What drives reality?

By J.A.J. van Leunen

Last modified: 11 december 2014

Abstract

The dynamics of reality is well regulated. What is the mechanism that controls dynamics and what rules this mechanism? The models of contemporary physics do not answer these questions.

In the realm of elementary particles the special habits of quaternions appear to play an essential role. In the past physics had a choice between the Maxwell based approach and the quaternionic based approach. That choice has a significant influence on how physics equations look. Einstein selected the Maxwell approach and in this way physics inherits the spacetime view on the universe in which we live.

Contents

1 Introduction

Ask a physicist the question "What drives the dynamics of reality?" and a chance exists that he answers that one of the operators in the Lagrange equation or some force will do this. The operators only describe what is happening and the Lagrange equation at the utmost defines the restrictions under which the behavior occurs, but it does not explain the origin of that behavior. Forces are usually related to potentials and potentials are reflecting the influence of more fundamental processes. Thus, the origin of the behavior must be sought in these more fundamental processes.

2 Progression

At the start of quantum physics two different methods were in use in order to store the parameter that represents progression. The first method was introduced by Schrödinger and places time dependence into the state of the considered object. This approach uses static operators. The second method was introduced by Heisenberg and stores time dependence in operators and uses a static object state. Later Paul Dirac showed that the Schrödinger picture and the Heisenberg picture describe the same reality. In fact a more general view exists that puts progression as a parameter in the complete separable Hilbert space. In that view progression steps along a sequence of separable Hilbert spaces that each describe a static status quo of the model.

2.1 Space and progression

The development of quantum physics and the development of relativity theory are strongly influenced by the way that Maxwell equations describe the transfer of information. This is most expressively described by the wave equation. The intriguing fact here is that alternatives exist for the Maxwell equations that offer a slightly different wave equation. Both wave equations describe how information is transferred. The alternative equations are formed by the differential equations of quaternionic functions. This approach delivers a space-progression model that has a Euclidean signature. The Maxwell equations offer a spacetime model that has a Minkowski signature.

In the quaternionic model space and progression are located at mutually perpendicular axes. In this model our common notion of time is a mixture of space and progression and is represented by a quaternion with non-zero real part and non-zero imaginary part, while progression is represented by the real part of the quaternion and space is represented by the imaginary part.

3 Coherence

The dynamics of reality is not chaotic. The behavior of reality appears to occur according to certain rules that determine that its dynamics is quite coherent. The lowest level players in this game are the elementary particles. These objects feature particle behavior and wave behavior. As a particle they appear to be point-like objects. This seems to conflict with the wave behavior. The word "seems" is correct. In large sets, point-like objects can behave such that they simulate wave patterns.

4 Storing properties

Another problem is that a point-like object does not have many means to store the properties that are attached to elementary particles. At every instance, they only can own properties that correspond to the dynamics of a point. These properties are position, speed, acceleration and so on. Observed over a period, these data can create a history. However, the point object itself has no means to change the basic properties: position, speed, acceleration. If those data change, then it is caused by an external mechanism.

The mechanism can work in a continuous or in a stepwise fashion. If it works in a stepwise fashion, then the mechanism can be viewed as recreating the particle at every subsequent progression step. It means that the particle is hopping along a hopping path. If that is done in a coherent fashion then the locations form a coherent swarm. That swarm and the path characterize the particle. The relocation can be thought to be controlled by a stochastic process. After a while the statistical characteristics of the swarm stabilize and the swarm can then be described by a continuous location density distribution. That distribution will come close to the squared modulus of the wave function of the particle. This on itself is an astonishing conclusion!

A continuous working mechanism cannot so easily reach this result and no known continuous mechanism can simulate the stochastic behavior of the wave function. Thus, the suggestion that the mechanism works in a stepwise stochastic fashion might be justified.

5 Wave behavior

It is known that the wave function has a Fourier transform, thus the same might hold for the normalized location density distribution. If that is true, then the stabilized swarm has a displacement generator. On its turn this means that in first approximation this swarm moves as one unit. As a consequence the swarm, like its point-like owner, has many characteristics of a particle. But, it also means that the density distribution can be considered as a wave package. Again this only holds in first approximation. The reason is that the swarm is continuously regenerated. Thus, even if the swarm moves, it keeps its wave package shape. With other words, even if the swarm moves, its "wave package" does not disperse. The swarm keeps its statistical characteristics and it keeps its symmetry properties. This set of properties classify elementary particle types.

