All about mass and gravitation

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Abstract

Gravitation and mass are explained by the fact that spherical pulse responses locally and temporarily deform the embedding field. Over time the spherical pulse response integrates into the Green's function of the field. The shape of the Green's function resembles the shape of the gravitational potential of point-like masses. At large enough distance an ensemble of massive objects acts as a single point-like mass. This alone does not explain why the gravitational force exists. Inertia explains how physical reality minimizes the third-order change of the universe and generates the acceleration that mutually attracts massive objects. These ingredients explain how gravity works. The mass has a significance of its own and can characterize discrepant regions.

1 Gravitation laws

1.1 Center of mass

In a system of massive objects $p_i, i = 1,2,3,...n$, each with static mass m_i at locations r_i, the center of mass $\vec{R}$ follows from

$$\sum_{i=1}^{n} m_i \left(\vec{r}_i - \vec{R}\right) = \vec{0} \qquad (1.1.1)$$

Thus

$$\vec{R} = \frac{1}{M} \sum_{i=1}^{n} m_i \vec{r}_i \qquad (1.1.2)$$

Where

$$M = \sum_{i=1}^{n} m_i \qquad (1.1.3)$$

In the following, we will consider an ensemble of massive objects that own a center of mass $\vec{R}$ and a fixed combined mass M as a single massive object that locates at $\vec{R}$. $\vec{R}$ can be a dynamic location. In that case, the ensemble must move as one unit. The problem with this treatise is that in physical reality, point-like objects that possess a static mass do not exist.

1.2 Newton

Newton's laws are nearly correct in nearly flat field conditions. The main formula for Newton's laws is

$$\vec{F} = m\vec{a} \tag{1.2.1}$$

Another law of Newton treats the mutual attraction between massive objects. This gravitational attraction can be derived from the gravitational potential. Massive objects deform the field that embeds these objects, but if this effect is ignored and if the gravitational potential is a static function, and if the massive object moves uniformly, then at large distances, the gravitational potential describes properly what occurs.

The following relies heavily on the chapter on quaternionic differential calculus in [1].

1.3 Gauss law

Gauss law for gravitation is

$$\oiint_{\partial V} \langle \vec{g}, dA \rangle = \iiint_V \langle \vec{\nabla}, \vec{g} \rangle dV = -4\pi G \iiint_V \rho dV = -4\pi GM \tag{1.4.1}$$

Here $\vec{g}$ is the gravitational field. G is the gravitational constant. M is the encapsulated mass. The differential form of Gauss law is

$$\langle \vec{\nabla}, \vec{g} \rangle = \langle \vec{\nabla}, \vec{\nabla} \rangle \phi = -4\pi G\rho \tag{1.4.2}$$

$$\vec{g} = -\vec{\nabla}\phi \tag{1.4.3}$$

ϕ is the gravitational potential.

1.4 The spherical pulse response

This paper considers the formulas that compute the gravitational potential from an integral over a distribution of point-like massive objects as incorrect. In physical reality, no point-like objects that own a persistent mass exist. Instead, spherical pulse responses exist that behave as spherical shock fronts and integrate over time into the Green's function of the field that embeds the actuator of the pulse.

The pulse response temporarily deforms the field, and after injecting the volume of the Green's function of the field, the front wipes this volume over the field. Consequently, the deformation quickly fades away. The injected volume persistently expands the field.

The field equations that govern spherical pulse responses are

$$\left(\nabla_r\nabla_r - \left\langle \vec{\nabla},\vec{\nabla}\right\rangle\right)\psi = 4\pi\delta\left(\vec{q}-\vec{q'}\right)\theta\left(\tau \pm \tau'\right) \tag{1.4.4}$$

$$\nabla\nabla^*\psi = \left(\nabla_r\nabla_r + \left\langle \vec{\nabla},\vec{\nabla}\right\rangle\right)\psi = 4\pi\delta\left(\vec{q}-\vec{q'}\right)\theta\left(\tau \pm \tau'\right) \tag{1.4.5}$$

Here $\theta(\tau)$ is a step function and $\delta(\vec{q})$ is an isotropic Dirac pulse.

