Base model

STORAGE BASE FOR QUATERNIONIC SETS AND FIELDS

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Field F of scalars

<table>
<thead>
<tr>
<th>Axiom</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Associativity of addition and multiplication:</strong></td>
<td>( a + (b + c) = (a + b) + c, ) and ( a \cdot (b \cdot c) = (a \cdot b) \cdot c. )</td>
</tr>
<tr>
<td><strong>Commutativity of addition and multiplication:</strong></td>
<td>( a + b = b + a, ) and ( a \cdot b = b \cdot a. )</td>
</tr>
<tr>
<td><strong>Additive and multiplicative identity:</strong></td>
<td>there exist two different elements ( 0 ) and ( 1 ) in ( F ) such that ( a + 0 = a ) and ( a \cdot 1 = a. )</td>
</tr>
<tr>
<td><strong>Additive inverses:</strong></td>
<td>for every ( a ) in ( F ), there exists an element in ( F ), denoted ( -a ), called the additive inverse of ( a ), such that ( a + (-a) = 0. )</td>
</tr>
<tr>
<td><strong>Multiplicative inverses:</strong></td>
<td>for every ( a \neq 0 ) in ( F ), there exists an element in ( F ), denoted by ( a^{-1} ) or ( 1/a ), called the multiplicative inverse of ( a ), such that ( a \cdot a^{-1} = 1. )</td>
</tr>
<tr>
<td><strong>Distributivity of multiplication over addition:</strong></td>
<td>( a \cdot (b + c) = (a \cdot b) + (a \cdot c). )</td>
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</table>
## Vector space

Set $V$ of vectors $\times$ field $F$ of scalars

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<tr>
<td>Associativity of addition</td>
<td>$\mathbf{u} + (\mathbf{v} + \mathbf{w}) = (\mathbf{u} + \mathbf{v}) + \mathbf{w}$</td>
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<tr>
<td>Commutativity of addition</td>
<td>$\mathbf{u} + \mathbf{v} = \mathbf{v} + \mathbf{u}$</td>
</tr>
<tr>
<td>Identity element of addition</td>
<td>There exists an element $\mathbf{0} \in V$, called the zero vector, such that $\mathbf{0} + \mathbf{v} = \mathbf{v}$ for all $\mathbf{v} \in V$</td>
</tr>
<tr>
<td>Inverse elements of addition</td>
<td>For every $\mathbf{v} \in V$, there exists an element $-\mathbf{v} \in V$, called the additive inverse of $\mathbf{v}$, such that $\mathbf{v} + (-\mathbf{v}) = \mathbf{0}$ for all $\mathbf{v} \in V$</td>
</tr>
<tr>
<td>Compatibility of scalar multiplication with field multiplication</td>
<td>$a \cdot (b \cdot \mathbf{v}) = (ab) \cdot \mathbf{v}$</td>
</tr>
<tr>
<td>Identity element of scalar multiplication</td>
<td>$1 \cdot \mathbf{v} = \mathbf{v}$, where $1$ denotes the multiplicative identity in $F$</td>
</tr>
<tr>
<td>Distributivity of scalar multiplication with respect to vector addition</td>
<td>$a \cdot (\mathbf{u} + \mathbf{v}) = a \cdot \mathbf{u} + a \cdot \mathbf{v}$</td>
</tr>
<tr>
<td>Distributivity of scalar multiplication with respect to field multiplication</td>
<td>$(a + b) \cdot \mathbf{v} = a \cdot \mathbf{v} + b \cdot \mathbf{v}$</td>
</tr>
</tbody>
</table>
Hilbert space $H$ components
The universe contains about a trillion elementary particles
Base model

Elementary modules

Floating

Stochastic process

Quaternionic number system version

Background platform

Hilbert space

Embed

Non-separable Hilbert space

Separable
Hilbert Book Model

- Background separable Hilbert space
  - Symmetry-related field
  - Parameter space
  - The universe
- Non-separable Hilbert space
  - Flat field
- Elementary modules
  - Floating Hilbert space
  - Floating Hilbert space
  - Floating Hilbert space
  - Floating Hilbert space

Parameter space
The elementary modules constitute a modularly designed set of modules and modular systems.

Stochastic processes define the composed modules via their characteristic functions.

These characteristic functions are dynamic superpositions of the characteristic functions of the components.

The superposition coefficients are displacement generators.

The displacement generators define the internal positions of the components.

