Propelling phenomenon revealed by electric discharges into layered Y123 superconducting ceramics

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Reproduced Abstract :
Electric discharges of several megawatts were applied, at 77 K, to a Y123 superconducting ceramic having two layers of different critical temperatures (50K and 90K). During the discharges, the ceramic was pushed in the direction opposed to the electron flow. The ceramic was apparently propelled by its emission of a momentum-bearing flux of an unknown nature. This flux weakly accelerated distant irradiated matter and created several physical effects not yet reported. The emitted beam had no electric charge, and travelled through materials without apparent absorption or dispersion, at a speed larger than 1% the speed of light. The kinetic energy transferred by the propelling momentum of the ceramic to an external mass, was proportional to the square of the electric energy of the discharge. We could increase the energy of the mechanical output to a value close to the energy of the electric discharge during several microseconds. No artefactual effects were found which could explain these phenomena. We conclude that the propelling energy could not come from the energy of the electric discharges and that its source is still unknown.

Links to Content

Video movies of six discharges (to be seen with QuickTime Player or equivalent)

Annex 0 — Our hypotheses about the role of the specific ceramic (C. POHER)
Annex I — The Universons theory (C. POHER)
Annex II — Other confirmations of the Universons theory (C. POHER)
Annex III — Universons and de Broglie Double Solution (C. POHER & P. MARQUET)
Annex IV — Compatibility with General Relativity (P. MARQUET)
Video movies of six discharges
(Four in a layered ceramic, Two in a normal conductor)
(Two options)

The movie is 7.7 Mb long in .mov format and 14.2 Mb long in .avi format, therefore it takes some time to load. It shows six discharges experiments recorded by the same camera, situated at the same distance of three meters from the horizontal pendulum, but with a different objective field of view in the two last discharges.

These movies have a much higher resolution than the one available on www.epjap.org.

The four first discharges are made into a layered ceramic, bathing in liquid nitrogen. The corresponding discharge voltages are successively 822, 915, 1010, 1152 Volts. Therefore, the momentum transferred to the long horizontal pendulum increases as the square of the discharge voltage. The “schlack“ sound recorded by the video camera microphone is heard during these four discharges, and the momentum electronic detector light (left side) is triggered.

By looking carefully at these movies, one image at a time, during the very beginning of all the four discharges in layered ceramic, the light emitted inside the cryostat is visible during one single compressed image.

The two last discharges (999 and 1002 Volts) are made into an aluminum cylinder of the same size as the ceramic. This conductor cylinder is also bathing in liquid nitrogen. These two last discharges were made with our first experimental system, using the short (more sensitive) horizontal pendulum. No “schlack“ sound is heard during these two discharges, the horizontal pendulum does not move, and the electronic momentum electronic detector is not triggered.

Please click here to load and see the QuickTime Player movie

Please click here to load and see the .avi format movie
SUPPLEMENTARY ANNEX 0

HYPOTHETIC ROLE OF
THE SPECIFIC CERAMIC
IN OUR EXPERIMENTS

Claude POHER

We propose the following hypotheses, based on the Universons model (Annex 1), in order to explain the experimental facts we reported.

The propelling flux appears simply to be an anisotropic flux of Universons created by the strong acceleration of electrons, inside the ceramic cylinder. This flux is theoretically emitted in the direction of the electrons acceleration, and its intensity is the vectorial sum of the intensities of the fluxes emitted by each individual accelerated electron.

The flux bears a momentum transferred to it by the accelerated electrons inside the ceramic cylinder during Universons re-emission. This momentum moves up the ceramic, because the electrons are tied to it by the strong electromagnetic field of atomic nuclei, and the horizontal pendulum is ejected up.

The emitted flux is not absorbed by matter, because the value of the capture time $\tau$ of the Universons is quite small ($7.8 \times 10^{-14} \text{s} \pm 10\%$).

The anisotropic flux accelerates irradiated matter, because the momentum transferred to matter is anisotropic, and proportional to the number of captured Universons, which is proportional to the mass of matter. Thus, the pushing force is proportional to the mass of matter. This is an acceleration.

The acceleration should theoretically be the same for any kind of matter, and it should also be the same for the electrons of this matter. This is effectively what is observed experimentally.

All the effects we observed experimentally were predicted by the Universons model.

Why is a specific ceramic necessary to create the propelling flux?

When an electric field is applied to a conductor, free electrons jump from atom to atom, moving relatively slowly towards the positive end of the conductor. During each jump, electrons are submitted to the low average electric field existing inside the conductor, and they are also submitted to the strong electric field of the atomic nuclei. So electrons are successively accelerated and decelerated. Their average speed is constant, and none average macroscopic anisotropic Universons flux is emitted by the electrons in a conductor. The anisotropic emission exists only when electrons are accelerated.

Therefore, theoretically, a conductor cannot emit an anisotropic Universons flux.

That is experimentally confirmed.

In grains of the superconductive layer of our specific ceramic, free electrons move by Cooper’s pairs, inside vacuum “tunnels” (Fig. 1).

The theory of high temperature superconductivity is not yet completely clear, however, for our purpose we can use the BCS theory because it seems to explain what we observe.
According to BCS theory of superconduction, the arrival of the first electron attracts the atomic nuclei in a direction perpendicular to the displacement of the electron. Then the second electron is accelerated by the atomic nuclei electric field. There is a quantum exchange of phonons between the two electrons of the Cooper’s pair, via crystal lattice vibrations.

The result is a nil electric resistance.

That phenomenon can only exist in superconducting crystals.

Moreover, thanks to the very high value of the charge to mass ratio of electrons (176 billions), there is a very high acceleration of an electron by a modest electric field, in vacuum.

However, the electric field is nil inside the superconducting material. Therefore, a ceramic made of only one superconductor material layer cannot theoretically emit an anisotropic flux of Universons.

That is experimentally confirmed.

