Mechanisms that keep reality coherent

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Abstract

Quantum physics applies Hilbert spaces as the realm in which quantum physical research is done. However, the Hilbert spaces contain nothing that prevents universe from turning into complete chaos. Quantum physics requires extra mechanisms that ensure sufficient coherence.

If you think, then think twice.
In any case, think frankly.

The story

I started a study in physics because I was interested in what destined my environment to be so complicated and yet controlled that environment such that it appeared to be so well coordinated. The belief in a creator that settles everything seemed to me a far too simple solution. My environment must have a built-in principle that in one way or another installed the necessary coherence. That principle must therefore be incorporated in the foundation of the structure of reality. If you think about it, then this foundation must be relatively simple. This means that this foundation can easily be comprehended by skilled scientists. The question now is how exactly this foundation will be structured. The foundation must restrict its extension such that sufficient coherence keeps ensured. This requirement complicates the search for a potential candidate in a significant way. However, observing reality may guide the exploration.

The simplest mathematical structures are sets and relational structures. The classical logic that we use in order to characterize a proper way of reasoning is in fact a relational structure. This logic describes what statements are allowed and what relationships between these statements are tolerated. Early in the twentieth century two scientists discovered a slightly different relational structure that according to them directly related to the way in which quantum mechanics is performed. Because this relational structure largely resembles classical logic they called their discovery "quantum logic". That is a curious name, because in the report in which they published their discovery they showed that a more complicated structure contained this relational structure as an essential part. This more complicated structure is a Hilbert space. The Hilbert space is named after David Hilbert who more than ten years earlier along with others discovered this special vector space. The set of the closed subspaces of the Hilbert space has a relational structure that mirrors the relational structure of quantum logic. Nothing indicates that these closed subspaces match logical statements. This destines the name giving of the relational structure at least as a curious decision. The mathematicians gave the structure a different name. In mathematics, this structure is called “orthomodular lattice”. Quantum physicists use the Hilbert space as a storage medium for dynamic geometric data. That happens in the form of eigenvalues of operators, which map some of the Hilbert vectors onto themselves. Such vectors are then called eigenvectors. The operator associates the eigenvectors with corresponding eigenvalues. Different eigenvalues correspond to mutually perpendicular eigenvectors. The Hilbert space defines for each pair of its vectors a scalar product. For mutually perpendicular Hilbert vectors, the scalar product equals zero. The value of the scalar product must be a member of a division ring. A division ring is a number system, in which each non-zero number has a unique inverse. There are only three suitable division rings. These are the real numbers, the complex numbers and the quaternions. The Hilbert space can only cope with numbers that are elements of these division rings.

The foundation that was selected by the duo Birkhoff and von Neumann does not contain numbers. The orthomodular lattice only knows relations and elements that are connected by these relations. It is an atomic lattice. This means that multiple elements exist that are not themselves a result of a relation. In the Hilbert space, these atoms are represented by subspaces that cannot be split into other subspaces and therefore they are spanned by a single Hilbert vector. A special operator connects every atomic Hilbert vector with a quaternion that acts as its eigenvalue. In this way, each orthomodular atom corresponds with a matching quaternion. Quaternions consist of a real scalar and a three dimensional vector. The scalar can represent a progression value and the three dimensional vector can represent a spatial location. This shows that the selected foundation indirectly emerges into notions of progression and geometric location. However, this interpretation couples every atom to a single progression instant and a single spatial location. This is a static and not a dynamic geometrical location.

The discoverers of the orthomodular lattice saw this structure as a logical system. They saw the atoms as logical statements and not as Hilbert vectors and also not as quaternions that might represent dynamic locations. The question now is what the atomic elements of the lattice will be if they do not represent logical statements and also do not represent dynamic locations. After all, a dynamic location only makes sense if at other progression instants it may take a different location value. However, that different location would then belong as eigenvalue to a different Hilbert vector as the eigenvector. This dilemma can be solved when a somewhat broader interpretation is given to the representation of an orthomodular atom. The dilemma is cured if we allow the representation to possess more persistence. We allow the elementary object that represents the orthomodular atom to cover more progression instants and more corresponding geometric locations. This means that on other progression moments the elementary object exists on other locations. After reordering of the progression instants the elementary object appears to hop along a hopping path. After a large number of hops, the landing locations form a location swarm. Both the hopping path and the location swarm now represent the elementary object. Without further measures, nothing prevents the elementary object to use a completely arbitrary hopping path and a chaotic location swarm. In this way, the orthomodular lattice cannot ensure the relatively coherent behavior that we know from the reality that surrounds us. Something must exist that ensures the coherence of the hopping path and the corresponding location swarm. We therefore postulate a mechanism that establishes this coherence by ensuring that the swarm gets a coherent shape and a location density distribution that can be characterized by a continuous function. We go one step further by postulating that this distribution owns a Fourier transform. This requirement corresponds to the condition that the swarm owns a displacement generator. This means that in first approximation the swarm itself moves as one unit. The Fourier transform of the location density distribution is the characteristic function of the elementary object. The location density distribution corresponds to the squared modulus of the wave function of the elementary object. This indicates that we are on the right track. However, in this model the wave function is replaced by the characteristic function of the stochastic process that defines the landing locations. This goes a lot deeper than the concept of the wave function.