Each module owns a displacement generator that determines the position of the module.
Quaternionic fields

- Quaternionic fields are represented by the eigenspaces of normal operators.
- In the quaternionic non-separable Hilbert spaces these fields can be continuums.
- Quaternionic differential calculus describes the behavior of continuums.
- Second-order partial differential equations describe the interaction between point-like actuators and continuums.
Mother of all field equations

$$\nabla \psi = (\nabla_r + \vec{\nabla})(\psi_r + \vec{\psi}) = \nabla_r \psi_r - (\vec{\nabla}, \vec{\psi}) + \nabla_r \vec{\psi} + \vec{\nabla} \psi_r \pm \vec{\nabla} \times \vec{\psi}$$

First-order change

Dynamic change

Five terms

divergence

curl

gradient
Second-order change

\[ \phi = \nabla \varphi = \nabla (\nabla^* \psi) = \nabla^*(\nabla \psi) = \left( \nabla \nabla_r + \langle \nabla, \nabla \rangle \right) \psi \]

Double first order change

\[ \phi = \left( \nabla \nabla_r - \langle \nabla, \nabla \rangle \right) \psi \]

if \( \phi = 0 \) then \( \nabla \nabla_r \psi = \left[ \nabla, \nabla \right] \psi = -k^2 \psi \)

\[ \phi = \langle \nabla, \nabla \rangle \psi \]

Wave equation

Helmholtz equation

Poisson equation
Dark Energy Objects

Photons are strings of equidistant one-dimensional shock fronts

\[ \psi = f \left( \bar{q} - \bar{q}' \right) \pm c \left( \tau - \tau' \right) \bar{n} \]

Polarization vector

- At emission all photons feature the same emission duration and have the same length

\[ E = h \nu \]
Circular polarized photon

The black arrows represent the polarization vector of the one-dimensional shock fronts. The red line connects the tips of the arrows.

A photon is not an EM wave.
Over time, spherical shock fronts integrate into the Green’s function

\[ \psi = \frac{1}{|\vec{q} - \vec{q}'|} \]

The injected volume temporarily deforms the field and persistently expands the field.
Newton's gravitational potential

- Far enough at distance $r$ of the center of mass of the object with mass $M$ the gravitation potential equals

$$g(r) = \frac{MG}{r}$$

- This has the **shape of the Green's function** of the field
- This holds for all massive particles and for black holes
Inertia

- The artificial field \( \zeta \) consists of a real part that equals Newton’s gravitational potential and an imaginary part that equals the uniform speed of the corresponding massive object. This field is defined such that physical reality tries to keep this change equal to zero

\[
\zeta = \zeta_r + \vec{\xi} = \frac{MG}{r} + \vec{v}
\]

- The imaginary part of the change of field \( \zeta \) is

\[
\vec{\zeta} = \vec{\nabla} \cdot \zeta_r + \vec{\nabla}_r \vec{\xi} + \vec{\nabla} \times \vec{\xi} = 0
\]

\[
\vec{\nabla} \cdot \zeta_r = \vec{\nabla} \cdot \left( \frac{GM}{r} \right) = -\frac{GM}{r^2} = -\frac{\vec{v}}{r^2} = -\vec{a}
\]

The curl is also zero
Thus, if two uniformly moving masses $M_1$ and $M_2$ exist in each other’s neighborhood, then the situation will cause the gravitation force

$$\vec{F}(\vec{r}_1 - \vec{r}_2) = M_1 \ddot{a} = \frac{GM_1 M_2 (\vec{r}_1 - \vec{r}_2)}{|\vec{r}_1 - \vec{r}_2|^3}$$
Black holes

- In a non-separable Hilbert space a quaternionic field can be a mixture of a continuum and several enclosed regions that are countable.
- Inside those regions no field excitations exist.
- At the border of the enclosed region shock fronts are blocked.
- No field excitations can enter the countable region.
- No field excitation can leave the countable region.
- These regions deform their surrounding continuum.
- Far from the center of the region, Newton's gravitational potential describes the deformation of the surrounding continuum.
Black hole size

- At the border of the countable region, the energy of the one-dimensional shock fronts equals the gravitational potential energy of this region.
- The mass equivalent of this energy is $mc^2$.
- The gravitational potential energy of mass $m$ is $\frac{mMG}{r_{bh}}$.
- This sets the size of the black hole at radius $r_{bh}$.
- The size increases proportional with the mass of the region.
Black hole growth

- Due to the strong gravitation, a huge number of elementary particles cling with the geometrical center of their parameter space to the border of the black hole.
- For a part, the active area of the private stochastic process of the elementary particle hovers over the countable region.
- Outside the black hole the private stochastic process of the elementary particle generates the spherical pulse responses that constitute the footprint of the elementary particle.
- Inside the black hole the private stochastic process of the elementary particle adds objects to the content of the countable region. This increases the size of the countable region.