Gravitation, Matter, and the Expanding Universe

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The Lorenz and Einstein theories are here revisited from the perspective of our present pragmatic knowledge of the universe. The field of gravitation emerges in a chain of Lorenz transformations, while linking the micro cosmos of the particles to the macro cosmos of the Universe. In this context, the precession of the Mercury orbit is reconfirmed as a consequence of the field itself.

The acceleration in the gravitational field is attributed to a flow velocity which covers up a subluminal deficit left by the world-lines in the Lorenz transformations in the direction towards singularities in the gravitational centers.

The nuclear force emerges as a local variety of gravitation in the micro-scales of the particles within the macro-scale of the Universe. In this context a revised Planck length returns a proper mass in the dimension of the nucleon quarks. From this follows also that force balance is achieved in the local fields of the electron. These examples indicate that the universe is functioning in a holographic way.

In the overall picture it seems to be the Arrow of Time which governs the development of the Universe, resulting in a general inflation in time, space and mass, as well as gravitation, while the mass-increase is offset by negative potential energy in the gravitational fields, thus allowing for a still ongoing avalanche creation of the Universe without any requirement for external energy.

1. Relativity in World-lines

Einstein tried initially to describe gravitation with his Special Theory of Relativity, but replaced soon that effort with the concept of a "minimal path" in a curving space-time, rather than describing gravitation by acceleration in terms of an increasing velocity. This led him to his General Theory of Relativity.

In the framework of General Theory of Relativity, many different solutions to gravitation have been proposed, based on different "metrics" for different purposes. The cause and effect of gravitation on the cosmological level has long been an outstanding question, the answer to which is one subject of this presentation.

Einstein was one of the early proponents of the concept of world-lines to describe particle patterns in the time-dimension, since used with various interpretations. In short, a world-line is defined as a time-like curve that maps the path of a particle in the time-dimension. This branch of relativistic physics is more recently described in [2].

In special relativity, or Minkowski space, the speed of light is constant and the world-lines of particles at constant speed relative to each other are straight lines. Special Relativity is a theory of the relativity of physical concepts in the frameworks of objects with a relative linear velocity in respect of each other. This theory is illustrated in Figure 1, where the Lorenz transformation is captured there by the geometry marked ***OBCD***.

If two particles are at rest in respect of each other, their world-lines are parallel. If the particles have a velocity relative to each other, their world-lines will be at an angle to each other. If one of the particles is changing its velocity in respect of the other, its world-line will rotate until the acceleration is completed.

Two world-lines can represent the same object before and after it is accelerated. This is proven by integration of the kinetic energy when the angle α in Fig. 1 changes from 0 to α while the relative velocity changes from 0 to v.

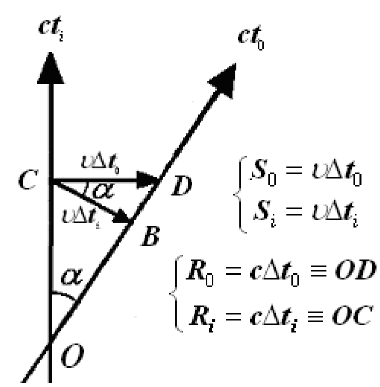

Fig. 1. World-lines

Geometrically, the time required for the acceleration is geometrically $R_0 \equiv OD \equiv c\Delta t_0$ in the system of the stationary observer. The corresponding geometrical time in the accelerating system is $R_i \equiv OC \equiv c\Delta t_i$. The two lines ct_0 and ct_i are the world-lines of the object before and after acceleration.

From the triangle ***OCD*** in Figure 1, the following geometric relations are valid:

$$\sin\alpha = S_0/R_0 \equiv \frac{v \cdot \Delta t_0}{c \cdot \Delta t_0} \equiv v/c \tag{1.1}$$

The same result is valid for the triangle ***OBC***:

$$\sin\alpha = S_i/R_i \equiv \frac{v \cdot \Delta t_i}{c \cdot \Delta t_i} \equiv v/c\ . \tag{1.2}$$

Hence, in both time-systems, the velocity v is the same function of α , therefore generally

$$v = c\sin\alpha \tag{1.3}$$

Einstein's relativistic factor, originating from the Lorenz transformation, with $v/c = \sin\alpha$ results in

$$\gamma = \left(1 - v^2/c^2\right)^{-\frac{1}{2}} \equiv 1/\cos\alpha \,. \qquad (1.4)$$

These relations are all continuous functions and can be used as such for evaluation of a step in velocity congruent with a step in the angle α .

1.1. Kinetic Energy in Special Relativity

The kinetic energy gained by a mass by acceleration, is calculated with the use of the rotating world-line under the assumption of Einstein that the force by which a mass is resisting any change of its momentum is the time-derivate of its momentum.

The momentum of a particle is $P = Mv$. Using the geometrical nomenclature introduced above, the momentum becomes

$$P = M_0\gamma v \equiv M_0 c \sin\alpha/\cos\alpha \equiv M_0 c \cdot tg\alpha \,, \qquad (1.5)$$

from which

$$dP = \left(M_0 c/\cos^2\alpha\right)d\alpha \,. \qquad (1.6)$$

With this, the kinetic energy given to a mass by inertial acceleration becomes:

$$\begin{aligned} E_K &= \int_S F \cdot ds \equiv \int_S \frac{dP}{dt} \cdot ds \equiv \int_{P=0}^{P} \frac{ds}{dt} \cdot dP \equiv M_0 c^2 \int_0^{\alpha} \frac{\sin\alpha}{\cos^2\alpha} \cdot d\alpha \\ &\equiv M_0 c^2 \left[\frac{1}{\cos\alpha}\right]^{\alpha} \equiv M_0 c^2 (\gamma - 1) \end{aligned} \qquad (1.7)$$

Newton’s non-relativistic solution is retrieved approximately when $v \ll c$:

$$E_K = M_0 c^2 (\gamma - 1) \cong \frac{M_0 v^2}{2} \qquad (1.8)$$

1.2. Kinetic energy in the Gravitational Field

When a test-particle is falling freely from “far distance” in a field of gravitation, no external energy is supplied, why the two effects of “falling in the field” and “increasing velocity” cancel out and its total mass relative to “non-falling” observers along the field during the fall is constantly the same:

$$M = \left(M_0 / \gamma\right) \cdot \gamma \equiv M_0 \qquad (1.9)$$

Hence, the total energy of a test-particle is the same all along the “fall”, gradually changing over from a constant rest-mass outside the field to finally all relativistic energy when reaching the velocity c at the interception of an event horizon at a Schwarzschild radius.