After the instant τ', the spherical pulse response is described by

$$\psi = \frac{f\left(\left|\vec{q}-\vec{q'}\right| \pm c(\tau-\tau')\vec{n}\right)}{\left|\vec{q}-\vec{q'}\right|} \tag{1.4.6}$$

The normalized vector $\vec{n}$ does not occur in the solutions of the wave equation (1.4.4). The spherical pulse must be recurrently regenerated to obtain a persistent deformation.

The equations (1.4.4) and (1.4.5) also govern one-dimensional pulse responses that behave as one-dimensional shock fronts.

$$\psi = f\left(\left|\vec{q}-\vec{q'}\right| \pm c(\tau-\tau')\vec{n}\right) \tag{1.4.7}$$

One-dimensional shock fronts do not deform the embedding field. During travel, the shape of the front f does not alter. For the one-dimensional shock front also the amplitude does not change. Shock fronts only occur in an odd number of participating dimensions.

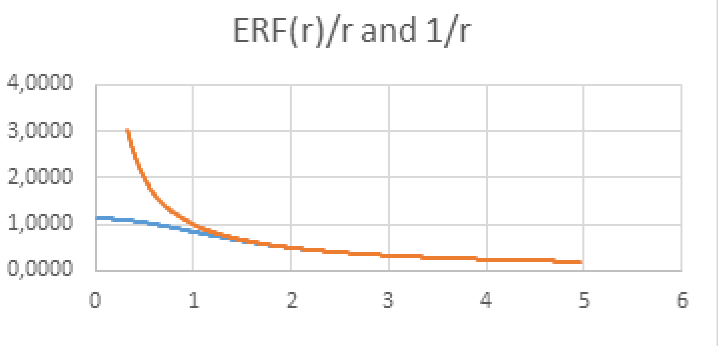
1.5 Pulse location density distribution

It is false to treat a pulse location density distribution as a set of point-like masses as is done in formulas (1.1.1) and (1.1.2). Instead, the gravitational potential follows from the convolution of the location density distribution and the Green's function. This calculation is still not correct, because the exact result depends on the fact that the deformation that is due to a pulse response quickly fades away and the result also depends on the density of the distribution. If these effects can be ignored, then the resulting gravitational potential of a Gaussian density distribution would be given by

$$\phi(r) \approx GM \frac{ERF(r)}{r} \tag{1.5.1}$$

Here $ERF(r)$ is the error function.

Far from the center of this distribution, the shape of the gravitational potential (blue line) looks again like the shape of the Green's function (red line) of the embedding field.



Due to the convolution, and the coherence of the location density distribution, the blue curve does not show any sign of the singularity that is contained in the red curve.

In physical reality, no point-like static mass object exists. The most important lesson of this investigation is that far from the gravitational center of the distribution the deformation of the field is characterized by the gravitation potential

$$\phi(r) \approx \frac{GM}{r} \tag{1.5.2}$$

1.6 Inertia

The condition that for each type of massive object, the gravitational potential is a static function and the condition that in free space, the massive object moves uniformly, establish that inertia rules the dynamics of the situation. These conditions define an artificial quaternionic field that does not change. The real part of the artificial field is represented by the gravitational potential, and the uniform speed of the massive object represents the imaginary (vector) part of the field.

The change of the quaternionic field can be divided into five separate changes that partly can compensate each other.

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.

$$\zeta = \nabla\xi = \nabla_r\xi_r - \left\langle \vec{\nabla}, \vec{\xi} \right\rangle + \vec{\nabla}\xi_r + \nabla_r\vec{\xi} \pm \vec{\nabla}\times\vec{\xi} = 0 \qquad (1.6.1)$$

Thus

$$\zeta_r = \nabla_r\xi_r - \left\langle \vec{\nabla}, \vec{\xi} \right\rangle = 0 \qquad (1.6.2)$$

$$\vec{\zeta} = \vec{\nabla}\xi_r + \nabla_r\vec{\xi} \pm \vec{\nabla}\times\vec{\xi} = 0 \qquad (1.6.3)$$