In our specific ceramic, there are two different materials, with a similar chemical composition and different superconductive critical temperatures. When immersed in liquid nitrogen, one layer is conductive, the other layer is superconductive. Between these two layers is “the thin transition zone $Z_t$” made of two different composition grains in contact, and the joint between them. Grains of that transition layer have a 10 to 20 microns average size (Fig. 2).

In our plain ceramics, the transition layer contains about 1 million grains of each kind, with randomly oriented axes. There are statistically 0.586 % of these grains with axes aligned within less than 7° from the electrons flow.

Thus there are about 5860 grains of the transition layer, where the longitudinal “vacuum tunnels” of the grains are aligned as shown by Fig. 1 within $\pm 7^\circ$ of the average electric field.

When electrons Cooper’s pairs are moving along these vacuum tunnels, the electrical resistance is nil.

The strongest electric field exists at the joints between conductive and superconductive grains. For example, during a 2900 volts discharge, there is an average electric field along a 15 microns conductive grain of the order of 250 V/m, while the electric field at a 0.1 micron width joint is about 3.6 millions V/m. The higher electric field accelerates the electrons 14000 times more in the joints than in the conductive grains.

The joint electric field of 3.6 millions V/m does no stop abruptly at the joint boundary, it spreads largely inside the adjacent superconductive grain.

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**Fig. 1** — Alignment of atoms inside a superconducting grain, in the transition layer. When electrons Cooper’s pairs move along the vacuum tunnels, atomic nuclei vibrate perpendicularly to the electrons direction of movement. This is the BCS theory of superconductivity.
This fact is crucial. So, electrons are successively accelerated very strongly inside joints space and also inside superconductive grains boundaries, where there are no obstacles and relatively long vacuum tunnels.

These highly accelerated electrons emit the anisotropic flux of Universons of the ceramic cylinder. Moreover, the anisotropic flux is then able to accelerate itself the electrons Cooper’s pairs in the roughly aligned grains of the superconductive layer of the ceramic, without any electric field. There is an auto-amplification of the emitted flux intensity.

This hypothesis is supported by the experimental ceramic radiance diagram.

During a 3000 amperes discharge, where 75% of the stored energy is flowing in 12 microseconds, electrons move about 1,2 nm in copper bars, and less than that inside the ceramic cylinder, where the current density is lower. Therefore, the behaviour of electrons, inside the transition layer of about 30 microns total width, dominates the macroscopic effect.

Electrons acceleration $A$ by an electric field $E = 3.6 \times 10^6$ V/m is given by expression (1) where $e$ is the electron charge and $m$ the electron mass:

$$A = e \frac{E}{m} = 6.3 \times 10^{17} \text{ m/s}^2$$  

(1)

That is a very high acceleration. Moreover, there are $2.17 \times 10^{14}$ electrons per square millimeter, in a 3000 amperes current, therefore even if only 0.59% of them are accelerated along the vacuum tunnels of the superconducting grains, that creates a quite strong anisotropic flux of Universons.

The flux intensity $\Phi$ emitted by a discharge voltage $U$ in a circuit of resistance $R$ is given theoretically by expression (2), where $D$ is the average distance where voltage $U$ is applied:

$$\Phi = \frac{U^2 c}{(2RD)Eu}$$  

(2)

This flux, emitted during an average duration of 12 microseconds should theoretically bear a total kinetic impulse $P$ given by expression (3), as each Universon has an $Eu / c$ momentum:

$$P = 12 \times 10^{-6} \frac{U^2}{(2RD)}$$  

(3)

Our experiments confirm that the auto-propulsive momentum $P$ is effectively proportional to the square of the discharge voltage $U$, as predicted by expression (3).

And according to (3), the intensity and direction of $P$ should not change when the voltage $U$ is reversed. This is also experimentally confirmed.

These hypotheses are supported by the behaviour of thin films emitters where exists only the transition zone Zt.
SUPPLEMENTARY ANNEX I

THE UNIVERSONS MODEL

Claude POHER

We propose the following hypothetic model, based on special Relativity, in order to try explaining the experimental facts we reported here.

Several authors have proposed, since long, models where an isotropic flux of fast moving particles travel in the Universe and interact with matter. One of the first to have built such a model was the Swiss physicist Georges-Louis Lesage in 1758.

However these models are not acceptable mostly because the interaction of the moving particles with matter was supposed to be an elastic collision. Effectively, with such a collision, the Inertia principle of Newton would not exist.

Therefore, the interaction of our hypothetic Universons with elementary particles of matter cannot be a classical collision, such as in the Compton effect for example.

A different kind of interaction should be supposed.

This interaction must be closer to an absorption followed by a re-emission, like the behaviour of photons and atoms in an excitation interaction.

Le Sage ignored, in 1758, that interactions of this type do exist in Nature.

The Universons interaction with matter **MUST be temporary**, with no energy transfer on average.

The Universons may exchange their momentum \( P \) with matter, but it must be taken back a little later.

There can be a non null interaction (or capture) time \( \tau \) of the Universons by matter, but this capture time must be as small as permitted by the Heisenberg’s uncertainty principle.

About the travel speed of the Universons, Le Sage has shown that it must be as high as possible. But the speed cannot be larger than the speed of light \( c \). As gravitation propagates at the speed of light, according to Einstein’s theory, let us choose speed \( c \) for the Universons while they do not interact with matter. The speed of the Universons must be \( c \) in all reference frames.

According to special relativity theory a Universon bears a certain linear momentum \( P \), corresponding to a rest mass energy \( E \) such that:

\[
P = E / c
\]

The rest mass \( m \) would then be equal to:

\[
m = E / c^2
\]

If the Universon comes to a rest when interacting with a particle of matter.

Evidently, we will have to consider only the interaction of Universons with elementary particles of matter, bearing a mass, as such an interaction cannot be considered macroscopically. This imposes that the rest mass \( m \) of each Universon must be much smaller than the rest mass of the less massive known particles of matter.

We do not call «Gravitons» our Universons because there might be confusions with unproven past hypotheses.
Let us summarize the concept of Universons we are going to study:

There is supposed to be an interaction of matter with a flux of Universons existing everywhere in the Universe.