If the local rest-mass energy of a test particle is added to the kinetic energy, its total energy becomes:

$$E_K + \left(\frac{M_0}{\gamma}\right)c^2 = M_0 c^2 \,, \qquad (1.10)$$

In trigonometric terms

$$E_K + M_0 c^2 \cos\alpha = M_0 c^2 \,. \qquad (1.11)$$

This is equivalent with:

$$E_K = M_0 c^2 \left(1 - \cos\alpha\right) \qquad (1.12)$$

The geometry of Fig. 2 gives the following relation between $R_S = BD$ and R_0 :

$$R_0 \sin^2\alpha = R_S \qquad (1.13)$$

Substituting ***BD*** with R_S from Figure 2, and using the conjugate rule, the kinetic energy becomes:

$$E_K = \frac{M_0 c^2 \left(1 - \cos\alpha\right)\left(1 + \cos\alpha\right)}{1 + \cos\alpha} \equiv M_0 c^2 \frac{R_S}{R_0 + R_i} \qquad (1.14)$$

At the Schwarzschild radius, the kinetic energy becomes:

$$E_K = M_0 c^2 \,, \qquad (1.15)$$

With the value of $R_S = 2GM_G/c^2$, where ***G*** is Newton's constant and M_G is the gravitating mass, the kinetic energy is:

$$E_K = G\frac{2M_0 M_G}{R_0 + R_i} \qquad (1.16)$$

At larger distances from the center, i.e. $R_0 = R \gg R_S$ the kinetic energy becomes:

$$E_K = G\frac{M_0 M_G}{R} \,, \qquad (1.17)$$

This is Newton's law for kinetic energy in the field of gravitation.

1.3. Gravitation in Special Relativity

In order to calibrate the gravitational field, a "test-particle" will be subject to study while it “falls” in the field from far distance. The test-particle will be assumed to have a rest-mass, which is so much smaller than the gravitating mass that it will not be notably dislocate the center of gravity.

The migration from the Lorenz transformation in Figure 1 to gravitation in the special theory of relativity is done in Figure 2, which includes the additional condition that the distance ***BD*** shall be equal to the Schwarzschild radius (R_S) of the gravitating mass.

From the geometry follows also that the velocity along ***CD*** in the figure is equal to $v = c\sin\alpha$. This gives:

$$v = c\sqrt{\sin^2\alpha} \equiv \sqrt{c^2\frac{R_S}{R_0}} \equiv \sqrt{\frac{2GM_G}{R_0}} \,, \qquad (1.18)$$

Here $R_0 = OD$ is the distance from the center of gravitation to an object at a fixed peripheral distance from the center. In a "fall from infinite distance" in the field of gravitation, v is the escape speed, which will further on be complemented by a flew-velocity directed towards the center of gravitation.

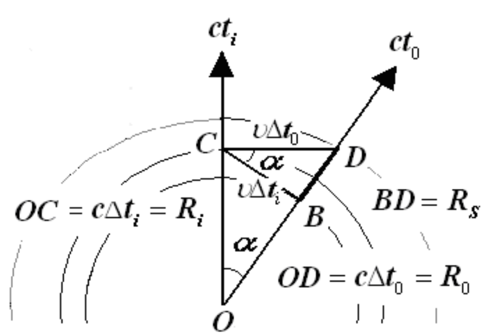

Fig. 2. From world-lines to Special Relativity

This relation leads back to a requirement on the ct_0 -world-line to be quantized in steps of the Schwarzschild radius of the gravitating mass, which can be with a fine structure in terms of the smallest autonomic particle participant in the gravitating mass. The angle between the world-lines will accordingly depend on the distance from the center of gravitation, which is

$$\nu R_S = R_{0,\nu}\,, \tag{1.19}$$

Following which

$$\sin\alpha = \sqrt{R_S / R_0} \equiv \sqrt{1/\nu} \tag{1.20}$$

The world-lines must therefore rotate in respect of each other in a “free fall”, from zero radians at a far distance from the gravitational center to $\alpha = \pi/2$ radians at the theoretical center of gravitation where R_i is equal to zero and R_0 is the Schwarzschild radius. This condition is illustrated in Figure 3.

The quantizing requirement that will map the gravitational field is that ***OD*** is equal to a natural number of Schwarzschild radii. With reference to Figure 3, the quantum condition can be written as:

$$R_0 = \nu \cdot R_S \tag{1.21}$$

ν is a natural number. In regard of the geometry follows now that $\sin^2\alpha = R_S / R_0 = 1/\nu$, which gives the trigonometric relations:

$$\begin{aligned} \sin\alpha &= \sqrt{1/\nu} \\ \cos\alpha &= \sqrt{1-1/\nu} \\ tg\alpha &= \sqrt{1/(\nu-1)} \end{aligned} \tag{1.22}$$

The sequence of Lorenz transformations with the quantum requirements from above will set up the quantized gravitational field, as illustrated in Figure 3. The first transformation in the chain, at the theoretical center of gravitation, has the number $\nu = 1$. All the following transformation cycles have sequential numbers ν that are "natural" numbers, i.e. 1, 2, 3 etc.

At the inner cycle, $\nu = 1$, the distance R_i is a singular point, R_0 is equal to R_S and the angle between the world lines is $\alpha_{\nu=1} = \pi/2$. In the following cycles, the angles between the world lines have $\sin\alpha_\nu = \sqrt{1/\nu}$. Therefore, the world-line of a test-particle in the flow towards the center will be subject to a rotation from the angle α_ν and the position D_ν to the angle $\alpha_{\nu-1}$ and the position $D_{\nu-1}$ while the point B_ν moves to $D_{\nu-1}$ in Figure 3.

