Modularity, Consciousness, and Intelligence

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Abstract

Physical reality has a modular structure. Consciousness gets introduced in the higher levels of the module hierarchy. Intelligence is introduced at the top level.

1 The Hilbert Book Model

The Hilbert Book Model starts from the idea that physical reality owns a foundation that can be formulated in the mathematics that physical reality applies. The foundation is a structure that emerges into more complicated levels of the structure, and the applied mathematics restricts the extension such that only one type of reality can evolve and that is the type of reality that we can observe. Thus, the foundation acts as a seed that can only grow into one type of plant. The structure of the foundation must be very simple. Thus, it is expectable that scientists already have discovered this founding structure without knowing that it acts as the foundation of reality. The founding structure can be used to generate a model of reality by just extending this structure and listening to the restrictions that mathematics poses to this extension. It happens that eighty years ago two scholars detected a relational structure that suits as a foundation. The duo called their discovery "quantum logic" and showed that this structure emerges into a separable Hilbert space. Already at that stage Garrett Birkhoff and John von Neumann indicated that Hilbert spaces could only apply number systems for which every non-zero member must correspond to a unique inverse. Only three number systems fulfill this restriction. They are the real numbers, the complex numbers, and the quaternions. Apart from being an extension of quantum logic the separable Hilbert space is also an extension of the concept of a linear vector space. The extension is that the inner product of pairs of vectors can be specified in terms of members of the three mentioned number systems. Consequently, the eigenvalues of normal operators can also be expressed in these numbers. The HBM exploits this idea by defining reference operators that apply the rational members of a selected version of the quaternionic number system as the eigenvalues of the reference operator. Cartesian and polar coordinate systems sequence the members of the selected version of the number system. In this way, the reference operator manages a private parameter space as its eigenspace. Further, the HBM allows separable Hilbert spaces to share the same underlying vector space. They also share the same real number valued Hilbert space for providing the real part of the eigenvalues of their reference operators. One infinite dimensional quaternionic separable Hilbert space acts as the background platform. This model allows defining a subspace that scans over all quaternionic separable Hilbert spaces as a function of a real-valued progression value. This subspace divides the resulting dynamic model into three parts

1. Past
2. Current static status quo
3. Future

The background platform owns a unique quaternionic non-separable Hilbert space that embeds the background platform. It provides operators that offer continuum eigenspaces that can act as fields [1].

1.1 The base model

The reference operators enable the specification of a category of defined operators that share the eigenvectors of the reference operator but apply the target values of a selected quaternionic function as the eigenvalues of the new defined operator for the corresponding eigenvector. This trick combines Hilbert space operator technology with quaternionic function theory and indirectly with quaternionic differential and integral calculus. In this way, the HBM creates a very powerful modeling platform. It also indicates that fields that are archived in the model can be described by quaternionic functions and that the behavior of these fields is described by quaternionic differential and integral calculus. Up to so far, the model does not exhibit much dynamism. A series of platforms consisting of a separable quaternionic Hilbert space and its private parameter space, float by the geometric center of their private parameter spaces over a background parameter space that acts as parameter space of the function that defines an embedding field. That field is managed by a dedicated operator in the non-separable quaternionic Hilbert space. In the HBM this field is going to represent the universe.

We will call the current stage of the model the “base model.” This dynamic model has a well-defined beginning and end.

1.2 The creator

The Hilbert Book Model implements its creator. At the instant of the creation, for every floating separable Hilbert space, the creator filled the eigenspace of a special footprint operator with the dynamic geometric data of a point-like object that lives on this platform. Quaternions are ideally suited as storage bins for a combination of a scalar time-stamp and a three-dimensional location vector. Thus, the time-sequenced series of eigenvalues of the footprint operator tell the life-story of the object. The object exists as long as the platform exists, and the platform exists as long as the Hilbert Book Model exists. The creator is a modular designer and a modular constructor. The archived object plays the role of an elementary module, and together the elementary modules generate all other modules. Some modules generate modular systems. In this way, the creator generates a deterministic system in which everything is predetermined.

The footprint of each elementary module is embedded step by step into the embedding field. The embedding of a hop landing can cause a pulse response. A spherical pulse response only occurs when the symmetry break is isotropic.