These Universons travel at the speed of light when they do not interact with matter, and they come from all directions of space with the average same intensity.

This means that the natural (cosmological) flux of Universons is supposed isotropic.

Each free (moving) Universon bears a momentum, and this momentum is, on average, the same for all Universons of the natural flux.

Certain Universons interact momentarily with particles of matter bearing a mass.

During the interaction, the Universon comes to a rest, and transfers its momentum to the particle of matter.

But this is not a stable situation, and after a very short time, the particle of matter spits back out the Universon in accordance with the conservation principles.

**QUANTUM PHYSICS?**

A priori, the study of the Universons hypothesis should use the classical methods of quantum physics where the treatment of electromagnetic and De Broglie waves is the rule.

This is indeed needed when these waves manifest interference, diffraction, and dispersion. These phenomena exist because the wavelength of the waves considered in classical quanta physics are always much smaller than the sizes of matter particles.

Here, with the Universons hypothesis, the situation is completely different, because the wavelength associated with a moving Universon is considerably larger than the size of matter particles. This because of the experimental proper energy we determined \((8.58 \cdot 10^{-21} \text{ Joule})\).

This will not be discussed into more detail in this annex, but the Nesvizhevsky experiments in Grenoble suggest that the energy associated with one Universon is of the order of 0.05 electronvolt, so the wavelength of the De Broglie wave associated with an Universon should be of the order of tens of micrometers.

This does not allow interferences, diffractions, or dispersions when Universons interact with particles of matter, characteristic dimension of which is about ten billion times smaller.

This fact justify a model limited to the momentum and energy exchanges of the captured Universons with matter, using classical special relativity relations.

However, a study of the quantum fluctuations associated with the natural flux of Universons, in the frame of the Heisenberg uncertainty principle has confirmed a study from Louis De Broglie that he published in the late 1960’s. We will show in Annex III that the average rest energy \(E\) of a captured Universon, and its average capture time \(\tau\) are narrowly dependent of the Planck’s constant \(h\):

\[ E \tau = h \]  

**RELATIVISTIC NOTATIONS WE USE HERE:**

Let us consider two parallel reference frames #1 and #2 (Fig.29). They are classical, with 3
perpendicular axes. Frame #1 is the one of a virtual observer at rest. He looks at the arrival of one incident Universon, from the natural flux. Frame #2 is tied to an elementary particle of matter, of mass $M$, and speed $v$ in frame #1, along the Ox axis of frame #1. The speed of light $c$ is the Universons speed in the two reference frames. We define the two classical relativistic quantities:

$$\beta = \frac{v}{c} \quad (1)$$

$$\gamma = \left(1 - \frac{v^2}{c^2}\right)^{-1/2} \quad (2)$$

The momentum $P$ of the Universon, or the one of the matter particle, will have subscript 1 or 2, according to the frame from where this momentum is observed. Moreover, this momentum, which is a vector, will be represented by its components along the 3 axes of each frame. So there will be one more subscript, $x$, $y$ or $z$ in order to show this.

The rest energy of the Universon will be represented by $E$ in each frame, with the corresponding subscript.

The direction of the positive constant speed $v$ of the particle of matter is supposed parallel to the Ox axis of each of the two frames. So, the transformation of the momentum observed in the two frames will use the following Lorentz relativistic physics relations:

$$P_{x2} = \gamma \left( P_{x1} - \beta E_1 / c \right) \quad (3)$$

$$P_{y2} = P_{y1} \quad (4)$$

$$P_{z2} = P_{z1} \quad (5)$$

$$E_2 = \gamma \left( E_1 - c \beta P_{x1} \right) \quad (6)$$

The interaction time $\tau_2$ of the Universon, in frame #2, is not the same when observed in frame #1:

$$\tau_1 = \gamma \tau_2 \quad (7)$$

Moreover, as free Universons travel at constant speed $c$ in the two frames, one can say necessarily:

$$P_i = E_i / c \quad (8)$$

The 3 components of the momentum $P_i$ of the Universon in frame #1 are tied to the incident trajectory of the Universon. Let us suppose that the Universon trajectory is in the xOy plane of frame #1, as shown in Figure 29, with an angle $\phi$ between the Universon trajectory and the Ox axis, we can write:

$$P_{x1} = \left( E_i / c \right) \cos \phi \quad (9)$$

$$P_{y1} = \left( E_i / c \right) \sin \phi \quad (10)$$

$$P_{z1} = 0 \quad (11)$$

**INTERACTION OF THE UNIVERSONS WITH MATTER IN UNIFORM MOVEMENT**:

The first verification we need to do is evidently the compatibility of the behaviour of Universons with the Inertia principle.

This means that a constant speed particle of matter should not be perturbed by the existence of an isotropic, natural flux of Universons, interacting with it.

Let us consider the interaction of a single Universon with an elementary particle of matter
bearing a mass. As previously, this particle has a constant speed $v$ along axis Ox in frame #1. The particle is at rest in frame #2.

Figure 29 illustrates the situation in an imaginary manner.

The momentum and rest energy of the incident Universon, defined by expressions (8) to (11) in reference frame #1 do not have the same values when observed from the particle, in reference frame #2.