The length of the $R_{0,\nu}$ - world-line is $R_{0,\nu} = \nu R_S$. We have

$$\sin\alpha_\nu = \sqrt{1/\nu} \;\text{ and }\; tg\alpha_\nu = \sqrt{1/(\nu-1)}\,. \tag{1.23}$$

Therefore the following handshake is valid between consecutive cycles in the outward direction:

$$\sin\alpha_\nu = tg\alpha_{\nu+1} \tag{1.24}$$

The following pattern was therefore consequently applied in the construction of Figure 3:

$$\sin\alpha_1 = \frac{R_S}{S_{1,2}} = tg\alpha_2\,,\;\; \sin\alpha_2 = \frac{R_S}{S_{2,3}} = tg\alpha_3\,, \tag{1.25}$$

$$\sin\alpha_3 = \frac{R_S}{S_{3,4}} = tg\alpha_4\,,\;\; \sin\alpha_4 = \frac{R_S}{S_{4,5}} = tg\alpha_5\,, \text{ etc.} \tag{1.26}$$

The first cycle, at the gravitational center has $\sin\alpha_1 = 1$ and accordingly $\alpha_1 = \pi/2$. The handshake defines the transformation from one cycle ν, to the next, $\nu + 1$. With this, all the cycles are defined by natural numbers up to the expanding event horizon of the Universe.

The $B_{\nu+1}D_\nu$ circle elements are binding paths between the Lorenz loops, which illustrate a rotation of the field, which is further analyzed and confirmed by the observation of the precession of the planet Mercury's orbit around the sun.

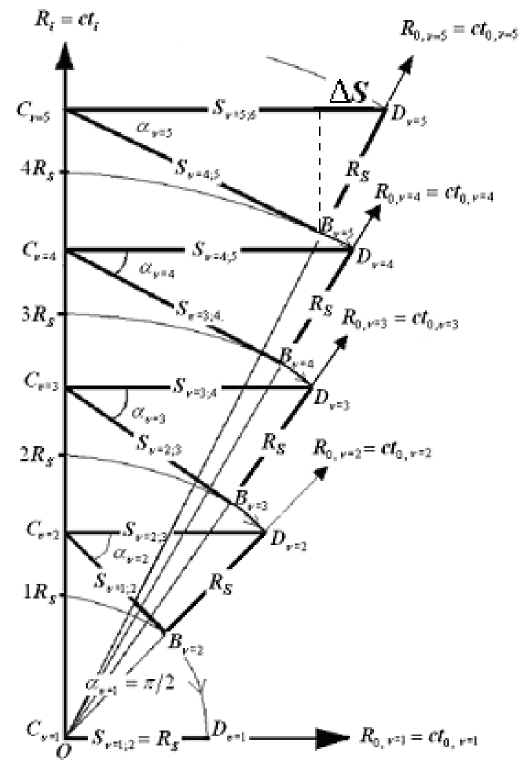

Fig. 3. The sequence of Lorenz transformations in the gravitational field.

2. The Orbital Precession

At distances sufficiently far from the gravitational center, where $R_0 \gg R_S$, the angle α is sufficiently small to be approximated by $\sin\alpha$. At such distances from the center, the horizontal angular precession can with good approximation be given by:

$$\Delta\alpha \approx \sin\alpha_\nu - \sin\alpha_{\nu+1} \approx \frac{1}{2}\sqrt{1/\nu^3} \approx \frac{\sin^3\alpha_\nu}{2} \tag{2.1}$$

This calculation corresponds to the inherent rotation of the angle in the field at the distance $R_{0,\nu}$ from the center in respect of the northern hemisphere. To this comes the simultaneous rotation in respect of the southern hemisphere. The result is a rotation of the field itself, which in the two hemispheres together is $2\Delta\alpha \approx \sin^3\alpha$ radians during the time $\Delta t_0 = R_0 / c$. The precession of the orbit due to the rotation of the gravitational field itself results then in:

$$\Delta\omega_\nu \approx \frac{\sin^3\alpha_\nu}{\Delta t_{0,\nu}} \approx c \cdot \frac{\sin^3\alpha}{R_0} \;\text{rad/s} \tag{2.2}$$

Geometrically from Figure 3, on a sufficient long distance from the center, when $R_0 \gg R_S$, the relation $\sin^3\alpha = \Delta S/R_0$ is found to be approximately valid. On this condition, the angular velocity of the precession can be developed into the same as above.

From this follows that the precession of the orbit is pertinent to the gravitational field and depends on the distance from the gravitational center and the mass of the gravitating object, which is included in R_S. The here described rotation of the gravitational field can be expected to be generally valid either it concerns the rotation of the planets around a star or stars rotating around a galactic center. For example, the distance $R_0 \equiv R_{0,\nu}$ can be the distance from the center of the sun to a planet

2.1. The Mercury Orbit Precession

The angular velocity of the gravitational field around the Sun is calculated below for a comparison with the precession of the planet Mercury's orbit. For the calculations we note that

$$1 \text{ rad/s} \cdot 100 \text{ years} = 6.5047667328 \cdot 10^{14} \text{arcsec} \tag{2.3}$$

The geometric medium of the Mercury orbital radii is $10^{10} \cdot \sqrt{4.6 \cdot 7.0} = 5.67(45) \cdot 10^{10}$ m. This distance is substituted for the distance R_0 above.

The angular perturbation velocity in the field at the geometrical average distance from the Sun to the Mercury orbit is:

$$\Delta\omega \approx \frac{3 \cdot 10^8}{5.6745 \cdot 10^{10}} \left(\frac{2.9505 \cdot 10^3}{5.6745 \cdot 10^{10}} \right)^{3/2} \approx 6.268 \cdot 10^{-14} \text{ rad/s}, \tag{2.4}$$

from which the rotation of the field at that distance from the center over 100 years becomes

$$\Delta\phi \approx 6.5048 \cdot 10^{14} \times 6.268 \cdot 10^{-14} \approx 41 \text{ arcsec}. \tag{2.5}$$

The closeness of the result to the observations is as good as could be expected, considering that the calculation is made approximately, using the geometric average of the distances at perihelion and aphelion. The here calculated excess angular velocity is still in a good agreement with the astronomically observed angular precession of the planet Mercury, as well as with the 42 arcsec, calculated on the base of General Relativity.

3. Matter at the Time-Front of the Universe

The distance to the expanding time-front of the universe can be understood in two complementary ways. On one side, it can be regarded as a sphere, which is expanding in all the directions of space and time from the point of view of every observer point in the universe. On the other side, the time-horizon can be regarded as the frontier of historical time, ending at the present time of every observation point. The radius of the universal time-globe can therefore be defined as the distance to the "event horizon" of the large universe around us, as well as the arrow of time from the creation until present time.