All modules act as observers. Observers can only retrieve historical data from the read-only repository. The information is transferred to them by the field that embeds them. The data was stored in Euclidean format. The observers perceive in spacetime format. The hyperbolic Lorentz transform describes the corresponding conversion of the coordinates. Depending on the relative velocity between the observer and the observed event, the Lorentz transform introduces time interval dilation and length contraction. The creator fools his creatures by giving them the impression that they still have a free will by applying for each elementary module a stochastic process that owns a characteristic function and that generates for each time-stamp the corresponding geometric location. Consequently, the elementary module hops around in a stochastic hopping path. After a while, the hop landing locations have formed a hop landing location swarm that can be described by a location density distribution. This distribution is the Fourier transform of the characteristic function.

The stochastic process mimics the later embedding of the hop landings into the embedding field. The arrangement cares that the hop landing locations form a coherent swarm that is recurrently regenerated. Since the object is point-like, the location density distribution acts as a detection probability density distribution. Now mathematics states that the variance of the location density distribution is coupled with the variance of the characteristic function.

In general, if f is an arbitrary probability density distribution and F is its Fourier transform, then

$$\mathrm{var}(f)\,\mathrm{var}(F) \geq 1$$

Physicists will recognize the similarity with Heisenberg's uncertainty principle. There is more. The location density distribution equals the squared modulus of what quantum physicists would call the wavefunction of the elementary module. Indeed, the elementary modules in the HBM represent the elementary particles in quantum physics. The private stochastic process can be considered as a combination of a genuine Poisson process and a binomial process. The binomial process is implemented by a point spread function.

The combination of a stochastic process and a characteristic function also occur outside of the realm of quantum physics [2]. For example, the concept of the Optical Transfer Function uses the Point Spread Function in the image to define the OTF as the Fourier transform of the PSF. In optics, the OTF and its modulus the Modulation Transfer Function are applied as imaging quality measures. If the PSF gets more blurred, then the MTF turns out to be smaller.

1.3 Zigzag

In the view of the creator, elementary modules live from the begin to the end of the existence of the model. However, elementary modules can zigzag over time. Observers will perceive the reflection instants as pair annihilation and pair creation events of the combination of a particle and its antiparticle and two photons. At the reflection instants, the symmetry of the number system swaps to the time-reversed state. Except for mass, all properties of the elementary module will change sign. The combination of the separable Hilbert space, the selected version of the quaternionic number system, and the stochastic process with its characteristic function is a complicated configuration. It is not easily annihilated or (re)created. Instead, reality changes the operation mode of the configuration from particle mode to anti-particle mode or vice versa. At an intermediate stage, the mass is temporarily stored as energy. The energy is temporarily stored in the photons. One photon is emitted. Another photon is absorbed.

1.4 The Begin

At the begin, the stochastic processes have not done yet any work. The field that represents the universe then equals its parameter space. It is empty. At the start, a myriad of private stochastic processes starts injecting volume into the field. This occurs randomly distributed over the spatial part of the parameter space. This differs from the Big Bang idea of contemporary physics. Only after the first cycle, the elementary particles can start conglomerating into composed modules.

2 Elementary modules

The stochastic process of the elementary module generates a cyclic hopping path. At each cycle, the hopping path is nearly closed. The resulting closure step can be considered as the act of a displacement generator that controls the movement of the elementary module. Due to the influence of the characteristic function the violent hopping of the elementary module results in a smooth movement of the geometric center of the hop landing location swarm.

According to the Standard Model, elementary particles exist only in a small number of different types. The Hilbert Book Model explains this fact by assuming that the floating platforms can select only a limited number of versions of the quaternionic number system. First, all Cartesian coordinate systems must share the directions of their axes. Only the direction of ordering along these axes may vary between the allowed versions. Also, the geometric center may be different. In this way, the symmetries of the allowed versions reduce to a small set. In fact, only the difference of the symmetry with the background platform counts. The result is a small set of differences that correspond to the short list of electric charges and color charges that are supported by the Standard Model.

The electric charge resides at the geometric center of the platform. The platform is the separable Hilbert space combined with its private parameter space. The geometric center of the platform is the center of the parameter space. Every elementary module has an electric charge, but its value can be zero. By accounting over the three dimensions the symmetry differences in up or down direction, a short list of numbers results.

$$-3,-2,-1,0,+1,+2,+3$$

After dividing by 3 results the list of electric charges that corresponds to the shades of the elementary particles.

$$-1,\frac{-2}{3},\frac{-1}{3},0,\frac{+1}{3},\frac{+2}{3},+1$$

The fractioned charges belong to quarks. Quarks don't have isotropic symmetry. This is indicated by color charges. The "color" can have one of six values. The in time forward floating particles get RGB colors. The antiparticles get anti-colors.