So, the particle of matter interacts with an incoming Universon $A$ having different characteristics than the (8) to (11) ones. We have to use transformations (3) to (6) to know the values of the momentum and energy exchanged while the interaction is taking place:

\[
P_{x2} = \gamma \left\{ \frac{E_1}{c} \cos \phi - \beta \frac{E_1}{c} \right\} \tag{12}
\]
\[
P_{y2} = \left(\frac{E_1}{c}\right) \sin \phi \tag{13}
\]
\[
P_{z2} = 0 \tag{14}
\]
\[
E_2 = \gamma \left\{ \frac{E_1}{c} - c \beta \left(\frac{E_1}{c}\right) \cos \phi \right\} \tag{15}
\]

Expression (12) can be written:

\[
P_{x2} = \left(\gamma \frac{E_1}{c}\right) \left( \cos \phi - \beta \right) \tag{16}
\]

Expression (15) becomes:

\[
E_2 = \gamma E_1 \left( 1 - \beta \cos \phi \right) \tag{17}
\]

At the very moment of the Universon capture by the particle of matter, we can suppose that its energy $E_2$ is changed into a mass increase $m$ of the particle, in such a way that the relativistic equivalence of mass and energy is satisfied:

\[
m = \frac{E_2}{c^2} \tag{18}
\]

Or:

\[
m = \left(\gamma \frac{E_1}{c^2}\right) \left( 1 - \beta \cos \phi \right) \tag{19}
\]

Moreover, the particle of matter receives an increase of its momentum, because the impulses defined by (13), (14) and (16) are transferred to it integrally.
It is interesting to consider what should happen to the particle of matter if it would capture simultaneously another Universon, coming from a direction exactly opposed to the direction of the previous one. In this case we should consider the previous relations, but with an incidence angle \( \phi + \pi \) instead of \( \phi \) that would reverse the signs of \( \sin \phi \) and of \( \cos \phi \), so that for this second Universon we would observe:

\[
\begin{align*}
P_{x_2} &= (\gamma E_1 / c) ( - \cos \phi - \beta ) \\
P_{y_2} &= -(E_1 / c) \sin \phi \\
P_{z_2} &= 0 \\
E_2 &= \gamma E_1 (1 + \beta \cos \phi) \\
m &= (\gamma E_1 / c^2) (1 + \beta \cos \phi)
\end{align*}
\] (20)

The momentum communicated to the particle of matter by the two interacting Universons, along axis Oy of reference frame #2, defined by (13) and (21) are opposed and they cancel each other when observed macroscopically. Effectively, the particle interacts with a large number of Universons from an isotropic flux, so there are numerous Universons interacting simultaneously from all the directions of space.

Expressions (17) and (23) tell us the value of the energy transferred to the particle of matter by two Universons with an opposed trajectory. These energies are not equal.

However, if we consider the effect of these two Universons on the mass increase of the particle while they interact simultaneously, we have to add expressions (19) and (24), and then we get:

\[
m_{(19)} + m_{(24)} = 2 \gamma E_1 / c^2
\] (25)

We observe that the total mass increase of the particle of matter is exactly the same as if two Universons of the same energy \( E_1 \) (the rest energy observed in frame #1), were interacting with the same particle, at rest, in frame #1. This is a curious but important result.

Let us stop for a moment our verification of the inertia principle compatibility, in order to consider the consequences of this fact.

**THE PROPER MASS OF A PARTICLE OF MATTER:**

Expression (25) demonstrates that the simultaneous capture of two incident Universons, with opposed trajectories, induces a total mass increase of the matter particle, equal, if we ignore the \( \gamma \) factor, to the mass increase induced by any two Universons captured when the particle is at rest. So, for the particle, being at rest or in uniform movement, does not change its mass increase, except by the \( \gamma \) factor, which is precisely a known result of the relativity theory.

Moreover, the interaction of one Universon with a particle of matter has a finite duration, which is a constant time \( \tau_2 \) in frame #2.

Let us call \( F_u \) the intensity of the natural flux of free Universons. This intensity is measured in particular units: Universons per second, per square meter, coming from the \( 4 \pi \) steradians.

Let us call \( S \) the « specific capture cross section » of Universons by particles of matter. This is not a surface, but « a surface per kilogram of matter particle mass ». With these units, an elementary particle of matter of rest mass \( M_o \) interacts simultaneously with \( n \) Universons, during the capture time \( \tau_2 \) of one of them:

\[
n = \tau_2 S M_o F_u
\] (26)

Each interacting pair of these \( n \) Universons, with an opposed trajectory, induces a mass increase of the matter particle given by expression (25).
So, the total mass increase $M_2$ caused by all the $n$ Universons captured during time $\tau_2$ will be the product of (25) by $n/2$:

$$M_2 = \tau_2 S M_o F_u \gamma E \, / \, c^2$$

(27)

Replacing $\tau_2$ by its value (7), we get:

$$M_2 = \tau_1 S M_o F_u \gamma E \, / \, c^2$$

(28)

Now, when the capture time $\tau_1$ has elapsed, the first captured Universons are re-emitted, and immediately replaced by new interacting ones. So the total number of permanently captured Universons remains constant and equal to $n$. Finally, the total mass increase $M_o$ of the matter particle in reference frame #2 remains constant on average, and, evidently it must be equal to the observed, permanent, and constant, rest mass $M_o$ of the particle:

$$M_o = \tau_1 S M_o F_u \gamma E \, / \, c^2$$

(29)

So, evidently:

$$\tau_1 S F_u E \, / \, c^2 = 1$$

(30)

Expression (30) is a fundamental relation of the Universons theory. It ties the parameters of the theory.

We might consider also that, with relation (0), we get another fundamental result:

$$S F_u = c^2 \, / \, h$$

(30 bis)

This expression tells us the total number of Universons permanently captured by a kilogram of matter, and permanently replaced by new captured ones, as they are re-emitted. This number is gigantic : $1.36 \times 10^{30}$.

According to (18) & (26), relation (30) has an important signification: the rest mass of an Universon captures only one Universon during the capture time.

More than that, from the previous relations, we see that, for matter at rest:

$$M_o = n E \, / \, c^2$$

(31)

This means that the rest mass of any particle of matter is made of the total energy of the simultaneously captured Universons.

These captured Universons are continuously replaced after being captured for a very short time.

Effectively, if the capture time $\tau$ was quite long, we should have already observed the fluctuations of the mass caused by the non perfect coincidence of capture and re-emission of the pairs of Universons. This behaviour is only acceptable if the capture time is sufficiently small so as the uncertainty principle be macroscopically respected, concerning the conservation of the energy and momentum of matter and the Universons.

