psi + \nabla^*\chi \tag{3}$$

$$\nabla\xi = 0$$

Thus in general:

$$\nabla^*\nabla\psi = \nabla_0\nabla_0\psi + \langle\boldsymbol{\nabla},\boldsymbol{\nabla}\psi\rangle = \rho \neq 0 \tag{4}$$

ρ is a quaternionic function.

Its real part ρ_0 represents an object density distribution.

Its imaginary part $\boldsymbol{\rho}$ represents a current density distribution.

$$\nabla^*\nabla\chi_0 = 0 \tag{5}$$

$$\nabla^*\nabla\boldsymbol{\chi} = 0 \tag{6}$$

Equation (5) forms the basis of the Huygens principle.

It is the reason of the emission of a 3D wave front during the process of embedding of an object at a given location in a continuum.

In a similar way equation (6) forms the basis of the emission of a 1D wave front during the embedding of a displacement in the continuum. The direction of the displacements is coupled to the direction of the emitted 1D wave front.

Displacements can be treated in a local complex number based sub-model.

In a complex number based model the 3D gauge transformation becomes a 1D gauge transformation.

3.3.4 Displacement generator

The definition of the differential is

$$\Phi = \nabla\psi \tag{1}$$

In Fourier space the nabla becomes a displacement generator.

$$\tilde{\Phi} = \mathcal{M}\tilde{\psi} \tag{2}$$

$\mathcal{M}$ is the ***displacement generator***

A small displacement in configuration space becomes a multiplier in Fourier space.

In a paginated space-progression model the displacements are small and the displacement generators work incremental.

3.3.5 The coupling equation

The coupling equation follows from peculiar properties of the differential equation. We start with two normalized functions ψ and φ.

$$||\psi|| = ||\varphi|| = 1 \tag{1}$$

These normalized functions are related by:

$$\Phi = \nabla\psi = m\,\varphi \tag{2}$$

$\Phi = \nabla\psi$ defines the differential equation. (3)

$\nabla\psi = \Phi$ formulates a continuity equation. (4)

$\nabla\psi = m\,\varphi$ formulates the coupling equation.

It couples ψ to φ. m is the coupling factor.

$$\nabla\psi = m_1\,\varphi \tag{5}$$

$$\nabla^*\varphi = m_2\,\zeta \tag{6}$$

$$\nabla^*\nabla\psi = m_1\,\nabla^*\varphi = m_1 m_2 \zeta = \rho \tag{7}$$

Each double differentiable quaternionic function represents a normalized density distribution.

3.3.5.1 In Fourier space

The Fourier transform of the coupling equation is:

$$\mathcal{M}\tilde{\psi} = m\tilde{\varphi} \tag{1}$$

$\mathcal{M}$ is the ***displacement generator***

4 What happens to the continuum?

In the previous chapter only mathematical formulas were listed. Here we give these formulas an interpretation in the model.

The quaternionic differential equation

$$\phi = \nabla\psi \tag{1}$$

can be interpreted as a continuity equation. It describes how a coherent set of discrete objects are embedded in a continuum.

$$\nabla^*\nabla\psi = \nabla_0\nabla_0\psi + \langle\boldsymbol{\nabla}, \boldsymbol{\nabla}\psi\rangle = \rho \neq 0 \tag{2}$$

$$\nabla\chi = 0 \tag{3}$$

$$\nabla^*\nabla\chi = \nabla_0\nabla_0\chi + \langle \boldsymbol{\nabla}, \boldsymbol{\nabla}\chi \rangle = 0 \tag{4}$$

Here ψ describes the embedding continuum including the added coherent swarm of objects ρ in the form of a normalized continuous quaternionic density distribution. χ describes the embedding continuum without the swarm.

The quaternionic function χ describes how the embedding continuum reacts on the embedding.

Formula (4) is used by the Huygens principle. For each embedding of the location part of a dual a 3D wave front is generated at that location.

For each embedding of the displacement part of a dual a 1D wave front is generated at the landing location of the hop. For this case the formula can better be considered in a local complex number based context. The angular distribution of the 1D wave fronts depends on the angular distribution of the hops.

4.1 Curvature

In practice the emission of 3D wave fronts will cause a local folding and thus a curvature of the embedding continuum. This effect is the basis of the gravitation potential, which represents the averaged effects of these wave fronts.

