Mass

By J.A.J. van Leunen

Last modified: 28 September 2018

Abstract

The target of this document is the explanation of the essentials of gravity and its characteristic, the mass of discrete objects.

Introduction

This paper wants to go very fundamental. That is why we need a solid mathematical platform that enables the modeling of reality for as far as fields and particles are concerned. We only consider the field that implements our living space. It is certainly not the electromagnetic field. Our living space exists always and everywhere in what we call the universe. The paper does not consider multiverses. Everything must fit in a single quaternionic non-separable Hilbert space. It comprises an infinite dimensional separable Hilbert space that easily can cover all discrete objects that exist in the universe.

Our living space

Our living space is a field that is defined by a quaternionic function. It equals the eigenspace of an operator in a quaternionic non-separable Hilbert space. The parameter space of the quaternionic function is a flat field, which is eigenspace of a reference operator of the same Hilbert space. That eigenspace is formed by a version of the quaternionic number system that is sequenced by a selected Cartesian coordinate system and a selected polar coordinate system. The non-separable Hilbert space applies the members of this version of the quaternionic number system to define the inner product of pairs of Hilbert space vectors. The non-separable Hilbert space embeds a unique companion separable Hilbert space that applies the rational values of the selected version of the quaternionic number system for defining the eigenvalues of its operators. We will call this separable Hilbert space the background platform. The eigenspace of its reference operator acts as the background parameter space.

Floating platforms

Floating platforms are quaternionic separable Hilbert spaces that are defined on the same vector space that carries the background platform, but that apply a different version of the quaternionic number system to specify the inner product of pairs of their Hilbert vectors. Floating is defined for the private parameter spaces of the platforms and occurs relative to the geometric centers of these parameter spaces and the background parameter space. On each floating platform resides an elementary particle. Elementary particles are elementary modules and together they constitute all other modules. Some of the modules constitute modular systems.

A private stochastic process generates the footprint of the elementary particle and a dedicated footprint operator registers the footprint. At every subsequent progression instant, the stochastic process generates a new hop landing location and this location is archived together with the corresponding time-stamp in an eigenvalue of the footprint operator. Consequently, the elementary particle hops around in a stochastic hopping path and the hopping path forms a coherent hop landing location swarm. A location density distribution describes this swarm. It equals the squared modulus of the wavefunction of the elementary particle. The stochastic process owns a characteristic function that equals the Fourier transform of the location density distribution. In this way the characteristic function can ensure the coherence of the generated swarm.

Spherical pulse response

A spherical pulse response is a solution of a homogeneous second order partial differential equation that was triggered by an isotropic pulse. The spherical pulse response integrates over time into the Green's function of the field. The Green's function is a solution of the Poisson equation. The Green's function occupies some volume. This means that locally the pulse pumps some volume into the field. The dynamics of the spherical pulse response shows that this volume quickly spreads over the field.

Thus, locally and temporarily, the pulse deforms the field and the injected volume persistently expands the field.

This paper postulates that the spherical pulse response is the only field excitation that temporarily deforms the field, while the injected volume persistently expands the field.

The effect of the spherical pulse response is so tiny and so temporarily that no instrument can ever measure the effect of a single spherical pulse response in isolation. However, when recurrently regenerated in huge numbers in dense and coherent swarms the pulse responses can cause a significant and persistent deformation that instruments can detect. This is achieved by the stochastic processes that generate the footprint of elementary particles.

The spherical pulse responses are straight forward candidates for what physicists call dark matter objects. A halo of these objects can cause gravitational lensing.

Gravitation potential

The gravitation potential that an elementary particle causes can be approached by the convolution of the Green's function of the field and the location density distribution of the swarm. This approximation is affected by the fact that the deformations, that are due to the individual pulse responses quickly fade away. Further, the density of the location distribution affects the efficiency of the deformation.

At some distance of the center of the swarm the gravitation distribution can be approximated by

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

where m is the mass of the particle and r equals the distance to the center. Here we omit the physical units, such as the gravitational constant.

This can be comprehended by looking at the result for a Gaussian location density distribution. In that case the gravitation potential would be described by

$$g(r) = m\frac{ERF(r)}{r}$$

Where $ERF(r)$ is the well-known error function. Here the gravitation potential is a perfectly smooth function that at some distance from the center equals the approximated gravitation potential that was described above.

According to this reasoning the symbol m is more like a mass capacity, than a hard and well-established property because it still depends on the density of the distribution and the duration of the recurrence cycle. This might explain why each elementary particle type exists in three generations.

Regeneration

The requirement for regeneration introduces a great mystery. All generated mass appears to dilute away and must be recurrently regenerated. This conflicts with the conservation laws of mainstream physics. The deformation work done by the stochastic processes vanishes completely. What results is the ongoing expansion of the field. Thus, these processes must keep generating the particle to which they belong.

Only the ongoing embedding of the content that is archived in the floating platform into the embedding field can explain the activity of the stochastic process. This supposes that at the instant of creation, the creator already archived the dynamic geometric data of his creatures into the eigenspaces of the footprint operators. These data consist of a scalar time-stamp and a three-dimensional spatial location. The quaternionic eigenvalues act as storage bins.

After the instant of creation, the creator left his creation alone. The set of floating separable Hilbert spaces, together with the background Hilbert space act as a read-only repository. After sequencing the time-stamps, the stochastic processes read the storage bins and trigger the embedding of the location into the embedding field.