The most important aspect of the foregoing is that the existence of the Hilbert space automatically follows from the existence of the underlying orthomodular lattice. So if this orthomodular lattice structure is indeed the foundation of physical reality, then physical reality also contains the structure of the Hilbert space with everything that goes with it and that's a lot. The mechanisms that ensure coherence are not part of the Hilbert space. They form an addition to the model and that addition does not emerge from the selected foundation.

The Hilbert space that arises from the orthomodular lattice is a separable Hilbert space. This structure can only store countable sets of dynamic geometric data. That could, in principle, count to infinity, but that is not enough in order to achieve the fineness of the continuums which also occur in reality. However, it is possible to link the mapping operators to continuous functions and thus achieve a Hilbert space which features operators that own continuum eigenspaces. The first step concerns the definition of reference operators. Reference operators associate the members of an orthonormal base of the Hilbert space to the rational elements of a quaternionic number system. The eigenspaces of these reference operators can be used as parameter spaces. The reference operators can be converted into new operators by replacing the rational parameter values by the target values of continuous functions. The eigenvectors are kept. Now, the step to continuums is small. The countable parameter spaces that consist of discrete rational values must be compacted into continuums. This step embeds the rational values among the irrational values. By applying this step the non-separable Hilbert space emerges from a corresponding separable Hilbert space. This procedure merges both Hilbert spaces unequivocally together.

Dynamic model

In order to make the picture even more realistic, the real part of the continuum eigenspace of a reference operator that resides in the non-separable Hilbert space can be split such that a part represents the past and the other part represents the future. On the separation resides a representation of the current static status quo. A progression value that is the same for the entire border region characterizes the split. A steady increase of the selected progression value creates a dynamic model.

For this model, two interpretations are possible. The first interpretation sees the Hilbert space as a repository that already contains all stored values. Thus, past, present and future are already fixed. The other interpretation is based on observers who travel with the split. They see the past indeed as a fully and exactly defined part, but the future is unknown and is inaccessible for these observers. The present static status quo exists, but the information on objects that are farther away must still reach the observer. This information flows to the observers through the fields that describe the swarms. Here we mean with fields the smooth location density distributions. This second interpretation resembles the view that most physical theories apply.

Also the mentioned fields allow two different interpretations. On the one hand, they describe the swarms, but on the other hand, their shape is determined by the presence of the landing locations of the hopping paths. These landing points are embedded between rational numbers that form the parameter space of the functions that describe the fields. Together the descriptors of the parameter spaces and the swarms form a contiguous field that can be considered as living space of the elementary objects. The different interpretations do not influence the underlying model.

About this dynamic model can be said much more. The Hilbert space can accommodate a large number of parallel reference operators that each match with a corresponding parameter space. It is even possible that one parameter space floats over another parameter space. The number systems exist in different versions, which differ by the way in which they are ordered. The quaternions exist in sixteen different versions, that are each ordered by an independent Cartesian coordinate system. The spatial parts of these coordinate systems can be ordered even further with a polar coordinate system. The latter can be done with ascending or descending polar angle or it can start an ascending or descending azimuth. These orderings may influence on the arithmetic behavior of these numbers and they affect the behavior of the associated functions in the determination of integrals. The elementary objects and their swarms live on a private parameter space and that space is ordered in a private way. In their environment, the elementary objects and their swarms behave like artifacts. They live on parameter spaces that possess an ordering that differs from the ordering of the background parameter space on which the platform of the elementary particle floats. The ordering reveals itself as a charge that is located at the geometric center of the parameter space. This symmetry related charge corresponds to a dedicated symmetry related field. A direction of a possible anisotropy can be indicated by an RGB color.

In the model this results in the existence of two totally different basic fields. These fields interact via the geometric centers of the parameter spaces of the elementary objects. One field describes the swarms that go along with the elementary objects and their swarms. The other field describes the charges of the elementary objects.