While the conglomerate of all the particles represents all the mass of the universe, their own theoretical Schwarzschild radii will sum up to the radius of the event horizon of the universe, which is also the radius to the expanding time-sphere of the universe.

The proposal that the frontier of the expanding time-sphere of the universe is equivalent with the event horizon of the universe, defined as its Schwarzschild radius, is supported by the following evidence. The mass of the observable universe can be approximately estimated from astronomical observations which indicate a content of about 10^{11} galaxies, each composed of average 10^{11} stars with the average mass a bit larger than our sun's mass of $2 \cdot 10^{30}$ kg, plus some so far less explored mass and energy possibilities and margin for field energies and radiation, which sums up to $\approx 10^{52}$-10^{54} kg. A reasonable assumption for the total mass in the universe is therefore in the order of $\sim 10^{53}$ kg.

The Schwarzschild radius corresponding to a mass of $\sim 10^{53}$ kg is:

$$R_{S,U} = \frac{2GM_U}{c^2} \approx 1.5 \cdot 10^{26} \text{ m} \tag{3.1}$$

The radius corresponds to the result of an expansion of time with the velocity c during about 15.10^9 light years. This is compatible with the Hubble radius, although on the high end of the current estimates. It is within reason to be the age of the universe considering that our solar system with the Earth is already about 4.5 billion years old and the most distant galaxy observed so far with the Hubble telescope is estimated to be more than 13 billion light years away. It must have been preceded by some time for its formation, why 15-16 billion years is a very defendable age of the universe.

This reasoning implies that the radius of the event horizon of the universe is equal to the sum of the theoretical Schwarzschild radii of all of its mass components.

With $R_S = 2GM_P/c^2$, the disc- or sphere-interface to the universal time sphere can be defined as:

$$A = \frac{\Phi_U}{M_U} = \frac{\Phi_P}{M_P} \equiv \frac{2\pi R_U R_S(M_P)}{M_P} = \frac{4\pi R_U G}{c^2}. \tag{3.2}$$

AM_P is the particle's share of the surface of the event horizon of the universe. According to the following investigation, ***A*** will not change during the evolution of the universe, ref. chapter 4.2. Different from ***c*** and ***A***, it is Newton's "constant", which has to be a parameter depending on of the size and age of the universe:

$$G = \frac{Ac^2}{4\pi R_U} \equiv \frac{Ac}{4\pi T_U} \tag{3.3}$$

Here T_U is the age of the universe, which can be represented by the Hubble time. An approximate value of ***A*** can therefore be calculated from an equally approximate value of a Hubble age of the universe of about 15 billion light years and the current value of ***G***. This gives:

$$A = \frac{4\pi G R_H}{c^2} \approx 1.5 \text{ m}^2/\text{kg} \tag{3.4}$$

In the following, ***A*** is calibrated in a number of examples in the macro-cosmos as well as the micro-worlds of the particles.

With the above definition of ***G***, the Schwarzschild radius of an object with mass ***M*** is:

$$R_S = \frac{2GM}{c^2} \equiv \frac{2M}{c^2}\left(\frac{Ac^2}{4\pi R_U}\right) \equiv \frac{AM}{2\pi R_U} \tag{3.5}$$

Hence,

$$AM = 2\pi R_S R_U \tag{3.6}$$

This is also the surface of a polar cap on the extending transfer of the universe. In a local particle system, this equation can also be reformulated to become the time-interface of a spherical configuration:

$$\Phi_P = 2AM_P \equiv 4\pi R_P^2 \equiv 4\pi R_S R_U \tag{3.7}$$

The relation between the surfaces attributed to the particles and the surface of the universe becomes simply the following, summed over all particle mass quanta in the universe:

$$\begin{aligned}\Phi_U &= \sum_\nu \Phi_{P,\nu} = \sum_\nu 2AM_{P,\nu} \equiv \sum_\nu 4\pi R_{P,\nu}^2 \equiv \\ &\equiv \sum_\nu 4\pi R_{S,\nu} R_U \equiv 4\pi R_U \sum_\nu R_{S,\nu} \equiv 4\pi R_U^2\end{aligned} \tag{3.8}$$

The above equation gives for the mass of the universe of $\sim 10^{53}$ ***Kg*** the radius:

$$R_U = \sqrt{AM_U/2\pi} \approx 1.5 \cdot 10^{26}\ \text{m} \tag{3.9}$$

On the micro-scale of the particles, the same value of ***A*** seems also to be valid. For example, for a nucleon, say a proton, with the above given value for ***A*** of $1.5\,\text{m}^2/\text{kg}$ the radius to the mass-time interface becomes:

$$R_{\text{proton}} = \sqrt{\frac{AM_{\text{proton}}}{2\pi}} \cong \sqrt{\frac{1.5 \cdot 1.672 \cdot 10^{-27}}{2\pi}} \cong 2 \cdot 10^{-14}\ \text{m} \tag{3.10}$$

This is a realistic radius for a proton interface at interaction with other particles. Apparently, the scaling works for the micro-worlds of the particles as well as for the universe itself.

Comparing with Figure 3, it should be noted that the square of the line DC at the level of the time-radius to the event horizon of the universe is $S_U^2 = R_U R_S$, while a sphere with this radius has the same surface as the particle interface with the event horizon of the universe.

On the local particle level the so defined sphere is here named the Lorenz Sphere. It connects the micro-scales of the particles with the large scale universe.

4. Mass-Flow in the Time Dimension

4.1. The Flow Density in a World-Tube

As well as the world-line represents the part of a particle through the dimension of time, the transfer of a mass-object in the time dimension can be regarded as a flow of matter-density through its expanded world-line, or its world-tube serving as a "time-tunnel". The flow-density function can be defined from the initial requirement that the mass of the object shall be restored after a certain distance in time, say $R(\Delta t) = c\Delta t$, not including the cosmic expansion of matter. The cross section of the tube, or the mass-time interface, is set to that of a particle polar cap, $\Phi_{Cap} = AM$, equal to (3.6). For ordinary objects this is a very flat surface, which comment would even be valid for the mass of a whole galaxy.