In a curved environment the quaternionic nabla must be replaced by a differential that is constituted of 16 partial derivatives.

Where the 3D wave fronts decrease their amplitude with distance from the source, will the amplitude of the 1D wave fronts stay constant. As a consequence the 1D wave fronts do not curve the embedding continuum. Depending on the angular distribution of the hops that generated them, the 1D wave fronts also combine and average down to an up to 3D potential. In contemporary physics this potential is known as electromagnetic potential. The messengers keep their amplitude.

5 Energy

In the model the energy of a composite is directly related to the number of duals that constitute the composite. It is also directly related to the dimension of the dual subspace that represents the composite.

In the open path objects energy is related to the number of hops that constitute the object. This is also equal to the number of 1D wave fronts that constitute the object.

Oscillations that are internal to a composite are represented by closed path objects. The enclosed extra hops add to the energy of the composite.

6 Messengers

6.1 Observed behavior

Photons are very special objects that are emitted by oscillating composites when they step down from a higher oscillation mode to a lower oscillation mode. Absorption of photons by a composite occurs when the composite steps up from a lower oscillation mode to a higher oscillation mode.

Further photons play a role in the creation and the annihilation of pairs of elementary building blocks. The pair consists of a merge of an elementary particle and its antiparticle.

A very particular difference occurs between young and old photons. Old photons appear to be red-shifted.

6.2 Representation in the model

In the model messengers are represented by open path objects. They are the equivalents of photons. The emission and the absorption of messengers are controlled by processes that work in parallel to the generation of swarms. Locally these processes act in sync. These processing periods depend on the number of involved progression steps. It is not probable that the number of involved progression steps will change with progression. However, the duration of a single progression step may change with progression.

With other words, the emission of an old messenger lasted as long as in those conditions the absorption of a messenger lasted, but the emission and absorption of young messengers takes a shorter duration. This means that when an old messenger is recently absorbed, then only part of the number of wave fronts are detected. With other words the detected old messenger appears to be red-shifted.

7 Interpretation of red shift

In the model the speed of information transfer is taken as a model constant. This means that extension of the progression step goes together with space extension.

In this paper, red shift of old messengers is explained as extension of the progression step with smaller progression values. This is in direct contrast to the interpretation that contemporary physics gives to red-shift of old photons.

This model relates the energy of messengers to the number of contained wave fronts. The model considers the duration of the emission, passage and absorption of messengers as a variable that decreases with progression. The difference between the emission duration and the absorption duration causes the observed red-shift.

Contemporary physics ignores the duration of these processes. It relates the energy of the photon to the frequency of the photon.

8 Object graininess

In the model, locally the duration of emission, passage and absorption of messengers is suspected to be equal or it depends on the graininess of the emitter. Measuring the duration and the frequency of the messenger will reveal the number of wave fronts that is contained in the messenger.

This is also the case for messengers that are released at pair annihilation. In this case the number of contained wave fronts will give information about the number of duals that were contained in the members of the annihilated pair. With other words it will reveal the dimension of the dual subspace that represented the annihilated object.

9 Appendix: History of discoveries

Quantum logic was introduced by Garret Birkhoff and John von Neumann in their 1938 paper. G. Birkhoff and J. von Neumann, *The Logic of Quantum Mechanics*, Annals of Mathematics, Vol. 37, pp. 823–843

The Hilbert space was discovered in the first decades of the 20-th century by David Hilbert and others. http://en.wikipedia.org/wiki/Hilbert_space.

Paul Dirac introduced the bra-ket notation, which popularized the usage of Hilbert spaces.

In 1843 quaternions were discovered by Rowan Hamilton.
http://en.wikipedia.org/wiki/History_of_quaternions

In the sixties Constantin Piron and Maria Pia Solèr proved that the number systems that a separable Hilbert space can use must be division rings. “Division algebras and quantum theory” by John Baez. http://arxiv.org/abs/1101.5690

In the sixties Israel Gelfand and Georgyi Shilov introduced a way to model continuums via an extension of the separable Hilbert space into a so called Gelfand triple. The Gelfand triple often gets the name rigged Hilbert space, which is confusing, because this construct is not a Hilbert space.

These discoveries are used as foundations by the e-book “The Hilbert Book Model Game”.
http://vixra.org/abs/1405.0340 .