The Fourier transform of the normalized continuous location density distribution can be interpreted as a mapping quality characteristic where the swarm acts as a point spread function. Thus, the dynamics of the particle can be treated as an imaging process. The environment of the particle acts as the imaging device. In order to understand the result of the imaging process the mapping quality characteristic of the particle must be multiplied with the Optical Transfer Function (OTF) of the imaging device. This result describes the Fourier transform of the resulting swarm. This procedure holds between two progression instants.

Thus the kinematics of elementary particles can be determined if its mapping quality function is known and if the OTF of the passed environment is available.

The mapping quality characteristic of the resulting swarm can become a wave-like interference pattern.

If a set of similar occasions of such swarms are detected, then the result is a wave-like interference pattern. It is not constituted by waves. It is a detection pattern that looks like an interference pattern.

6 Traces

The location swarm and the hopping path form reflections of the behavior of the point-like particle. However, each time that a temporary location is left this fact has become history. If nothing else happens, then nothing would show a trace of the temporary implanting of the point-like particle in the embedding continuum.

Mathematics might request that the current location and the corresponding hop together with the value of progression are stored as eigenvalues of operators that reside in a separable Hilbert space.

However, reality does not own a Hilbert space. So it has no means for storing these data. Still the event of embedding may leave some trace in the form of a message whose information is sent in all directions. For example the embedding may go together with the emission of an isotropic wave front that proceeds in the embedding continuum. The ripple of the wave front will slightly fold and thus curve that continuum. The amplitude of the ripple will quickly diminish as function of the distance from the source. Thus, the curvature will behave accordingly.

A similar phenomenon may happen with the embedding of the hop. However, in this case the wave front will act in only one dimension, which has the direction of the hop. Such wave fronts do not affect the curvature of the embedding continuum. Both kinds of wave fronts are originators of corresponding potentials.

7 Foundation

The fact that reality does not own a Hilbert space does not mean that a mathematical model of reality cannot make use of this Hilbert space[1]. A proper mathematical model must offer a convincing reason why it uses a Hilbert space as a structured storage medium. An acceptable strategy is to select a solid foundation from which the Hilbert space will automatically emerge. Such a foundation exists and is formed by the axioms that define the skeleton relational structure that since 1936 is known as quantum logic. This same relational structure is present in a separable Hilbert space in the form of the set of its closed subspaces.

The relational structure of quantum logic is quite similar to the relational structure of classical logic and that is the reason that its discoverers gave quantum logic its name. However, the elements of quantum logic can better not be interpreted as logic propositions. Instead they are better interpreted as construction elements of a modular system. But this means that at least a subset of the subspaces of a separable Hilbert space represent modules of a modular system. It also means that the Hilbert space might house several of these modular systems.

The modular structure appears to be typical for the relational structure of reality. This means that the Hilbert spaces that implement this structure are also characteristic for the relational structure of reality.

Separable Hilbert spaces are only structured storage media for discrete data. They cannot handle continuous data. As number systems the separable Hilbert spaces can only handle members of a division ring. Only three suitable division rings exist: the real numbers, the complex numbers and the quaternions. (bi-quaternions do not form a division ring!).

Each infinite dimensional separable Hilbert space owns a non-separable Hilbert space in the form of a Gelfand triple. The Gelfand triple features operators that possess continuums as eigenspaces. Thus in this way the mathematical model offers storage media for discrete as well as continuous data sets.

Quaternions can store progression and 3D spatial data in a single Euclidean geometric structure that can act as the eigenvalue of a normal operator. Progression steps in the separable Hilbert space and it flows in the non-separable Hilbert space.

8 Controlling dynamical coherence

Up to so far the model can register dynamic geometric data, but it offers no means to regulate the coherence of that dynamics. Thus the model must be completed with a mechanism that controls

[1] See: http://vixra.org/abs/1409.0050

dynamical coherence. That mechanism must also control the binding of modules into composites and it must properly schedule corresponding parallel tasks. Thus, this mechanism shows similarity with the activity of a real time operating system. It uses a real time model wide clock that registers the progression of the model. It regulates the recurrent embedding of the separable Hilbert space into its non-separable companion.

The fact that the separable Hilbert space must fit into the non-separable Hilbert space severely restricts the activity of the mechanism. The mechanism uses this restriction in order to control temporal and spatial coherence.

9 Swarms

Due to the restrictions of the embedding process the location swarms that represent elementary building blocks will show spatial and dynamic coherence. Three levels of coherence can be distinguished.

