What's important

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Abstract
Generating number systems reveals most of the structure and behavior of our universe. A system of Hilbert spaces that all share the same underlying vector space describes all aspects of the dynamic field that our universe represents.

1 Set theory

Importantly, the set theory makes no sense without taking into account the container of the set and is meaningless without taking into account the type of elements of the set. A finite set is fundamentally different from an infinite set. An infinite set cannot be achieved by gradually expanding a finite set. The set must be redefined to get an infinite set. A countable set is fundamentally different from an innumerable set. Countable means that each member of the set can be labeled with a natural number. The set of natural numbers is infinite. A countable set can be infinite. A countable set must be redefined to make it an innumerable set. An innumerable set is always an infinite set. The elements of sets that cannot otherwise be distinguished can be identified by elements of a number system.

A simple space can act as a container of locations. A vector is a combination of a base point and a pointer connected by a directional line. A scalar measures the distance between these points. A shift parallel to the direction line does not change the integrity of the vector. Using vectors instead of locations as elements of a set located in space has the advantage that vectors obey simple arithmetic. This vector arithmetic allows the vectors to reach any location in simple space. The vector arithmetic can be used to generate number systems whose elements can be applied to identify the locations in space. It turns out that this can be done in many ways.

The arithmetic of number systems does not regulate all the freedom of choice that remains in the container. This means that numbering systems exist in many versions that differ in the included choice freedoms. Freedom of selection is called symmetry. Most of these symmetries relate to the geometry of the locations. Some selection exemptions concern choices which are left open in the rules of the arithmetic.

2 Numbering systems

A treatise on number systems usually emphasizes the arithmetic of the number system, but most of the time the treatise ignores the symmetries of the number system. In physical reality, both arithmetic and symmetries play an essential role.

It seems that two base number systems can be mixed into three associative division rings.

2.1 Real numbers

The rational numbers for which the square is a zero or a positive rational number already form an associative division ring. The arithmetic of this set is taught in primary schools. All elements fit on a directional line and occupy a single dimension. If all irrational numbers take part, the set becomes countless. This combination is the set of real numbers. In real numbers, all converging series of elements end in a limit that is also a real number. The resulting set is a continuum and shows a special behavior when deformed.

2.2 Spatial numbers and mixed numbers

There is another number system where the squares are equal to zero or a negative real number. This is the spatial number system that is often called the system of imaginary numbers. It exists in a one-dimensional and a three-dimensional version. Together with the real numbers, the one-dimensional version of the spatial numbers forms the two-dimensional associative division ring of the complex numbers. Together with the real numbers, the three-dimensional version of the spatial numbers forms the four-dimensional associative division ring of the quaternions. The arithmetic of the spatial number system contains a commutative and associative addition. The product splits into an inner product that has a scalar value and is responsible for the negative square and an outer product that occurs only in the three-dimensional version. The outer product may be chiral right-handed, or it may be chiral left-handed.

The elements of a continuum obey the arithmetic of the corresponding number system. The geometry of a continuum can change in a well-ordered way. This change is regulated by special change arithmetic that mathematicians call differential calculus.

The dimension of associative division rings is always less than five. The spatial number system is not considered an associative division ring. Three-dimensional associative division rings do not exist.

Each dimension in a number system corresponds to a directional line and can be ordered by a countable or non-countable coordinate system based on real numbers.

2.3 The underlying vector space

The underlying vector space also has a type of inner product that is often called a dot product. The dot product of identical vectors delivers a positive scalar value. The underlying vector space can have infinite dimensions. It has some kind of inner product, but it does not have an outer product. The dot product makes it possible to generate a Cartesian coordinate system in the vector space.

3 Hilbert space

Dirac's bra-ket combination converts a vector space into a Hilbert space. This concept applies a selected version of an associative division ring to define the combination of bras and kets. The resulting Hilbert space enables archiving partial sets of elements of the selected version of the number system that the Dirac bra-ket combination has applied to construct the Hilbert space. Consequently, all Hilbert spaces manage a private parameter space in a special operator's eigenspace. This turns any separable Hilbert space into a sampled function space.

3.1 Position space and change space

The position space and the change space are different representations of a quaternionic Hilbert space in which the real part of the parameter space is limited to a single point. A Fourier transformation relates functions in the position space to corresponding functions in the change space. This means that in the change space, the location in the position space has no meaning. Similarly, changes in the position space have no meaning. This shows that the scalar part of the parameters can reflect the progress of change. A point in the scalar part of the parameter space represents a standstill and can often be seen as a timestamp.