We have extended the concept of the elementary object such that it covers multiple progression instants. The static status quo covers a single progression instant and conforms to a subspace of the separable Hilbert space which on itself also forms a separable Hilbert space. In this Hilbert space the elementary objects are represented by one-dimensional subspaces that are spanned by a single Hilbert vector. This Hilbert space has a one-to-one correspondence between normalized Hilbert vectors and elementary objects. Not all rational quaternions correspond to eigenvalues of the operator that provides the locations of the elementary objects as its eigenvalues.

The generated purely mathematical model starts to show quite a few characteristics and phenomena that we also find in reality. Yet it is no more than a thought experiment.

Discussion

We come back again to the question of what the elements of the orthomodular lattice according to the latest interpretation will represent. I came to the conclusion that these elements are modules or modular systems. If that's true, then the orthomodular lattice is no system of logical statements, but on the contrary, it is part of a recipe for modular construction. This will then give rise to the most basic and the most influential law of nature. This law cannot be summarized in a formula, because the lattice does not contain numbers, for which variables could be used in the formula. Instead, the law can be formulated as a commandment:

"Thou shalt construct in a modular way!"

The modular construction technique is extremely sparing with its resources and makes system configuration a lot easier. It encourages reuse. By selecting this construction method the creator teaches us a lesson. “Economize your environment and protect your resources!”.

Important is, that all modules and all modular systems are represented by a closed subspace of the separable Hilbert space. At the same time will not every closed subspace of the separable Hilbert space represent a module or a modular system. At every progression instant, every elementary module is represented by a single Hilbert vector and a single spatial location.

Rotators and persistence

Because their product is not commutative, quaternions can rotate other quaternions. In the formula $c = a\, b/a$, the part of the imaginary vector of b that is perpendicular to the imaginary part of a is rotated over an angle that is twice as large as the phase angle of a. This phase is determined by the size of the real part and the size of the imaginary part. Quaternions exist that can rotate another quaternion or even an entire swarm of quaternions over a right 90 degree angle. The size of their real part equals the size of their imaginary part. These special quaternions can switch an anisotropy to another dimension. In other words, they may switch the symmetry related charge of an anisotropic elementary object to a different value (color). Isotropic objects stay unaffected.

The presence of these quaternions during the generation of the swarm of an anisotropic elementary object can interfere with this building process. Thus, the presence of the color shifting quaternions affects the persistence of the anisotropic object. Isotropic objects are left alone. The mechanisms that ensure the coherence of the swarms respond by colluding with other mechanisms that also manage anisotropic objects by jointly generating isotropic composite objects. In physics the phenomenon of color neutralization is called "color confinement". This phenomenon thus has a binding effect. The process binds quarks into hadrons. The color shifting quaternions play the role of the gluons. That is why we will use the name "gluon" for the pairs of color shifting quaternions. The gluons give raise to a third basic field. They are governed by a special mechanism that controls their presence and their activity.

The mechanisms

The mechanisms ensure coherence and together with the gluons they install color confinement. These mechanisms do not appear in physical theories. However, without them dynamics would not exist and universe would be chaotic.

Self-coherence

The relation between a continuous location density distribution and the field that describes this distribution can be enforced by the form of the location density distribution. For example a Gaussian location density distribution is corresponds to a unique contribution to the field.

The Green's function $G(r)$ represents the response of the field to the presence of a single location.

$$G(r) = \frac{Q}{r} \tag{1}$$

A Gaussian location density distribution corresponds with a typical deformation of the field.

$$\rho(r) = -\frac{Q}{\left(\sigma\sqrt{2\pi}\right)^3} \exp\left(-\frac{r^2}{2\sigma^2}\right) \tag{2}$$

The corresponding deformation of the field has the form

$$\mathfrak{T}(r) = -\frac{Q}{4\pi} \frac{ERF\left({}^{r}/_{\sigma\sqrt{2}}\right)}{r} \tag{3}$$

If the controlling mechanism is self-coherent, then this relation can also interpreted in the reverse way. The field $\mathfrak{T}(r)$ can then be considered to enforce the distribution of the locations to take the form $\rho(r)$. With other words due to the shape of field $\mathfrak{T}(r)$, long hops in the wrong direction are avoided.

In contrast to Green's function $G(r)$ the convolution $\mathfrak{T}(r)$ does not contain a singular point.

Stochastic processes

The fact that the visual trajectory of vertebrates appears to be optimized for low dose rate imaging and the way that this optimization is implemented in the brain of these vertebrates indicates that the photon generation processes are stochastic processes that have the characteristics of a Poisson process, which is connected to a binomial process that is implemented by a spatial point spread function. Also the generation of elementary particles appears to be generated by such stochastic processes.

More

For a more detailed investigation of the subject, see: “The Hilbert Book Test Model”; http://vixra.org/abs/1603.0021

Low dose rate imaging is treated in : http://vixra.org/abs/1606.0329.