1. Due to the four dimensions of quaternions, quaternionic number systems and continuous quaternionic functions exist in sixteen versions that differ only in their discrete coordinate related symmetry properties. Thus, all elements of a coherent location swarm and the corresponding hopping path must belong to a single quaternionic symmetry flavor.
2. A second level coherent location swarm can be described by a continuous location density distribution. The quaternionic distribution that describes the hops must reflect the symmetry flavor of the swarm.
3. The continuous location density distribution must own a Fourier transform.

The third restriction has two consequences. It means that the swarm owns a displacement generator and as its consequence at first approximation the swarm moves as one unit. It also means that at every progression instant the continuous descriptor can be viewed as a wave package and it means that the pattern of the swarm can take the form of an interference pattern.

The fact that the Fourier transform of the continuous location density distribution acts as a mapping quality characteristic offers the possibility to compute the behavior of the moving swarm in non-uniform conditions in which the embedding continuum is curved in an arbitrary way.

9.1 Uncertainty

The swarm represents a spatial spread and at the same time it reflects the dynamics of a point-like object during a given period. At every progression instant only one element of the swarm represents the current location of the point-like object. Locations that were used before that instance are stored as eigenvalues of the location operator that resides in the separable Hilbert space. These locations are precisely determined. Future locations are not yet known and are generated by a stochastic process. Thus this part of the swarm represents uncertainty. It is possible to interpret the swarm's generation process as a being prepared in advance. In that case the stochastic process selects the order of the locations in a random fashion. The spread of the swarm then corresponds to a statistical spread. The Fourier transform of the continuous location density distribution that describes the swarm will also show a corresponding spread. Both spreads represent the base of Heisenberg's uncertainty relation.

Heisenberg's relation is just a mathematical correspondence. It does not add extra uncertainty. The unvertainty is generated by the stochastic process that generates the not yet established locations.

10 Mapping to a curved continuum

The embedding of the point-like objects into an embedding continuum represents a map onto a curved manifold. In the mathematical model this manifold is represented by a quaternionic function. That same function represents the map. The swarm can be described by the convolution of this mapping function and a stochastic spatial spread function. The individual locations form a micro-path, but also the swarm as a whole will follow a path. If the swarm moves with uniform speed, then the curved path can be characterized by a Frenet-Serret frame. This frame describes the path in three mutually perpendicular directions. The fact that this is possible represents a further restriction to the behavior of the point-like object. The frame is characterized by three mutually orthonormal vectors and two scalar characteristics[2]. From these data the Euler-Lagrange equations can be derived[3].

11 Gravitation and electrostatic potential.

The origin and the existence of the gravitation potential is now explained by the smoothed and averaged influences of the isotropic wave fronts that are emitted at the embedding events. Together the pinches combine in a wider pitch that no longer has the form of a local singularity. This view also shows how the gravitation potential executes its attractive action. The size of the gravitation potential depends on the number of elements in the swarm. The shape of the local gravitation potential depends on the spread of the swarm.

Where the gravitation potential combines the actions of the separate swarm elements, will the embedding of the hops not result in such individual element action. The electrostatic potential reflects the symmetry properties rather than the location density distribution of the swarm. Any stochastic spread of hop directions is hidden by the temporal and spatial averaging and smoothing process. However the coordinated discrete symmetry is not affected. These symmetries are determined with respect to the symmetry that exists in the parameter space. These symmetry properties hold for the swarm as a whole. Still the location of the charge or source of the electrostatic potential coincides with the statistical center location of the swarm. This is why electrons and quarks have charges that reflect their symmetry. Electrons and positrons have coordinate related isotropic symmetry and quarks show coordinate related anisotropy. The direction of the anisotropy is indicated by the color charge of the quark. The size of the electric charge indicates how many dimensions are covered. The sign of the charge indicates the differences of the direction within these dimensions.

12 Quaternion habits

By now it may have become clear that especially in the realm of the elementary particles the special habits of quaternions play a crucial role. These habits play an essential role in the properties and in the behavior of the elementary particles. Together these characteristics determine the diversity of the elementary particles.

12.1 Coupling equation

The coupling equation follows from peculiar properties of the differential of quaternionic functions. We start with two normalized functions ψ and φ and a normalizable function $\Phi = m\,\varphi$.