4 System of Hilbert spaces

The definition of Hilbert space results in a system of separable Hilbert spaces that all share the same underlying vector space. The system limits its members to the Hilbert spaces which have parameter spaces

that have the axes of their Cartesian coordinate systems parallel to the coordinate system of the vector space. This constraint reduces the number of types of these parameter spaces to a shortlist.

The system of separable Hilbert spaces represents all possible coverages of vector space by sets of locations that can be identified by a member of a countable number system. One of the separable Hilbert spaces acts as a background platform. All other members of the system float with their geometric center over the private parameter space of the background platform. Only the difference in the symmetry between the background parameter space and the floating parameter spaces appears to be relevant. The shortlist is very similar to the shortlist of electric charges that appear in the Standard Model that experimental particle physicists have discovered. This indicates that there is a strong relationship between symmetry differences in the system of Hilbert spaces and the electrical charges in the Standard Model.

4.1 Background platform

The background platform is a separable Hilbert space. It possesses a non-separable companion who embeds its separable partner. The resulting Hilbert space provides operators who manage continuous eigenspaces. One of these eigenspaces is the continuum extension of the background parameter space. It represents a dynamic field that can represent what physicists call their universe.

5 Quantum physics

So far, the system has not exposed any sign of the uncertainty that characterizes quantum physics. Quantum physicists believe that the wave function is the carrier of this characteristic. The wave function is interpreted as a state function. The square of the modulus of the wave function is a location density distribution. The existence of the wave function can be explained by associating a private state vector with each floating member of the Hilbert space system. The state vector comes from the underlying vector space. A stochastic process generates the hopping path of the state vector in the parameter space of the floating Hilbert space. The hopping path focuses in a stochastic blurry way to the geometric center of the parameter space. The hopping path repeatedly regenerates a hop landing swarm with many landing locations. Covering this swarm with a coordinate grid shows that the swarm can be described by a location density distribution. This distribution is a stable function. This means that the expected value of the stochastic process is the geometric center of the private parameter space.

The stochastic process can be described as the combination of a Poisson process and a binomial process. The binomial process is implemented by a point scattering function equal to the named location density distribution. This distribution has a Fourier transformation, which is the characteristic function of the stochastic process. Therefore, the wave function can simulate a wave package. Unlike mainstream quantum physics, this paper uses a quaternionic equivalent of the complex wave function.

In some Hilbert space types, the existence of the state vector has a noticeable effect because the images of these Hilbert spaces in the dynamic universe field the hop landings cause distortion of the dynamic universe field. The hop landing of the floating Hilbert spaces with an isotropic symmetry difference with the background platform distort the continuum that acts as the dynamic universe. The isotropic pulse response is a spherical shock front that travels away from the location of the pulse at the speed of light in all directions until the front disappears into infinity. Thus, the distortion also extends the coverage of the vector space.

This phenomenon explains the origin of gravity and contributes to the dynamics of the universe. Each isotropic pulse depicted on the dynamic universe field causes a corresponding distortion of that field. Why this happens is a mystery, but it explains the gravitational potential in the dynamic universe field.

5.1 Electric charges and fields

Electric charges appear to correspond to the difference between the geometric symmetry of the background platform and the geometric symmetry of the floating platforms representing the other elements of the system of separable quaternionic Hilbert spaces. Probably, the electric charge is located in the geometric center of the floating platforms. The charge generates a corresponding electric field that moves with the floating platform. The values of the symmetry differences correspond to the shortlist -3, -2, -1, 0, 1, 2, 3. The corresponding charges form the shortlist 1, 2/3, 1/3, 0, -1/3, -2/3, -1. Why the symmetry-related electric charges appear in the geometric center of the corresponding Hilbert spaces is a mystery. The corresponding electric fields are fundamentally different from the dynamic universe field. Yet both fields obey the change arithmetic that governs the behavior of continuums. The dynamic universe field has existed everywhere since the beginning of time. The electric fields are linked to the electric charges and indirectly to the symmetries of the prevailing number systems. Fields differ in their start and boundary conditions.The

If we limit ourselves to the elementary fermions of the first generation, then electric charge -1 corresponds to the electrons, and the antiparticle called positron corresponds to electric charge 1. In the system, antiparticles are represented by Hilbert spaces in which the sign of the real parts of the parameters is reversed. As a result, the antiparticle seems to move against the direction of time. Also, the sign of the geometric symmetry difference acts reversed. The geometric symmetry of electrons differs isotropically from the geometric symmetry of the background platform. This means that the hop landings of electrons distort the dynamic universe field. The positrons also appear to distort the dynamic universe field.