The polar coordinate system relates to the spin properties of the particles. A start with the polar angle results in half-integer spin. A start with the azimuth results in integer spin.

2.1 Field deformation and expansion

Embedding of the content of the footprint operator's eigenspace into the field that represents the universe goes step by step and can only occur when the symmetries differ in an isotropic way. This means that only colorless elementary modules can be embedded into the background platform and due to the isotropic symmetry break the embedding may cause a spherical pulse response. Electrons, positrons, and neutrinos are colorless elementary modules. Spherical pulse responses are spherical shock fronts, which are solutions of a second order partial differential equation, such as the well-known wave equation. The shock front is not a wave and has no frequency. During travel, its front keeps its shape, but its amplitude diminishes as 1/r with distance r from the trigger location. Over time the spherical shock front integrates into the Green's function of the field. This function has some volume, and this volume is injected into the field. The shock front shows that this volume quickly spreads over the field. Consequently, the initial deformation quickly fades away. In order to cause a more persistent deformation, the stochastic process must keep generating new pulses, such that the pulse responses overlap in time and in space. The procedure both deforms and expands the embedding field.

Quarks would break symmetry in an anisotropic way. Thus, in isolation, quarks cannot cause spherical pulse responses. They must first combine with other quarks to form hadrons. Hadrons are colorless conglomerates that can cause spherical shock fronts. This effect is known as color confinement.

2.2 Deformation and the wavefunction

The squared modulus of the wavefunction equals the location density distribution of the footprint swarm of the elementary particle. For a large part, the convolution of the Green's function of the field and this location density distribution equals the deformation of the embedding field by the elementary particle. The difference is caused by the fact that the spherical shock fronts do not completely overlap in space and in time. At some distance from the center of the location density distribution the deformation gets the same shape and amplitude of the Green's function when it is multiplied with a factor. This means that the formula

$$\frac{mG}{r}$$

describes the deformation at these values of r . m is the mass of the particle and G is the gravitational constant that takes care of physical units. Closer to the center the shape of the deformation is a smooth function that does not contain the singularity, which is shown by the Green's function.

3 Composed modules

Only elementary particles with half-integer spin can compose modules. The HBM does not explain why this rule exists.

The binding in composed modules is controlled by another type of stochastic process that also owns a characteristic function. This characteristic function is a dynamic superposition of the characteristic functions of the components. The superposition coefficients act as displacement generators and in this way, they control the internal position of the corresponding component. The deformation that is caused by the components strengthens the binding effect that is initiated by the stochastic process. The electric charges attract or repel.

Attached to the characteristic function, all modules can have a gauge factor that acts as a displacement generator. It controls the displacement of the whole module.

1.1 Compound modules

Compound modules are composed modules for which the geometric centers of the platforms of the components coincide. The charges of the platforms of the elementary modules establish the binding of the corresponding platforms. Physicists and chemists call these compound modules atoms or atomic ions.

In free compound modules, the electric charges do not take part in the oscillations. The targets of the private stochastic processes of the elementary particles oscillate. This means that the hopping path of the elementary particle folds around the oscillation path and the hop landing location swarm gets smeared along the oscillation path. The oscillation path is a solution of the Helmholtz equation. Each fermion must use a different oscillation mode. A change of the oscillation mode goes together with the emission or the absorption of a photon. The center of emission coincides with the geometrical center of the compound module. During the emission or absorption, the oscillation mode and the hopping path halt, such that the emitted photon does not lose its integrity. Since all photons share the same emission duration, that duration must coincide with the regeneration cycle of the hop landing location swarm. Absorption cannot be interpreted that easily. In fact, it can only be comprehended as a time-reversed emission act. Otherwise, the absorption would require an incredible aiming precision for the photon.

The type of stochastic process that controls the binding of components appears to be responsible for the absorption and emission of photons and the change of oscillation modes. If photons arrive with too low energy, then the energy is spent on the kinetic energy of the common platform. If photons arrive with too high energy, then the energy is distributed over the available oscillation modes, and the rest is spent on the kinetic energy of the common platform. The process must somehow archive the modes of the components. It can apply the private platform of the components for that purpose. Most probably the current value of the dynamic superposition coefficient is stored in the eigenspace of a special superposition operator.