Nevertheless any rest mass $M_o$ of any particle of matter is subject to tinny and very rapid random fluctuations. These fluctuations follow the Laplace-Gauss statistics, as it is the case for all particles phenomena, with the corresponding properties. For example, about 99% of the time, the rest mass of a matter particle fluctuates between $M_o - 3\sigma$ and $M_o + 3\sigma$ with $\sigma = (M_o)^{1/2}$ and a frequency of these fluctuations proportional to $n/\tau$.

Moreover, we have shown that the observed mass $M_v$ of a particle of matter of rest mass $M_o$ observed from reference frame #1, when the particle moves at constant speed $v$ relative to this frame, is, according to relativity theory:

Propelling phenomenon from superconducting ceramics
that is simply the result of the capture time transformation between the two frames (7):

\[ \tau_1 = \gamma \tau_2 \]

This shows that the theory is correct from the relativistic point of view.

But let us now return to the main verification process of the compatibility of the theory with the inertia principle.

**RE-EMISSION OF CAPTURED UNIVERSONS BY THE PARTICLE IN UNIFORM MOVEMENT:**

Now, we are considering a new reference frame #3, which is frame #2 moving at constant speed \(-v\) along Ox axis. Evidently, frames #1 and #3 are identical, but this will avoid errors on the subscripts in our calculations.

Each captured Universon is re-emitted at the end of the capture time \(\tau\) in such a way that the average particle mass remains constant. This means that, in frame #2, energy \(E_2\) must be exchanged between the particle of matter and the re-emitted Universon. Consequently, the momentum defined by (13), (14) and (16) are transferred to the Universon, such that the average macroscopic movement of the particle of matter is not perturbed. Those are the necessary conditions imposed by the inertia principle.

These energy and momentum, transferred to the Universon will be observed from reference frame #3, so that we will be able to compare the characteristics of the incident and re-emitted Universon in the same frame #1. The transformation of these quantities from frame #2 to frame #3 uses expressions (3) to (6), with a reverted sign for \(\beta\) because speed \(v\) of frame #3 is negative:

\[
P_{x3} = \gamma (P_{x2} + \beta E_2/c)
\]

\[
P_{y3} = P_{y2}
\]

\[
P_{z3} = P_{z2}
\]

\[
E_3 = \gamma (E_2 + c\beta P_{x2})
\]

Replacing the terms defined by (13), (14) and (16) we obtain:

\[
P_{x3} = \gamma \{ (\gamma E_1/c) \cos \phi - \beta \} + \beta \gamma E_1 (1 - \beta \cos \phi)/c
\]

\[
P_{y3} = (E_1/c) \sin \phi
\]

\[
P_{z3} = 0
\]

\[
E_3 = \gamma \{ \gamma E_1 (1 - \beta \cos \phi) + c \beta (\gamma E_1/c) (\cos \phi - \beta) \}
\]

Simplifying (37), we get:

\[
P_{x3} = (E_1/c) \cos \phi
\]

Simplifying (40):

\[
E_3 = E_1
\]

The trajectory of the re-emitted Universon is defined by a new angle \(\phi'\):

\[
P_{x3} = (E_3/c) \cos \phi'
\]
Propelling phenomenon from superconducting ceramics

Poher C., Poher D. and Marquet P.

Supplementary Material

\[ P_{y3} = \left( E_3 / c \right) \sin \phi \]  \hspace{1cm} (44)

Considering the meaning of relations (38), (39) and (42) to (44), it becomes evident that, on the one hand, the re-emitted Universon has the same energy as the incident one in frames #1 and #3 that are strictly identical.

On the other hand, the incidence and re-emission angles \( \phi \) et \( \phi' \) are equal, which means that the Universon flux remains isotropic when interacting with matter moving at constant speed.

**We can affirm that the interaction of matter in uniform movement with the natural flux of Universons does not perturb the matter movement, and does not change the isotropy of the Universons flux.**

So, we have verified that this Universons theory is not in conflict with the inertia principle.

This is not sufficient to prove that this is a correct theory, because there must be a compatibility of the theory with two more phenomena : on the one hand, the behaviour with accelerated matter (Newton’s Inertia law), and on the other hand, we should also look at the behaviour when two bodies of matter are acting on each other (Newton’s gravitational law).

There is one important fact predicted by the Universons theory that must be taken into account for future verifications : particles of matter are submitted to random fluctuations of their rest mass, and momentum, caused by their permanent interaction with the natural flux of Universons.

**INTERACTION OF UNIVERSONS WITH ACCELERATED MATTER :**

Let us consider now the interaction of a single Universon with a particle of matter accelerated along the Ox axis of frame #1. The particle acceleration \( \ddot{A} \) is supposed constant, and frame #2, where the matter particle remains at rest is supposed starting at frame #1 position at the instant of the Universon interaction.

The imaginary figure 30 helps understanding this situation, with the two frames superposed.

The incident Universon \( A \) is captured in B at the start of the frame #2 acceleration with the particle \( M \).

The incident Universon \( A \) has the following momentum components in reference frame #1 :

\[ P_1 = E_1 / c \]  \hspace{1cm} (45)

\[ P_{x1} = \left( E_1 / c \right) \cos \phi \]  \hspace{1cm} (46)

\[ P_{y1} = \left( E_1 / c \right) \sin \phi \]  \hspace{1cm} (47)
When the Universon is captured in position \( B \), its energy \( E_1 \) is changed into a mass increase \( m \) of the matter particle. In this capture process the relativistic equivalence of mass and energy is satisfied:

\[
m = \frac{E_1}{c^2}
\]

(49)

So the particle of matter recoils because the momentum defined by (46), (47) and (48) are integrally transferred to it.

It is interesting to consider what would happen with another incident Universon, coming from a direction directly opposed to the direction of the previous one. In this case we should consider an incidence angle equal to \( \phi + \pi \) instead of \( \phi \) and this would reverse the signs of \( \sin \phi \) and \( \cos \phi \), in this case we would get:

\[
P_{x1} = -\frac{E_1}{c} \cos \phi
\]

(50)

\[
P_{y1} = -\frac{E_1}{c} \sin \phi
\]

(51)

\[
P_{z1} = 0
\]

(52)

\[
m = \frac{E_1}{c^2}
\]

(53)

One observe that the momenta of the two Universons with opposed trajectories would compensate exactly so that the particle of matter would not move. This is true for any pair of Universons with opposed trajectories.