Restoring the mass after a linear time travel in the word-tube of length $R(\Delta t)$ gives that

$$M = AM \cdot \rho \cdot R(\Delta t) \tag{4.1}$$

Here ρ is the average mass-flow density in the tube, which density is:

$$\rho = 1/AR(\Delta t) \tag{4.2}$$

The density approaches infinity when $R(\Delta t) \to 0$, which defines a singularity in the time dimension when the tube length approaches zero, which is at "present time".

For example, the energy of a photon can be expressed in mass-units:

$$E_{\text{photon}} = \frac{hc}{\lambda} \tag{4.3}$$

The cross-section of the photon's world-tube is therefore:

$$\Phi_{\text{tube}} = A \cdot E_{\text{photon}} / c^2 \equiv A\frac{h}{c\lambda} \tag{4.4}$$

Multiplying the cross-section with the wavelength λ results in a quantum volume, uniquely the same for all photons in their own systems:

$$V_{\text{tube}} = \frac{Ah}{c} \tag{4.5}$$

The average density (in mass-units per volume) of this quantum volume in the photon-system is:

$$\rho = \frac{M}{V} \equiv \frac{h/c\lambda}{Ah/c} \equiv \frac{1}{A\lambda} \tag{4.6}$$

This is equal to the density of above. Different configurations of this quantum volume seem to mimic different masses of known elementary particles. This is described in [4, 6, 7].

Because the wavelength λ of a photon is Lorenz-contracted to zero length in the direction of its movement in the system of an observer, the photon density can be argued to become infinite in the perception of the observer system and can therefore also be regarded as a singularity in "present time", as well as was the case for the initially discussed matter flow in a world-tube.

4.2. The Mass of a Gravitating World-Sphere

Figure 8 shows a cut through the diameter of a model of an expanding sphere in the time-dimension. At the distance r from the center of the sphere, the surface $4\pi r^2$ multiplied with dr serves as a differential world-tube with the density modified to

$$\rho = 1/Ar \tag{4.7}$$

The density function has a singular point in the center, where $\rho \to \infty$. This singularity attracts a mass-energy flow through the periphery, while maintaining the density distribution inside. With this the mass of the sphere increases, as well as the volume and the radius from the center to the periphery.

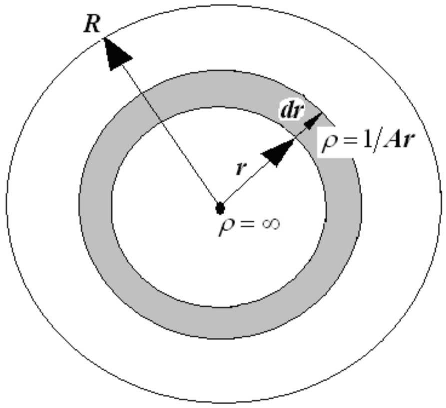

Fig. 4. A diametrical cut through a sphere, marking the density between radii r and $r + dr$.

Integrating from the central singularity to a radius ***R*** the mass of the sphere becomes:

$$M_{sphere} = \int_0^R 4\pi r^2 \rho dr \equiv \int_0^R 4\pi r^2 \frac{1}{Ar} dr = 2\pi R^2 / A \tag{4.8}$$

This gives $AM_{sphere} = 2\pi R^2$ for the sphere, while the surface is $4\pi R^2 = 2AM_{sphere}$. This reflects back to the initial discussion in chapter 3 on the distribution of surface to the particle mass quanta of the universe. This example is in particular valid for the universe itself, as well as the Lorenz sphere (3.7), as a local space for a particle.

From the equation above, the mass of an expanding particle is $AM = 2\pi R_S R_U$. For a spherical universe or a Lorenz sphere the geometry gives $AM = 2\pi R^2$.

If the expansion of the radius goes with a velocity *c*, and the age of the sphere is *T* = *R/c*, the expansion rate of the mass of the sphere is:

$$\frac{dM}{dt} = \frac{2}{T_U} M \tag{4.9}$$

With reference to Eq. (3.7), all particles shall share the time-sphere of the universe in proportion to their masses. In absolute terms, this sharing is done by the constant ***A*** multiplied with the individual particle mass, which defines the particle's share of interface with the universal time. Consequently, each particle mass will expand in proportion to the expansion of the mass of the universe. In conclusion, the mass-dimension of the universe expands generally with the rate as shown in Eq. (4.9).

This relation goes "hand-in-hand" with the general expansion of distances discovered by Edwin Hubble, who announced already in 1929 that almost all galaxies appeared to be moving away from us. His discovery leads to the discovery of a general expansion of the length dimension in the universe, which can be expressed as follows:

$$\frac{dR}{dt} = \frac{1}{T_U} R \tag{4.10}$$

5. The Flow Model for Gravitation

5.1. The World-Lines of the Flow

The world-lines in the Lorenz-transformation, illustrated by ct_i and ct_0 in Figures 2 and 3 are both defined as lines in the dimension of time. According to the Minkowski space-time geometry, they should be perpendicular to the dimensions of space, which is also a characteristic of Figure 2, because the lines ***CD'*** and ***CB'***, which are space lines, are drawn perpendicular to the two world-lines in the figure, to respect the separation between the dimensions of space and time. But the logic of doing this is not consequent, because one of the world-lines, here ct_0 , is for the purpose of gravitation normally assumed to be coinciding with the dimension of space, more precisely with the distance from a "non-falling" periphery to the center of gravitation.

In a relativistic perspective, the roles of the lines would be exchanged when judged by a an observer co-moving with the flow towards the center, which would change the ct_i -line to be his ct_0 -line along the distance to the center, while the fixed ct_0 -line would be Lorenz contracted in his system to become his ct_i -line. Therefore, the physical roles of the flow and the stationary space are of an interactive nature, both participating as distances in space and time.

For simplicity in the continued reasoning, the center of the gravitation in a field is here treated as a one particle center with one inherent singularity, while the geometry of the field is that is the sequence of Lorenz transformations illustrated in Figure 3. The ct_0 -line is therefore defined as a sequence of equal packets of length, whereas $R_0 = \nu R_S$.

The angle between the world-lines will open up more, the closer they are to the center. The accelerating object is the space between the peripheries DD' and BB' in Figure 5. The geometry of the chain of successive Lorenz transformations is shown in Figure 3, where also the effect of the increasing angle between the world-lines is incorporated. Due to the rotation of the ct_0 -world-line with the space in the field, the length-quanta R_S will just click into each other in a seamless sequence of Lorenz transformations, all to the center.