These formulas can be interpreted independently. For example, the variation in time of ξ_r must equal the divergence of $\vec{\xi}$. The terms that are still eligible for change must together be equal to zero. For our purpose, the curl of the vector field $\vec{\xi}$ is expected to be zero. The resulting terms are

$$\nabla_r\vec{\xi} + \vec{\nabla}\xi_r = 0 \qquad (1.6.4)$$

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. At a large distance r, we approximate this potential by using formula

$$\phi(r) \approx \frac{GM}{r} \tag{1.6.5}$$

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

If this object accelerates, then the new field $\left\{ \frac{GM}{r}, \vec{v} \right\}$ tries to counteract the change of the field $\dot{\vec{v}}$ by compensating this with an equivalent change of the real part $\frac{GM}{r}$ of the new field. According to the equation (1.6.4), this equivalent change is the gradient of the real part of the field.

$$\vec{a} = \dot{\vec{v}} = -\vec{\nabla}\left(\frac{GM}{r}\right) = \frac{GM\,\vec{r}}{|\vec{r}|^3} \tag{1.6.6}$$

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

Thus, if two uniformly moving masses M_1 and M_2 exist in each other's neighborhood, then any disturbance of the situation will cause the gravitational force

$$\vec{F}\left(\vec{r}_1 - \vec{r}_2\right) = M_1\vec{a} = \frac{GM_1M_2\left(\vec{r}_1 - \vec{r}_2\right)}{\left|\vec{r}_1 - \vec{r}_2\right|^3} \tag{1.6.7}$$

The disturbance by the ongoing expansion of the embedding 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.

The artificial field ξ represents the habits of the underlying model that ensures the constancy of the gravitational potential and the uniform floating of the considered massive objects in free space.

Inertia ensures that the third-order differential (the third-order change) of the deformed field is minimized. It does that by varying the speed of the platforms on which the massive objects reside.

1.7 Gravitational potential

A massive object at a large distance acts as a point-like mass. Far from the center of mass, the gravitational potential of a group of massive particles with combined mass M is

$$\phi(r) \approx \frac{GM}{r} \tag{1.7.1}$$

The formula does not indicate that the gravitational potential can cause acceleration for a uniformly moving massive object. However, the gravitational potential is the gravitational potential energy per unit mass. The relation to Newton's law is shown by the following.

The potential ϕ of a unit mass m at a distance r from a point-mass of mass M can be defined as the work W that needs to be done by an external agent to bring the unit mass in from infinity to that point.

$$\phi(\vec{r}) \approx \frac{W}{m} = \frac{1}{m}\int_{\infty}^{\vec{r}} \left\langle \vec{F}, d\vec{r} \right\rangle = \frac{1}{m}\int_{\infty}^{\vec{r}} \left\langle \frac{GmM\,\vec{r}}{|\vec{r}|^3}, d\vec{r} \right\rangle = \frac{GM}{|\vec{r}|} \tag{1.7.2}$$

1.8 Elementary particles

For elementary particles, a private stochastic process generates the hop landing locations of the ongoing hopping path that recurrently forms the same hop landing location density distribution. The characteristic function of the stochastic process ensures that the same location density distribution is generated. This does not mean that the same hop landing location swarm is generated! The squared modulus of the wavefunction of the elementary particle equals the generated location density distribution. This explanation means that all elementary particles and all conglomerates of elementary particles are recurrently regenerated.

2 Mass

2.1 Mass as a deformation strength characteristic

The fact that far from a massive object, the gravitational potential always takes the shape of the Green's function, gives the property mass an extra significance. The amplitude at a distance r can characterize the strength of the deformation that the massive object causes at this distance. Thus, if a compact object is inserted into a continuum, then the deformation by this object is characterized by the amplitude of the gravitational potential $g(r) \approx \frac{GM}{r}$ at a significant distance r. Thus. this amplitude determines the mass M of the object. ***It does not matter what the object is***.

2.2 Black hole

The object can be an encapsulated bubble that is generated by a non-continuous region that is encapsulated by a minimal surface. The surface is also a continuum. Inside the region, field excitations cannot exist. So, field excitations also cannot penetrate or leave the region. The phenomenon can be quite large and is known as a black hole.

In its simplest form, the region has the shape of a sphere. The black hole produces so much deformation and corresponding gravitational potential that one-dimensional shock fronts lose their energy against the gravitational potential energy before these energy packages reach the region. Photons are strings of equidistant one-dimensional shock fronts that obey the Einstein-Planck relation $E = h\nu$. Thus, also, these objects cannot enter or leave a black hole.