(1)

[2] See: http://en.wikipedia.org/wiki/Frenet%E2%80%93Serret_formulas

[3] See: http://mathsci.ucd.ie/~onaraigh/ACM_20150_sept_2013.pdf

$$||\psi|| = ||\varphi|| = 1$$

These normalized functions are supposed to be 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. (5)

12.2 Dirac equation

For example the Dirac equation for the free electron in quaternionic format is a special form of this coupling equation:

$$\nabla\psi = m_e\,\psi^* \tag{1}$$

And the Dirac equation for the positron runs:

$$\nabla^*\psi^* = m_e\,\psi \tag{2}$$

Thus

$$\nabla^*\nabla\psi = m_e\nabla^*\,\psi^* = m_e^2\,\psi \tag{3}$$

For electrons ψ represents its own normalized object density distribution.

This is an in-homogeneous wave equation.

12.3 Maxwell versus quaternionic wave equation

The transfer of information occurs via waves or strings of wave fronts. These are solutions of the homogeneous wave equation. A significant difference exist between the Maxwell based wave equation and the quaternionic wave equation.

In Maxell-Minkowski format the wave equation uses coordinate time t. It runs as:

$$\partial^2\psi/\partial t^2 - \partial^2\psi/\partial x^2 - \partial^2\psi/\partial y^2 - \partial^2\psi/\partial z^2 = 0$$

Papers on Huygens principle work with this formula or it uses the version with polar coordinates.

For 3D the general solution runs:

$$\psi = f(r - ct)/r, \text{ where } c = \pm 1; f \text{ is real}$$

For 1D the general solution runs:

$\psi = f(x - ct)$, where $c = \pm 1$; f is real

For the Hamilton-Euclidean version, which uses proper time τ, we use the quaternionic nabla ∇:

$$\nabla = \left\{\frac{\partial}{\partial \tau}, \frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z}\right\} = \nabla_0 + \boldsymbol{\nabla};$$

$$\nabla^* = \nabla_0 - \boldsymbol{\nabla}$$

$$\nabla \psi = \nabla_0 \psi_0 - (\boldsymbol{\nabla}, \boldsymbol{\psi}) + \nabla_0 \boldsymbol{\psi} + \boldsymbol{\nabla} \psi_0 \pm \boldsymbol{\nabla} \times \boldsymbol{\psi}$$

The $\pm$ sign reflects the choice between right handed and left handed quaternions.

In this way the Hamilton-Euclidean format of the wave equation runs:

$$\nabla^* \nabla \psi = \nabla_0 \nabla_0 \psi + (\boldsymbol{\nabla}, \boldsymbol{\nabla})\psi = 0$$

$$\partial^2\psi/\partial\tau^2 + \partial^2\psi/\partial x^2 + \partial^2\psi/\partial y^2 + \partial^2\psi/\partial z^2 = 0$$

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

For the general solution holds: $f = f_0 + \boldsymbol{f}$

For the real part ψ_0 of ψ:

$\psi_0 = f_0\,(\boldsymbol{i}\, r - c\,\tau)/r$, where $c = \pm 1$ and $\boldsymbol{i}$ is an imaginary base vector in radial direction

For the imaginary part $\boldsymbol{\psi}$ of ψ:

$\boldsymbol{\psi} = \boldsymbol{f}(\boldsymbol{i}\, z - c\,\tau)$, where $c = \pm 1$ and $\boldsymbol{i} = \boldsymbol{i}(z)$ is an imaginary base vector in the x, y plane

The orientation $\theta(z)$ of $\boldsymbol{i}(z)$ in the x, y plane determines the polarization of the 1D wave front.

The difference between the Maxwell-Minkowski based approach and the Hamilton-Euclidean based approach will become clear when the difference between the coordinate time t and the proper time τ is investigated. This becomes difficult when space is curved, but for infinitesimal steps space can be considered flat. In that situation holds:

Coordinate time step vector = proper time step vector + spatial step vector

Or in Pythagoras format:

$$(\Delta t)^2 = (\Delta\tau)^2 + (\Delta x)^2 + (\Delta y)^2 + (\Delta z)^2$$

The fact that physics has selected the Maxwell approach has caused its preference for a spacetime model with Minkowski signature.

12.4 Symmetry flavors

ψ^* and ψ are symmetry flavors of the same base function.

Other elementary particles couple different symmetry flavors $\{\psi^x, \psi^y\}$ of their shared base function:

$$\nabla\psi^x = m_{xy}\, \psi^y \tag{4}$$

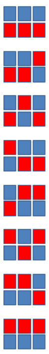
And for the antiparticle:

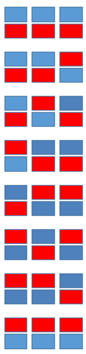
$$\nabla^*(\psi^x)^* = m_{xy}\, (\psi^y)^* \tag{5}$$

The difference in the symmetry flavors between the members of the pair $\{\psi^x, \psi^y\}$ can be related to the electric charge, color charge and spin of the corresponding elementary particle.