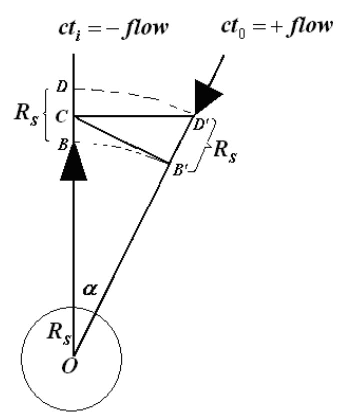

Fig. 5. Energy flows from and to a particle singularity

5.2. Processing the Flow through Lorenz Transformations

In the process of each Lorenz transformation, with reference to Figure 3, a flow of negative energy is streaming outwards through the periphery at the distance OB from the center of gravitation, while a counter-flow of positive energy is streaming inwards through the periphery at the distance ***OD*** from the center. The density function is that of the expanding sphere in Figure 4, i.e. a function of the distance from each singularity in the gravitating mass. The flow-densities are therefore: $\rho_B = 1/AR_B$ at periphery ***B*** and $\rho_0 = 1/AR_0$ at periphery ***D***. This results in the following mass-equivalent energy residue in the direction of the gravitating mass, M_G:

$$\begin{aligned}\Psi(M) &= 4\pi R_0^2 \rho_0 c - 4\pi R_B^2 \rho_B c \\ &\equiv 4\pi c\left(R_0^2 \frac{1}{AR_0} - R_B^2 \frac{1}{AR_B}\right) \\ &\equiv \frac{4\pi c}{A} R_S(M_G)\end{aligned} \tag{5.1}$$

This difference flow is the same at all distances from the center. Because of the linearity in the gravitating mass, the flow can be added from all the participating particles to embrace the total gravitating mass.

With reference to Figure 3, this flow is transported within the periphery interval $DD' - BB'$ by a sub-luminal flow, here named $\Delta\upsilon_f$, which bridges the deficit of space and time between the world-lines. In each Lorenz cycle, this deficit sums up to one Schwarzschild radius of the gravitating mass along the ct_0-line, as shown here in Figure 6.

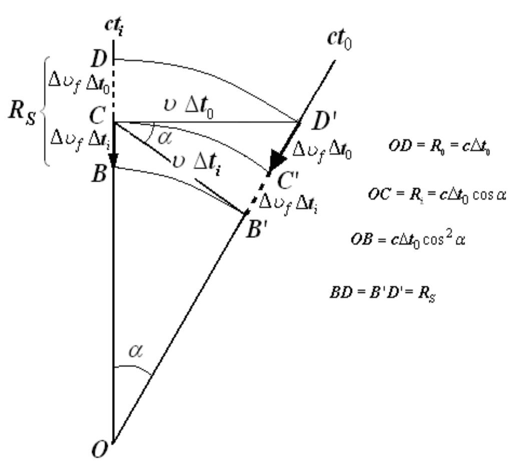

Fig. 6. The resulting gravitational flow in a Lorentz cycle of the field.

The displacement of the space from a periphery at DD' to a periphery at CC' is equivalent with a transport of the therein residing mass-equivalent energy of the flow:

$$\Psi_{DD'} = 4\pi R_0^2 \rho_0 \Delta\upsilon_f \equiv \frac{4\pi R_0 \Delta\upsilon_f}{A} \tag{5.2}$$

The simultaneous parallel displacement from a periphery at CC' to BB' gives the complement:

$$\Psi_{CC'} = 4\pi R_i^2 \rho_i \Delta\upsilon_f \equiv \frac{4\pi R_i \Delta\upsilon_f}{A} \tag{5.3}$$

Summing up these two flows gives the total mass-equivalent energy flow:

$$\Psi(M) = \Psi_{DD'} + \Psi_{CC'} \equiv \frac{4\pi}{A}\Delta\upsilon_f\left(R_0 + R_i\right) \tag{5.4}$$

This means that the space displaces with the flow along the ct_0-line from the periphery at ***DD'*** to the periphery at ***CC'***, simultaneously with the displacement of the space with the flow along the ct_i-line from the periphery at ***CC'*** to the periphery at ***BB'***, resulting in the flow originating from the periphery at ***DD'*** to arrive to the periphery at ***BB'*** simultaneously with that originating from ***CC'***.

This compacted flow shall be equal to that of (5.1) above, which gives the equation:

$$\frac{4\pi c}{A} R_S(M_G) = \frac{4\pi}{A}\Delta\upsilon_f\left(R_0 + R_i\right) \tag{5.5}$$

This results in the local flow velocity:

$$\Delta\upsilon_f = -c\frac{R_S(M_G)}{R_0 + R_i} \tag{5.6}$$

This can be further developed with (1.13); $R_0 \sin^2\alpha = R_S$ to:

$$\Delta\upsilon_f = -c\frac{R_S / R_0}{1+\cos\alpha} \equiv -c\frac{\sin^2\alpha}{1+\cos\alpha} \equiv -c\left(1-\cos\alpha\right) \tag{5.7}$$

This solution for the difference flow velocity corresponds to the timely difference between the peripheries at ***DD'*** and ***CC'*** which is:

$$\Delta R = c\Delta t_i - c\Delta t_0 \equiv -c\Delta t_0\left(1-\cos\alpha\right) \tag{5.8}$$

This difference shall be overcome in the time Δt_0, which is the timely distance to the center of gravitation, while the bridging velocity becomes identical with $\Delta\upsilon_f$:

$$\frac{\Delta R}{\Delta t_0} \equiv -c\left(1-\cos\alpha\right) \tag{5.9}$$

This clarifies the role of $\Delta\upsilon_f$ as the parametric flow velocity within the Lorenz cycles, which is directed towards the center of gravitation.