It is also interesting to consider what would happen with another incident Universon, coming from a symmetrical direction to the direction of the previous one, in relation to the direction of the acceleration +x. In this case we should consider an incidence angle equal to \( -\phi \) instead of \( \phi \) and this would reverse only the sign of \( \sin \phi \) and not the one of \( \cos \phi \), in this case we would get:

\[
P_{x1} = \frac{E_1}{c} \cos \phi
\]

(54)

\[
P_{y1} = -\frac{E_1}{c} \sin \phi
\]

(55)

One observe that the momenta transferred to matter by the two Universons with symmetrical trajectories would compensate exactly in the \( y \) direction, but would add in the \( x \) direction of the acceleration.

Exactly at the beginning of the capture time \( \tau \) we suppose that an external cause creates the acceleration \( A \) of the particle of matter which begins to move along axis \( x \).

The observer remains in frame \#1. Effectively, the Lorentz equations that we used previously are not adapted to accelerated frames.

So we are going to suppose that the capture time \( \tau \) of the Universon by the matter particle is observed from this \#1 frame.

The whole elementary particle of matter is supposed accelerated by an external cause, from the beginning of time count (time zero). And this is also supposed to be exactly the beginning of the Universon capture.

As soon as it is captured, the Universon disappears, and is changed into a part \( m \) of the matter particle mass. And we are going to consider that this mass element \( m \) is now the bearer of the energy and of the momentum of the captured Universon.

This is of course a purely pedagogical method for studying the interaction, because nothing distinguishes this mass element from others, and in strict rigor it would be more correct to use another method. But this simple method gives correct results and is easy to understand.
Thus, the elementary matter particle mass element \( m \) has the following momentum and energy at instant \( t = 0 \), when the Universon has just been captured:

\[
\begin{align*}
P_{x1} &= (E_1 / c) \cos \phi \\
P_{y1} &= (E_1 / c) \sin \phi \\
P_{z1} &= 0
\end{align*}
\]

(previous relations 46 to 49)

\[m = E_1 / c^2\]

The total energy \( E_{m0} \) of the mass element \( m \) is expressed by the following relation at instant zero:

\[E_{m0} = m c^2\]  (56)

Then, during the capture time \( \tau \) the matter particle and its mass element \( m \) are accelerated by an external cause along the \( x \) axis of frame #1.

Consequently, their speed increases versus time. And their momentum and kinetic energy increase accordingly.

**Now let us consider instant \( t = \tau \) in frame #1, just before the Universon re-emission.**

We are now going to look at the previous quantities at the end of capture time \( \tau \) just before the Universon is re-emitted. The variables indices 1 become \( 1\tau \) for clarity.

The matter particle is moving now at speed \( v = A \tau \) in frame #1, along the \( x \) axis.

In relativistic physics, the momentum \( P \) acquired by a matter particle of mass \( m \) moving at speed \( v \) is given by the expression:

\[P = m \gamma v\]  (57-1)

Where the parameter \( \gamma \) has the value defined by expression (2). Moreover, according to (2), and (49) and (57) we can write:

\[P = (\beta \gamma) E_1 / c\]  (57-2)

The total energy \( E \) of this same matter particle is given by the following expression:

\[E = \gamma m c^2\]  (57-3)

And the kinetic energy \( E_c \) of this particle is expressed by:

\[E_c = m c^2 (\gamma - 1)\]  (57-4)

In these expressions, let us recall that the mass \( m \) is the one caused by the Universon capture and defined by expression (49):

\[m = E_1 / c^2\]  (49)

So, the mass element \( m \) of the elementary particle of matter has the following components of its momentum, and the following total energy at the instant \( t = \tau \) in frame #1, just before the
Universon re emission:
\[ P_{x/\tau} = (E_1 / c) (\cos \phi + \beta \gamma) \]
\[ P_{y/\tau} = (E_1 / c) \sin \phi \]
\[ P_{z/\tau} = 0 \]
\[ E_{m/\tau} = \gamma E_1 \]

And exactly after this instant, the universon is re emitted and the mass increase \( m \) disappears.

But we must not forget that the matter particle captures and re-emits Universons permanently. And this is the reason why the matter particle mass remains constant on average. So the mass element \( m \) does not simply disappear, it is replaced by another one, created by the capture of another Universon, other mass element which is identical, and which is taking care of the momentum and kinetic energy.

**RE-EMISSION OF THE UNIVERSON BY THE ACCELERATED MATTER PARTICLE:**

At the end of the capture time, the previously captured Universon recovers its freedom.

We know, by experiments, that the total average mass of the matter particle does not change, and that its average kinetic energy is the one predicted in the absence of interaction with Universons.

The Universon re emission is represented on Figure 31 below. The observer remains in frame #1 as previously.

![Figure 31](image)

As the Universon interaction with the matter particle does not change the average mass of matter, and does not change its final kinetic energy, it is essential that the re emitted Universon energy \( E_\tau \) be equal to:

\[ E_\tau = E_{m/\tau} = \gamma E_1 \]  

(59 - 1)

The corresponding momentum \( P_\tau \) is equal to:
Precisely, the Univerisons re emission must not be the cause of a supplementary modification of the matter particle speed. This implies necessarily:

\[ P_x = \frac{E_x}{c} = \gamma \frac{E_1}{c} \quad (59 - 2) \]

If we call \( \phi ' \) the re emission angle of the Universon in frame #1, according to figure 31, we know that, by definition:

\[ P_x = (E_x/c) \cos \phi ' \quad (59 - 4) \]

So, with (59 - 1) and (59 - 2):

\[ P_x = \gamma \left( \frac{E_1}{c} \right) \cos \phi ' = (E_1/c) \left( \cos \phi + \beta \gamma \right) \quad (59 - 5) \]