If we use the energy-mass equivalence for the energy packages inside the photon, then the energy $E = mc^2$ is spent when this energy equals the gravitational potential energy

$$mc^2 = \frac{GMm}{r} \tag{2.2.1}$$

Thus, the energy of the energy packages is used up at radius r_{bh}

$$r_{bh} \approx \frac{GM}{c^2} \tag{2.2.2}$$

This does not agree with the Schwarzschild radius r_s

$$r_s = \frac{2GM}{c^2} \tag{2.2.3}$$

The encapsulating surface enables new physics because pulse responses behave differently in different numbers of participating dimensions. The direct surround of the region will attract many elementary particles that will cling with their geometric center to the encapsulating surface. This will introduce special conditions and corresponding phenomena. In the base model, elementary particles are represented by separate Hilbert spaces and the embedding field is represented by an eigenspace of an operator in a non-separable Hilbert space. The discrepant black hole region may correspond to a subspace of the underlying vector space that does not own a private version of a number system to sequence the members of that subspace. Therefore, the black hole region does not show a specific symmetry other than what follows from the minimal encapsulating surface condition.

2.2.1 Changing black hole mass

It is not clear what mechanism increases the mass of the black hole. Part of the platform of the elementary particles that cling together at the border of the black hole hovers over the black hole region. The stochastic process that generates the landing locations of the hopping path of the elementary particles also produces these locations inside the black hole region. There these landings cannot generate pulse responses. However, it can add members to the discrete set that locates inside the black hole region. Landing locations outside the black hole region can still produce shock fronts, but these shock fronts cannot enter the black hole region. Like the one-dimensional shock fronts, these fronts are stopped before they reach the border. What happens at the border is unclear. The chance to land at the border is nihil.

2.3 Mass versus volume

The pulses that generate the footprint of elementary particles temporarily deform the embedding field and permanently extend the volume of that field. The pulse causes an increment of the mass of the elementary particle. However, the corresponding deformation quickly fades away and must be recreated to ensure persistent mass. The volume addition is persistent. Thus, here, a temporary increment of mass corresponds to a persistent increment of the volume of the embedding field. An increment of the mass of the black hole corresponds with an increment of the radius of the black hole. The corresponding increment of the volume of the black hole region is much larger than the increase of the volume of the embedding field in the case of the elementary particle. Increasing the volume of the black hole causes an equivalent increase in the volume of the field that embeds the black hole. The mass that is added to the black hole does not quickly fade away.

2.4 Dark matter

The effect of the spherical shock fronts is so tiny that these field excitations cannot be perceived in isolation. For that reason, these phenomena are perfect candidates for what is called dark matter. In the universe, the isolated spherical pulse responses appear as a halo around the visible matter. There they produce the gravitational lensing effects. They add to the mass of the galaxies.

3 Charges

3.1 Symmetry-related charges

Symmetry-related charges only appear at the geometric center of the private parameter space of the separable Hilbert space that acts as the floating platform for an elementary particle. These charges represent sources or sinks for the corresponding symmetry-related field. Since these phenomena disturb the corresponding symmetry-related field in a static way that can be described by the Green's function of the field, the same trick that was used to explain inertia can be used here to explain the attraction or the repel of two symmetry-related charges Q_1 and Q_2.

$$\vec{a} = \dot{\vec{v}} = -\vec{\nabla}\left(\frac{Q}{r}\right) = \frac{Q\,\vec{r}}{|\vec{r}|^3} \tag{3.1.1}$$

$$\vec{F}(\vec{r}_1 - \vec{r}_2) = Q_1\vec{a} = \frac{Q_1 Q_2 (\vec{r}_1 - \vec{r}_2)}{|\vec{r}_1 - \vec{r}_2|^3} \tag{3.1.2}$$

3.2 Color confinement

Some elementary particle types do not possess an isotropic symmetry. Mainstream physics indicates this fact with a corresponding color charge. Spherical pulse responses require an isotropic pulse. Thus, colored elementary particles cannot generate a gravitational potential. They must first cling together into colorless conglomerates before they can manifest as massive objects. Mesons and baryons are the colorless conglomerates that become noticeable as particles that attract other massive particles.