Fermions appear to couple to the reference symmetry flavor $\boldsymbol{\psi}^{\textcircled{0}}$.

- Continuous quaternionic functions do not switch to other symmetry flavors.
- If the real part is ignored, then still ***8*** symmetry flavors result
- Symmetry flavors are marked by special indices, for example $\boldsymbol{\psi}^{\textcircled{4}}$
- They are also marked by colors $N, R, G, B, \bar{B}, \bar{G}, \bar{R}, \bar{N}$
- Half of them is right handed, **R**
- The other half is left handed, **L**
- $\boldsymbol{\psi}^{\textcircled{0}}$is the reference symmetry flavor
- The colored rectangles reflect the directions of the axes





Symmetry flavors ψ^x	Result of coupling ψ^x to $\psi^{\textcircled{0}}$
$\boldsymbol{\psi}^{\textcircled{0}} N$ **R**	$\boldsymbol{\psi}^{\textcircled{0}}$ *neutrino* ***0***
$\boldsymbol{\psi}^{\textcircled{1}} R$ **L**	$\boldsymbol{\psi}^{\textcircled{1}}$ *R upquark* *⅔*
$\boldsymbol{\psi}^{\textcircled{2}} G$ **L**	$\boldsymbol{\psi}^{\textcircled{2}}$ *G upquark* *⅔*
$\boldsymbol{\psi}^{\textcircled{3}} B$ **L**	$\boldsymbol{\psi}^{\textcircled{3}}$ *B upquark* *⅔*
$\boldsymbol{\psi}^{\textcircled{4}} \bar{B}$ **R**	$\boldsymbol{\psi}^{\textcircled{4}}$ $\bar{B}$ *downquark -⅓*
$\boldsymbol{\psi}^{\textcircled{5}} \bar{G}$ **R**	$\boldsymbol{\psi}^{\textcircled{5}}$ $\bar{G}$ *downquark -⅓*
$\boldsymbol{\psi}^{\textcircled{6}} \bar{R}$ **R**	$\boldsymbol{\psi}^{\textcircled{6}}$ $\bar{R}$ *downquark -⅓*
$\boldsymbol{\psi}^{\textcircled{7}} W$ **L**	$\boldsymbol{\psi}^{\textcircled{7}}$ *electron* ***-1***

12.5 Gluons

Gluons are supposed to play an important role in the binding of quarks into colorless composites. Gluons can convert the color charge of a quark. When they act as a quaternionic rotator, then they apply this capability to all hops in the complete quark swarm. In that case they can be represented by quaternions that have the form of a symmetry flavor convertor:

$$\varrho^{\textcircled{1}} = \frac{1+\boldsymbol{i}}{\sqrt{2}};\ \varrho^{\textcircled{2}} = \frac{1+\boldsymbol{j}}{\sqrt{2}};\varrho^{\textcircled{3}} = \frac{1+\boldsymbol{k}}{\sqrt{2}};\ \varrho^{\textcircled{4}} = \frac{1-\boldsymbol{k}}{\sqrt{2}};\ \varrho^{\textcircled{5}} = \frac{1-\boldsymbol{j}}{\sqrt{2}};\ \varrho^{\textcircled{6}} = \frac{1+\boldsymbol{i}}{\sqrt{2}};\ \boldsymbol{ij} = \boldsymbol{k};$$

Such quaternionic symmetry flavor convertors can shift the indices of symmetry flavors of sets of quaternions and continuous quaternionic functions. For example:

$$\psi^{③} = \varrho^{①}\psi^{②}/\varrho^{①}$$

$$\varrho^{①}\psi^{②} = \psi^{③}\varrho^{①}$$

It looks as if absorbing a $\varrho^{①}$ gluon into a $\psi^{②}$ flavored function result in the emission of a $\varrho^{①}$ from the resulting $\psi^{③}$ flavored function. This action influences the 1D vector wave fronts that are emitted at the embedding of hops.

The symmetry flavor convertors do not affect the isotropic (=colorless) quaternionic functions $\psi^{⓪}$ and $\psi^{⑦}$.

$$\psi^{⓪} = \varrho^{①}\psi^{⓪}/\varrho^{①}$$

Thus gluons only affect quarks and do not affect electrons or positrons. In addition they do not affect colorless composites.