Which simplifies the following way:

\[ \cos \phi ' = (1/\gamma) \cos \phi + \beta \quad (59 - 6) \]

However, we know that \( \beta = v/c \) with a speed \( v = A \tau \) (57) which is always extremely small, whatever the value of the acceleration \( A \) because the capture time \( \tau \) is extremely brief. In these conditions, the value of the parameter:

\[ \gamma = \left( 1 - \frac{v^2}{c^2} \right)^{-1/2} \quad (2) \]

Is always equal to one with an error inferior to \( 10^{-39} \) and equation (59 - 6) can be simplified:

\[ \cos \phi ' = \cos \phi + A \tau / c \quad (59 - 7) \]

The expressions system defining the Universon re emission conditions becomes:

\[ P_{x1\tau} = (E_1/c) \cos \phi ' \]
\[ P_{y1\tau} = (E_1/c) \sin \phi ' \quad (60 - 1 \text{ à } 60 - 4) \]
\[ P_{z1\tau} = 0 \]
\[ E_{m1\tau} = E_1 \]

In frame #2, tied to the accelerated matter particle, the momentum and the kinetic energy of the particle are null.

Consequently, relations (60) represent the characteristics of the re emitted Universon as seen by the observer situated in frame #1.

Let us examine the direction of the Universon re emission by comparing the angles \( \phi \) of capture and \( \phi ' \) of re emission, both measured from the axis \( x \) in frame #1.

According to definition (59 - 7) let us recall that these angles are tied by expression:

\[ \cos \phi ' = \cos \phi + A \tau / c \quad (59 - 7) \]

**INTERPRETATION OF THESE RESULTS:**

Interpretation of relations (59 - 7) and (60) reveals several facts:
1 — The angles of incidence $\phi$ and of re-emission $\phi'$ of the Universons are not equal. There exists an **anisotropy of the re-emitted flux of captured Universons**.

2 — The momentum communicated to the accelerated particle of matter by the Universon interaction is different, in the direction opposed to the acceleration, than in the acceleration direction.

It suffice effectively to compare expressions (46) and (60 -1) to draw this conclusion.

This explains the inertia effect, and the need to exert a force on matter in order to be able to accelerate it. More about that later.

3 — This difference in capture and re-emission momentum manifests itself the same way in all space around the particle.

**The anisotropy of the re-emitted flux of captured Universons, by accelerated matter, concerns all space around the particle of matter. This anisotropy has a revolution symmetry around the acceleration direction.**

4 — The compensation of the momentum transferred to matter, perpendicularly to the acceleration direction, by the interaction with the Universon flux does not appear Universon by Universon, but from pairs of captured Universons with opposed or symmetric incident trajectories according to the acceleration direction.

The conservation of energy, and of momentum is only true at macroscopic scale, on average. The uncertainty principle authorizes this behaviour if the capture time of the Universons’ pairs is sufficiently small, which is the case.

5 — Taking into account the fact that, for all practical acceleration values, $A\tau/c \ll 1$ which means that $\gamma = 1$, expression (62) becomes:

$$cos \phi' = cos \phi + A\tau/c$$  \hspace{1cm} (61)

Now, let us consider the solid angle $\Omega'$ defined by a cone with the half summit angle $\phi'$ because the interaction is symmetric around the direction of the acceleration. The axis of this cone is the acceleration direction.

When $\phi = \pi$ then, expression (63) can be written:

$$cos \phi' = -1 + A\tau/c$$  \hspace{1cm} (62)

From definition of solid angle:

$$\Omega' = 2\pi (1 - cos \phi')$$  \hspace{1cm} (63)

With (62) we obtain:

$$\Omega' = 4\pi - 2\pi A\tau / c$$  \hspace{1cm} (64)

This is the full sphere plus the solid angle:

$$\Omega' = -2\pi A\tau / c$$  \hspace{1cm} (65)

In this very small solid angle $\Omega'$, situated in the opposite direction of the acceleration, the accelerated particle of matter does not re emit any captured Universon.

**This explains how the re-emitted flux can be anisotropic.**
6 — In expression (61), if $\phi = 0$ then:
\[
\cos \phi' = 1 + A\tau/c \tag{66}
\]
But, as $A\tau/c$ is positive, this expression is impossible, because the cosine of the re-emission angle cannot be larger than one. Interpretation of this fact is evidently that, in a very small solid angle:
\[
\Omega = 2\pi A\tau / c \tag{67}
\]
*Situates in the direction of the acceleration, around $\phi = 0$, the accelerated particle of matter does not capture any Universon coming from this solid angle.*

These un-captured Universons continue their trajectory, as if matter was not there. So, in the direction of the acceleration, entirely inside the solid angle $\Omega$, the incident, natural flux of Universons, is not perturbed.

7 — We can write expression (63) the following way:
\[
2\pi (1 - \cos \phi') = 2\pi (1 - \cos \phi) - 2\pi A\tau / c \tag{68}
\]
Or, according to (63):
\[
\Omega' = \Omega - 2\pi A\tau / c \tag{69}
\]
This expression shows that for an incident solid angle $\Omega = 4\pi A\tau / c$ the re-emission solid angle is only $\Omega' = 2\pi A\tau / c$ or two times less.

But we already know that, for all Universons coming in the solid angle $\Omega = 2\pi A\tau / c$ there is no capture. This means that they simply continue their trajectory and emerge in the solid angle $\Omega' = 2\pi A\tau / c$;

However in this same emergence solid angle, there are also the Universons re-emitted after capture in the periphery of the incident solid angle $\Omega = 4\pi A\tau / c$.

So the **OUTPUT flux** of Universons, from the accelerated particle of matter, *in the direction of the acceleration*, and only in the solid angle $\Omega' = 2\pi A\tau / c$ is always **LARGER**, than in the opposite direction, where the captured Universons are not re-emitted.