1.2 Molecules

Molecules are conglomerates of compound modules that each keep their private geometrical center. However, electron oscillations are shared among the compound modules. Together with the electric charges, this binds the compound modules.

1.3 Bosons

Elementary fermions fit well as elementary modules. However, elementary bosons, such as W_+, W_- and Z seem not well fit to compose higher level modules. Still, the embedded quaternions cause the spherical pulse responses that deform the embedding carrier field. Physical theories consider photons to be bosons, but photons are no elementary particles. Photons are strings of equidistant one-dimensional shock fronts that each carry a standard amount of energy. Each photon obeys the Einstein-Planck relation $E = h\nu$. Photons have a frequency, but they are not waves. Light is a distribution of photons. This distribution can be described by a wave package and can show interferences.

Only elementary fermions act as elementary modules. Elementary bosons don’t compose.

4 Modular design and construction

Modular design is preparation for modular construction. The creator has prepared the universe for modular construction, which is a very efficient way of generating new objects. However, modular configuration of objects involves the availability of modules that can be joined to become higher level modules or modular systems. This means that enough resources must be available at the proper place and the proper time. The generation of a module out of composing modules makes sense when the new module has a profitable functionality. An advantage can be that the new module or modular system has a better chance of survival in a competitive environment. In that case, stochastic modular design can easily win from monolithic design. Therefore, evolution can evolve with a pure stochastic modular design. However, as soon as intelligent species are generated as modular systems, then these individuals can take part in the control of evolution by intelligent modular design. Intelligent modular design and construction occur much faster.

4.1 Consciousness and intelligence

In the Hilbert Book Model, all modules are considered to act as observers. That does not mean that these modules react on the perceived information in a conscious or intelligent way. In the hierarchy of modular systems, compared to intelligence, consciousness already enters at lower levels of complexity. However, consciousness cannot be attributed to non-living modular systems. Primitive life forms have primitive degrees of consciousness.

Intelligent species show self-reflection and can create strategies that guard their type community or their social community. Conscious species can also develop such guarding measures, but that is usually a result of trial and error instead of a developed strategy. The strategy is then inherited via genes.

For intelligent species, the modular design strategy of the creator can be an inspiration [3].

- Modular design is superior to monolithic design.
- Modular construction works economically with resources.
- It is advantageous to have access to a large number and a large diversity of suitable modules.
- Create module-type communities
- Members must guard their module type community.
- Modular systems must care about the type communities on which they depend.
- Modular systems must care about their living environment.
- Darwin's statement that the fittest individual will survive must be exchanged for the statement that the module-type community survives that cares best for its members, its resources and its environment.

5 Stochastic control, Superposition and Entanglement

Universe has a memory. It is a read-only repository. At the instant of the creation, the creator filled the storage bins of the repository with combinations of time-stamps and three-dimensional locations, which are the dynamical geometric data of point-like objects that we know as elementary particles. The creator used stochastic processes to generate these data. Each elementary particle got its own stochastic process and this process owns a characteristic function. After sequencing the time-stamps each elementary particle owns a book that describes its life story. Elementary particles are elementary modules. Together, these elementary modules constitute all other modules that exist in the universe. Some modules constitute modular systems. At each instant, each elementary particle gets a new position. Thus, it is hopping around in a stochastic hopping path. The characteristic function ensures that after a while the hop landing locations recurrently constitute a coherent hop landing location swarm. A location density distribution describes the hop landing location swarm. The location density distribution equals the squared modulus of the wavefunction of the particle and it equals the Fourier transform of the characteristic function of the stochastic process. The location density distribution represents the particle.

This kind of stochastic process appears to be a combination of a Poisson process and a binomial process that is implemented by a point spread function. The point spread function equals the location density distribution of the generated hop landing location swarm.

Another stochastic process type controls the generation of composed modules. This stochastic process also owns a characteristic function. That characteristic function equals a dynamic superposition of the characteristic functions of the components of the module. The superposition coefficients act as displacement generators. They determine the internal positions of the components. Attached to the characteristic function, all modules own an extra displacement generator. It ensures that the module moves as a single unit.

The important message is that the universe is controlled by stochastic processes and that superposition of particles occurs in Fourier space. This fact enables entanglement. What a composed module is, is defined in Fourier space. There localization is not important. Components can locate far from each other.

Photons are not elementary particles. Still they can be part of composed modules. In that case they obey the rules for components.

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