4 Gravitational waves

The term gravitational wave is a misnomer. In fact, the phenomenon that is indicated as a gravitational wave is a superposition of a huge number of spherical shock fronts. This superposition results in a broad front that like the separate spherical shock fronts travels with light speed. The source of this phenomenon can be traced back by reversing the spherical shock fronts at each point where the combined front passes. This means that the passage of the combined front tells the story of the events that happened at the source of the combined front.

If the chirp that was measured by LIGO and Virgo lasted only a few seconds, then this means that the whole combined event at the source only lasted that small period.

If that combined event showed some periodicity, then that periodicity can be traced in the combined front, but otherwise, the combined front is not a finite superposition of waves.

5 The universe

The universe is a dynamic field that acts as our living space, and that via its dynamics reports the story of the objects that reside in this field. Observers perceive via this field. The field is represented by a normal operator in a non-separable quaternionic Hilbert space that acts as a background platform in a mathematical model of physical reality. The field can be represented by a quaternionic function that applies a quaternionic parameter space.

5.1 Before the birth of the universe

Before the birth of the universe, the eigenspaces of the operators that represent the footprint of an elementary particle in the private separable quaternionic Hilbert space of that particle were filled with the complete life story of the particle by defining the hop landing locations of the hopping path as a combination of time-stamps and landing locations. This is done in a special way, such that the hopping path recurrently generates a coherent hop landing location swarm that can be described by a hop landing location density distribution, which equals the squared modulus of the wavefunction of that particle and equals the Fourier transform of the characteristic function of the stochastic process that generates these locations.

This comes down to the fact that the stochastic process can be considered as a spatial Poisson point process that can be interpreted as the combination of a genuine Poisson process and a binomial process. The binomial process is defined by a spatial point spread function. Consequently, the combination of separate Hilbert spaces that act as floating platforms for the elementary particles behaves as a read-only repository for the dynamic geometric data of all elementary particles.

This configuration cares that the gravitational potential of each type of elementary particle always has the same shape, and consequently that particle type always owns the same (rest) mass.

The way that elementary particles get their mass implies that all elementary particles and all their conglomerates must be recurrently regenerated at a high regeneration rate. Thus, the mass of elementary particles is not conserved. Instead, the recurrent regeneration establishes that for each elementary particle type the same mass results. The private stochastic processes are responsible for this fact.

5.2 Birth of the universe

At the birth of the universe, this field was flat, and its spatial part corresponded to the spatial part of the parameter space. At that instant, all time-stamps in the parameter space were equal to zero. At that instant, the stochastic processes that generate the hop landing locations of elementary particles had not done yet any work. Still, the separable quaternionic Hilbert spaces that act as floating platforms for the elementary particle were already floating around. They were already carrying the corresponding symmetry-related charges.The story of the universe can be interpreted as an ongoing embedding of the contents of the eigenspaces of the footprint operators of the elementary particles into the field that represents the universe. This embedding drives the dynamics of the underlying model.

So, directly after the first completed generation cycle of the elementary particles, the universe was sparsely covered by a huge set of footprints of elementary particles that were located widespread over the spatial part of the background parameter space. All these footprints own a characteristic deformation that defines the mass of the corresponding elementary particle. All the floating platforms may contain at their geometric center a source or a sink that represents the electric charge (and the color charge) of the corresponding elementary particle. Thus, after this first cycle, the universe was already filled with a variation of massive objects that may own an electric charge. Only after this phase, the generation of conglomerates can start. So, after a while, atoms and molecules can develop. The charges and masses regulate and stimulate this development.

This story deviates significantly from the Big Bang story.

6 The Higgs

The Higgs particle and the corresponding Higgs field were introduced by physicists because QFT, QED, and QCD could not explain why elementary particles own mass. The Hilbert Book Model applies the spherical pulse responses for this purpose. Thus the HBM does not need the Higgs. The spherical shock front is a field excitation and does not require a special field. No experiment has yet verified that the Higgs field adds mass to other particles. So far, the particle detected by the LHC is a normal conglomerate of elementary particles.

References

[1] The book "A Self-creating Model of Physical Reality" contains details and background for this paper. See:
http://vixra.org/abs/1908.0223 or
https://www.researchgate.net/project/The-Hilbert-Book-Model-Project/update/5d1a51a6cfe4a7968db0a7fd