Inertia

The relation between inertia and mass is complicated. It assumes that a field tries to compensate the change of the field when its vector part suddenly changes with time.

A special field supports the hop landing location swarm that resides on the floating platform. It reflects the activity of the stochastic process and it floats with the platform over the background platform. It is characterized by a mass value and by the uniform velocity of the platform with respect to the background platform. The real part conforms to the deformation that the stochastic process causes. The imaginary part conforms to the moving deformation. The main characteristic of this field is that it tries to keep its overall change zero. We call ξ the ***deformation field***.

The first order change of a field contains five terms. Mathematically, the statement that in first approximation nothing in the field ξ changes indicates that locally, the first order partial differential $\nabla\xi$ will be equal to zero.

$$\zeta = \nabla\xi = \nabla_r \xi_r - \left\langle \vec{\nabla}, \vec{\xi} \right\rangle + \vec{\nabla}\xi_r + \nabla_r \vec{\xi} \pm \vec{\nabla} \times \vec{\xi} = 0$$

The terms that are still eligible for change must together be equal to zero. These terms are.

$$\nabla_r \vec{\xi} + \vec{\nabla}\xi_r = 0$$

In the following text plays $\vec{\xi}$ the role of the vector field and ξ_r plays the role of the scalar gravitational potential of the considered object.

The new field $\xi = \left\{ \frac{m}{r}, \frac{m}{r}\vec{v} \right\}$ considers a uniform moving mass as a normal situation. It is a combination of the scalar potential $\frac{m}{r}$ and the uniformly moving potential $\frac{m}{r}\vec{v}$, which is a vector potential.

If this object accelerates, then the new field $\left\{ \frac{m}{r}, \frac{m}{r}\vec{v} \right\}$ tries to counteract the change of the field $\frac{m}{r}\dot{\vec{v}}$ by compensating this with an equivalent change of the real part $\frac{m}{r}$ of the new field. This equivalent change is the gradient of the real part of the field.

$$-\vec{\nabla}\left(\frac{m}{r}\right) = \frac{m\vec{r}}{|\vec{r}|^3}$$

This generated vector field acts on masses that appear in its realm.

Thus, if two masses m_1 and m_2 exist in each other's neighborhood, then any disturbance of the situation will cause the gravitational force

$$\vec{F}(\vec{r}_1 - \vec{r}_2) = \frac{m_1 m_2 (\vec{r}_1 - \vec{r}_2)}{|\vec{r}_1 - \vec{r}_2|^3}$$

The disturbance by the ongoing expansion of the field suffices to put the gravitational force into action. The description also holds when the field ξ describes a conglomerate of platforms and m represents the mass of the conglomerate.

In compound modules such as ions and atoms, the field ξ of a component oscillates with the deformation rather than with the platform.

Black holes

Black holes are regions of the field that are encapsulated by a surface that cannot be passed by spherical shock fronts. Only the shock fronts that locate at the border of the region can add volume to the region. Thus, the increase of the volume of that region is restricted by the surface of the encapsulation. This differs from free space, where stochastic processes can inject volume anywhere. Black holes represent the most efficient packaging of volume that stochastic processes can achieve.

Black holes are characterized by a Schwarzschild radius. It is the radius where the escape speed of massive objects equals light speed. The gravitational energy U of a massive object with mass m in a gravitation field of an object with mass M is

$$U = -\frac{GMm}{r}$$

The escape velocity follows from the initial energy $\frac{1}{2}mv^2$ of the object with mass m and velocity v.

$$½mv_0^2 - \frac{GMm}{r_0} = 0$$

This results in

$$v_0 = \sqrt{2\frac{GM}{r_0}}$$

Due to the kinetic energy equivalence $h\nu = \frac{1}{2}mv^2$,this means for photons

$$U = -\frac{2GMh\nu}{rc^2}$$

The frequency ν of the photon changes with the radius r

$$h\nu = h\nu_0 - \frac{2GMh\nu_0}{rc^2}$$

This formula describes the gravitational red shift of photons. The radius at which the frequency ν has reduced to zero is the Schwarzschild radius r_s

$$r_s = \frac{2GM}{c^2}$$

For a non-rotating neutral black hole, photons cannot escape from the sphere with the Schwarzschild radius r_s .

At the Schwarzschild radius the escape velocity of massive objects equals the light speed.

It also means that one-dimensional shock fronts and spherical shock fronts cannot escape the sphere.

Spherical shock fronts can only add volume at the border of the black hole. The injection increases the Schwarzschild radius. The injection also increases the mass M . An increase of the Schwarzschild radius means an increase of the volume of this sphere. This is like the injection of volume into the volume of the field that occurs via the pulses that generate the elementary particles. However, in this case the volume stays within the Schwarzschild sphere. In both cases the volume of the field expands.

The Schwarzschild sphere contains unstructured volume. No modules exist within that sphere.

References

Tracing the structure of physical reality by starting from its fundamentals; http://dx.doi.org/10.13140/RG.2.2.16452.07047

Behavior of Basic Fields; http://dx.doi.org/10.13140/RG.2.2.15517.20960

64 Shades of Space: http://dx.doi.org/10.13140/RG.2.2.28012.46724