Neutrinos correspond to electric charge 0. This means that neutrinos share geometric symmetry with the background platform. It seems that neutrinos also distort the dynamic universe field. The reason is that the chiral handedness of the outer product of neutrinos differs from the chiral handedness of the outer product of the background platform.

Quarks have fractional electric charges and therefore do not differ in an isotropic way from the geometric symmetry of the background platform. The chiral handedness of the outer product also does not differ. Therefore, quarks do not distort the dynamic universe field. Certain conglomerates of quarks can form isotropic symmetry differences. These hadrons are capable of distorting the dynamic universe field. The distortion betrays the presence of the conglomerate. Isolated quarks remain undetectable. This phenomenon is called color confinement.

5.2 Conglomerates

Elementary fermions appear to be able to form conglomerates. These conglomerates are superpositions of elemental fermions or other conglomerates defined in the change space. In the change space, positions have no meaning.

Higher generations of elementary fermions can be interpreted as higher oscillation modes of the first generation of elementary fermions. The hop landing location swarms of higher oscillation modes contain more hop landing locations than the swarms of the lower generation fermions. More hopping landing locations mean a higher ability to distort the embedding universe field.

If the definition of the conglomerate prohibits certain oscillation modes, then this limitation applies independently of the relative location of the participating components of the conglomerate. This phenomenon is known as entanglement.

The ability to form conglomerates produces a very powerful ability to generate modular systems. Modular system generation is more economical than monolithic system generation. All modular systems in the universe are conglomerates of the elemental fermions. Since all elementary fermions have mass or can be combined into particles that have mass, all modular systems in the universe will show mass.

5.2.1 Bosons

in this paper bosons are not considered to be elementary particles. Instead they are considered to be conglomerates.

5.2.2 Atoms

Atoms are conglomerates in which the components share the image of their geometric center in the dynamic universe. As a result, the electric charges do not participate in the oscillations of the internal components. Atoms that possess a resulting electric charge are ions.

5.2.3 Molecules

Molecules are conglomerates of ions that share some of their electrons. Molecules archive their essential properties in the system of Hilbert spaces that share the same underlying vector space.

5.3 Earth

On Earth, conglomerates of molecules can form living species. Living species archive essential properties in RNA and DNA molecules.

5.4 Black holes

Black holes are not conglomerates. They are encapsulated regions in the continuum that represents our dynamic universe. These regions do not contain a continuum. No field excitation can leave or penetrate the area.

6 Photons

Photons are not represented by a Hilbert space. A photon is not an elementary particle. Instead, a photon is a cord of equidistant energy packets. These packages consist of one-dimensional pulse reactions that act as one-dimensional shock fronts. These shock fronts are solutions of second-order partial differential equations that describe the behavior of a quaternionic continuum such as the dynamic universe. The shock fronts move at the speed of light. Photons can occur in streams called light beams. These bundles can have an energy distribution, an angle distribution, a phase distribution, or a location distribution. The location distribution may possess a Fourier transform. In that case, the light beam can behave like a wave package. The imaging properties of the light beam can be qualified by the optical transfer function. This is the Fourier transform of the point spread function. This point spread function is equal to the location density distribution of photons in the light beam.

Atoms and some interactions between elementary particles can cause photons to form or disappear. For example, the conversion of a particle into an antiparticle includes the emission or absorption of a corresponding photon containing a one-dimensional shock front for each hop landing replaced.

7 Conclusion

An important conclusion is that the number of Hilbert space types is one greater than the number of the first generation of fermion types. This is because the additional type represents a background platform. The other types are floating platforms. They move over the background parameter space. This suggests that the background platform represents what the Higgs object is supposed to represent. It is the object that supports the dynamic universe field, and it bears the origin of gravity.

Some mysteries remain unsolved. One of them is the reason for the existence of electric charges. The other mystery is why isotropic symmetry differences cause spherical shock fronts in the dynamic universe field.

References

More details can be found at
https://www.researchgate.net/publication/360423479_The_quaternionic_bra-ket_combination

This article contains all the formulas that describe the arithmetic of number systems and the change of continuums.