With the flow velocity $\Delta\upsilon_f = c\left(1-\cos\alpha\right)$ and (1.12), the kinetic energy can be written:

$$E_K = M_0 c\upsilon_f \tag{5.10}$$

In each cycle the Schwarzschild radius can be expressed as:

$$R_S = \Delta\upsilon_f\left(\Delta t_0 + \Delta t_i\right), \tag{5.11}$$

This results in the acceleration of the flow:

$$a_f = -\frac{\Delta\upsilon_f}{\Delta t_0} \equiv -\frac{c^2}{R_0}\frac{R_S}{\left(R_0 + R_i\right)} \tag{5.12}$$

This can also be expressed trigonometrically as:

$$a_f = -\frac{c^2}{R_0}\frac{R_S}{\left(R_0 + R_i\right)} \equiv -\frac{c^2}{R_0}\left(1-\cos\alpha\right) \tag{5.13}$$

This acceleration gives the parametric acceleration expressed in Newton's constant ***G*** and the gravitating mass M_G:

$$a_f = -\frac{\Delta\upsilon_f}{\Delta t_0} \equiv -\frac{c^2}{R_0}\frac{2GM_G}{\left(R_0 + R_i\right)} \tag{5.14}$$

At a distance much larger than the Schwarzschild radius, where $R_0 \cong R_i \cong R \gg R_S$, the acceleration becomes Newton's acceleration in the field:

$$a_f = -\frac{2GM_G}{R_0\left(R_0 + R_i\right)} \Rightarrow -\frac{GM_G}{R^2} \tag{5.15}$$

At the distance of the Schwarzschild radius from the center, the acceleration becomes:

$$a_f = -\frac{2GM_G}{R_0\left(R_0 + R_i\right)} \Rightarrow -\frac{2GM_G}{R_S^2} \equiv -\frac{c^2}{R_S} \tag{5.16}$$

This is a suitable acceleration for the event horizon of a "black hole", because it can serve as the centripetal acceleration required to keep a relativistic flow in a circular orbit at the Schwarzschild radius from the center. It agrees also with the kinetic energy from earlier), which confirms that the negative energy potential in the gravitational field of the universe corresponds to $-mc^2$ for each particle mass due to its attachment to the event horizon of the universe.

5.3. The Value of the Gravitational Flow

The gravitational flow towards a gravitating mass particle, M_G, is assumed to origin from the singularities inherent to each gravitating particle, as described in the preceding Chapter 3.2 on the flow-model as well as in the preceding chapters 4.4 and 4.5 on the world-tube and the world-sphere. From Eq. (5.1), the flow towards a particle singularity, transferred invariantly trough all the Lorenz transformations is:

$$\Psi \equiv \frac{4\pi c}{A} R_S(M_G) \equiv \frac{4\pi c}{A} \cdot \frac{2GM_G}{c^2} \equiv \frac{8\pi M_G}{Ac} \cdot G \tag{5.17}$$

To this comes Newton's ***G*** as a function of the age of The Universe:

$$G = \frac{Ac}{4\pi T_U} \tag{5.18}$$

Together, these two equations give the flow absorbed by the gravitating mass as:

$$\Psi_v(M) \equiv \frac{8\pi M_G}{Ac} \cdot \frac{Ac}{4\pi T_U} \equiv \frac{2}{T_U} M_G \approx 2H_0 M_G \tag{5.19}$$

This reflects a general inflation of mass on the cosmic time-scale.

The age of the universe, here given as T_U, is assumed to be approximately 16 billion years. With this age, all matter is absorbing mass-equivalent energy per Kg at the present rate of:

$$\frac{dM}{dt} = \frac{2}{T_U} M \approx 2H_0 M \approx 3{,}4 \cdot 10^{-18} \text{ kg/s} \tag{5.20}$$

On the level of our planet Earth, this is concurrent with an absorption rate of 20 million kg/s, which should be enough to explain all observed disturbances of different kinds, such as volcanic activities, tsunamis, etc.

The result looks even more important when mass is exchanged to energy with the exchange rate c^2, which gives the absorption rate of ~ 0.3 W/kg.

On the positive side, if it was possible to divert only a small fraction of the energy flow absorbed by the Earth via facilities that could use the accessible energy before it is absorbed by the Earth, all human energy requirements would be satisfied for all foreseeable future.

6. Mass and Forces at the Frontier of Time

Although the focus of this document is on gravitation, the fundamental importance of mass for gravitation cannot be ignored. The here developed theory for gravitation embraces also the origin of mass. The theoretical identification of important particle masses and the nuclear force serves therefore as a verification of the here presented theory of gravitation.

A good background to this chapter on particle mass at the frontier of time is to the presentation on the Speed of light by Narendra Katar [22], where many essential questions are made and answered.

In the holographic micro universes of the particles, the nuclear and gravitational forces are unified at a modified Planck length. As a result a feasible Planck mass has been found, which appears to be of key importance for the nucleon group and the electron. The transformation from gravitation to the nuclear force in the particle space explains also how the electrical charge is harnessed by its own mass. In the Lorenz transformations, basic quantum rules are found, which provide keys to the fine structure constant and a relation between the masses of the electron and the proton.

6.1. The Planck Mass Revisited

In the string theory, the Planck length has been the starting point, or rather length, in the efforts to find resonances, which can represent the spectra of elementary particles. This theory can, about others, be read more about in the comprehensible book, **The Fabric of the Cosmos** [10], in the literature list.

The Planck length is assumed to emerge when the wavelength of an electromagnetic quantum is equal to the Schwarzschild radius of a particle with the energy of the same quantum. This is expressed by the following equation system:

$$\begin{cases} R_{Pl} = 2GM/c^2 \\ M = h/cR_{Pl} \end{cases} \tag{6.1}$$

This gives the classical Planck length:

$$R_{Pl} = \sqrt{2Gh/c^3} \cong 5.722 \cdot 10^{-35} \text{ m} \tag{6.2}$$

Would this length be used as the wavelength of an electromagnetic quantum, the resulting mass would be in the order of

$$M_{Pl} = \frac{h}{cR_{Pl}} \approx 3.86 \cdot 10^{-8} \text{ kg} \tag{6.3}$$

This mass is about 10^{20} times larger than the mass of a typical nuclear particle - very far from any observed particles. This has led the String Theory to follow a path where the Planck length is assumed to be a "super string", and the cross-sections of particle world-tubes are "branes" with a number of hidden dimensions.

However, there is another solution for the Planck length and mass, as follows.

6.2. The Modified Planck Length - A Link to the Nucleon Masses

In this solution, Newton's "constant" is substituted by Eq. (3.3), here repeated:

$$G = Ac^2/4\pi R_U ,$$

Following this equation, Newton's constant is not a constant in the cosmological time-perspective. As well as G is expected to depend of the timely radius of the universe, we may assume that it will also adapt to the micro-size of a particle space, say as a fraction of a hologram of the universe. Therefore, we replace the radius of the universe, R_U, with the so far not yet evaluated distance R_X, which stands for the modified Planck length, and leaves to Nature to solve the equation for the length dimension in the micro particle system. This gives the equation:

$$R_X = \left(\frac{2 \cdot Ac^2/4\pi R_X \cdot h}{c^3} \right)^{\frac{1}{2}} \tag{6.4}$$

The result is:

$$\frac{2\pi R_X^2}{A} = \frac{h}{cR_X} \tag{6.5}$$

Applying Eq. (3.7) to this results in

$$AM_X \equiv 2\pi R_X^2 = A\frac{h}{cR_X} \tag{6.6}$$

This gives the radius:

$$R_X = \sqrt[3]{\frac{A\hbar}{c}} \approx 0.8 \cdot 10^{-14} \text{ m} \tag{6.7}$$

and the mass becomes:

$$M_X = \frac{h}{cR_X} \equiv 2\pi \cdot \sqrt[3]{\frac{1}{A} \cdot \left(\frac{\hbar}{c}\right)^2} \approx 2.7 \cdot 10^{-28} \text{ kg} \tag{6.8}$$

The value of the constant A was approximated to $A \approx 1.5\ \text{m}^2/\text{kg}$ in Eq. (3.4). The mass M_X falls therewith in the mainstream of the elementary particle masses. Its nearest hit is approximately one sixth of a nucleon mass, which is $\approx 2.8 \cdot 10^{-28}$ kg. Because of its photon-like origin, it may be considered as a vector-component in a rest-mass quantum system.

The concept of a rest-mass may initially require oscillations in three dimensions. This would require the ensemble of six wave-components, one each for the ± X, ±Y, and ±Z directions. With A calibrated to $\approx 1.42\,\text{m}^2/\text{kg}$, which assumes the age of the universe to be rather 16 than 15 billion years, the assembly of six times M_X becomes a typical nucleon mass:

$$M_Y = 6 \cdot M_X \equiv 6 \cdot 2\pi \sqrt[3]{\frac{1}{A}\left(\frac{\hbar}{c}\right)^2} \approx 1.67 \cdot 10^{-27} \text{ kg} \tag{6.9}$$

It can be hypothesized that the nucleon masses are created out of mass described as M_Y above, before the final masses of the nucleons find their quantum structures. The initial Planck mass, M_Y, may therefore be the source to feed nucleon's with mass on their way to become organized in quantum conditions, with some minor modifications to their masses as result. The quantum relations can be derived from the initial structure of the successive Lorenz-transformations which seem to be important for the nucleons and their quantum quark structures. On these bases, the Compton wavelength of the electron and the fine structure constant can be derived. This is further defined in a more extensive document still to be published

According to Eq. (5.16), the gravitational acceleration at the Schwarzschild radius towards the centre of gravity of a gravitating mass M_G is:

$$a_f \to -\frac{2GM_G}{R_S^2} \equiv -\frac{c^2}{R_S} \tag{6.10}$$

In a local particle system, Eq. (3.7) can be applied, which gives $R_U R_S = R_P^2$. The integrated force applicable to the modified Planck mass becomes:

$$-F = \frac{M_P c^2}{R_P} \equiv \frac{AM_P c^2}{AR_P} \equiv \frac{2\pi R_P c^2}{A} \approx 3.2 \text{ kN} \tag{6.11}$$

This results in the following pressure on the surface $T_P = 4\pi R_P^2$:

$$P = -\frac{2\pi R_P c^2}{AT} = \frac{c^2}{2AR_P} \approx -4 \cdot 10^{30} \text{ Pa} \tag{6.12}$$

Presumably, the breaking of the quantum conditions for a particle will lead to its destruction and decay in radiation and other quantum structures. Therefore, the distance over which the force will act is likely to be very short.

The magnitude of the force, its linear increase with the radius and short range of action are all indications of the nuclear force.

6.3. The Electron Mass

With the same reasoning as of above, the mass of the electron can be defined at the equilibrium of the pressures from the electrical charge (expanding) and the mass (nuclear-contracting) resulting in:

$$\frac{\mu\mu_0 e^2 c^2}{4\pi R_P^2} - \frac{2\pi R_{Cl} c^2}{A} = 0 \tag{6.13}$$

This gives the relation:

$$A\mu\mu_0 e^2 = 8\pi^2 R_P^2 R_{cl} \tag{6.14}$$

With the use of Eq. (3.7) with the classical radius in the place of the distance to the time-frontier of the universe in the electron system, we get

$$R_{Cl} R_S = R_P^2 \tag{6.15}$$

Setting $R_{Cl} = 2\pi R_P$ and $R_S = R_P / 2\pi$ the mass becomes tuned in the spirit of Maxwell to that of the electron:

$$M_e = \frac{1}{4\pi} \sqrt[3]{\frac{2\left(\mu\mu_0 e^2\right)^2}{A}} = 0.91093 \cdot 10^{-30} \text{ kg} \tag{6.16}$$

The factor μ fine-tunes the electron mass for the electromagnetic permeability in the electron's own electromagnetic field and mass environment. For example, if $\mu = 1$ in the electron system, the estimate of A= 1.3874 gives the correct electronic mass. With the combination instead of $\mu \approx 1.00852$ and $A = 1.41103\ \text{m}^2/\text{kg}$, the electron mass is still the same as of above, while the revised Planck mass M_X from Eq. (6.8) becomes more exactly 1/6 of the neutron mass. This leads to $A \approx 1.40\ \mathrm{m}^2/\mathrm{kg}$ as a good approximation, while Newton's G in Eq. (3.3) gives the age of the universe to be ≈ 16 billion years.

References [4, 6, 7] contain various topological models for particle masses and resonances.

The further geometric interpretations of the above equations are open for future research. An interesting trace is the relation between the Compton wave of the electron and the Fine Structure Constant, in agreement with [1] which are connected by quantum numbers from the Lorenz transformations near the particle singularity, still to be published in the foreseen follow-up edition of this paper.

7. Conclusion

The evolution of the universe seems to be guided by the arrow of time, leading to its ever expanding event horizon. In retrospect, it looks so simple that even a small particle will know how to move and act in space. Still, we are only increasing our frontier to the unknown by enlarging our knowledge? Even if this is the end of my report, I hope that others will make use of it in their efforts to research and understand our universe.

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