So, considering facts #5 and #7 about the anisotropy of the interaction with an accelerated particle of matter, *there are two particular, very small solid angles $\Omega = 2\pi A\tau / c$, of the same value, to consider. Both solid angles have the same axis, which is the acceleration direction, but they are opposed by their summit. One of these two solid angles is opened towards the front, the other one towards the rear.*

*In the front solid angle, the output flux of Universons is increased. In the rear solid angle, incident Universons are not captured.*

**CALCULATION OF THE INERTIA FORCE:**

According to (59 - 7) expression (60 - 1) can be written:
\[
P_{x1\tau} = (E_1/c) (\cos \phi + A\tau / c) \tag{70}
\]
We know that this is the momentum transferred to the particle of matter by the re emitted Universon, with a negative sign (in the direction $-x$).
Let us compare this momentum with the one transferred to the particle of matter, in the $+x$ direction, by the captured Universon. It was given by expression (46):

$$P_{x_{10}} = (E_1/c) \cos \phi$$

(46)

So now, by subtracting directly (46) from (70) we get the total momentum transferred to the matter particle, along the minus direction of the $x$ axis, by the interaction of a single Universon:

$$\Delta P_x = (E_1/c)(A\tau/c)$$

(71)

The residual momentum (71) impedes the acceleration of the matter particle. This fact justifies the inertia effect, and the need to exert an external force in order to accelerate the matter particle.

The elementary force $\delta f$ that must be applied to the element of mass $m$ of the matter particle, in order to compensate the back momentum delivered by the interaction of a single Universon during time $\tau$ must be, in principle, such that:

$$\delta f = \Delta P_x / \tau = E_1 A / c^2$$

(72)

We are going to verify if this is correct.

In reality, we want to verify that this theory is compatible with the Newton’s law of inertia.

So, we have to determine the value of the force, acting on the accelerated particle of matter by the difference in linear momenta induced by the Universons interaction. The particle of matter has a total rest mass $M_0$.

Let us call $F_u$ the intensity of the natural Universons flux, as previously. This flux is again expressed in Universons per second, in the $4\pi$ steradians.

This incident flux $F_u$ is isotropic, so the partial, flux $\delta F(\phi, \psi)$ per steradian, in a direction defined by angles $\phi$ and $\psi$ is equal to:

$$\delta F(\phi, \psi) = F_u / 4\pi$$

(73)

We will consider incident Universons, coming from direction $\phi, \psi$ where the angle $\phi$ is, as previously, measured in the $xOy$ plane, and angle $\psi$ in the $yOz$ plane.

Again, let us call $S$ the specific capture cross section of matter for the Universons interaction. So the flux $\delta F_c(\phi, \psi)$ of the captured Universons, coming in the direction $\phi, \psi$ is given by:

$$\delta F_c(\phi, \psi) = S M_0 F_u / 4\pi$$

(74)

This flux is expressed in captured Universons per second and per steradian, in the $(\phi, \psi)$ direction.

The number of Universons $\delta N(\phi, \psi)$ simultaneously captured, from this direction, during the capture time $\tau$ of one of them is equal to:

$$\delta N(\phi, \psi) = \tau \delta F_c(\phi, \psi) = \tau S M F_u / 4\pi$$

(75)

Each one of these captured Universons transfers, to the particle of matter, when re-emitted, a supplementary momentum, in the direction opposed to the acceleration, which value is given by (71) copied here:

$$\Delta P_x = (E_1/c)(A\tau/c)$$

(76)

For each re-emitted Universon, the elementary force $\delta f$ exerted on the particle of matter, at the end
of time $\tau$ is simply equal to $\Delta P_x / \tau$:

$$\delta f = \Delta P_x / \tau = A E_1 / c^2$$

(77)

So, the $\delta N(\phi, \psi)$ captured Universons during this time $\tau$, coming from the direction $(\phi, \psi)$ are exerting a total force, which is given by the product: $\delta f \cdot \delta N(\phi, \psi)$.

The total force acting on the particle of matter for all the Universons coming from all the directions of space is obtained by integrating the value of this product in all space. This means by varying angle $\phi$ from 0 to $\pi$, and angle $\psi$ from 0 to $2\pi$. We get:

$$\text{Force} = (2/\pi) \int_{\phi=0}^{\phi=\pi} \int_{\psi=0}^{\psi=2\pi} \tau S M_0 A E_1 F_u / (4\pi c^2) \; \delta \phi \; \delta \psi$$

(78)

Finally:

$$\text{Force} = \tau S M_0 A E_1 F_u / c^2$$

(79)

But, from (30) we already know that:

$$\tau S F_u E_1 / c^2 = 1$$

(30)

So, expression (85) becomes:

$$\text{Force} = M_0 A$$

(80)

That is simply the well known Newton’s inertia law.

So, the Universons model is compatible with the Galileo’s Inertia principle AND with the Newton’s inertia law.

A SIMPLER METHOD FOR THE FORCE DETERMINATION:

We have shown (76) that no Universon is re-emitted in a solid angle $\Omega’ = -2\pi A \tau / c$, opposed to the direction of the acceleration. Macroscopically speaking, this means that incident Universons, coming from the direction opposite to the acceleration direction, into this solid angle, transfer to the particle of matter, a momentum, opposed to the direction of the acceleration, which is not compensated.

Moreover, incident Universons coming in the direction of the acceleration, in a solid angle $\Omega = 2\pi A \tau / c$, which axis is the direction of the acceleration, are not captured. Macroscopically speaking, this means that the re-emitted Universons in the direction of the acceleration direction, into the same solid angle, transfer to the particle of matter, a momentum, opposed to the direction of the acceleration, which is not compensated.

So the solid angle value $\Omega=2\pi A \tau / c$ acts two times on the momentum transferred macroscopically to matter, in the opposite direction of the acceleration.

Expression (75) gives the average number of Universons captured, per steradian, during time $\tau$ in the $(\phi, \psi)$ direction. So the product of expression (82) by two times the value of the solid angle $\Omega=2\pi A \tau / c$, should be the average number $N_\Omega$ of Universons exchanging a momentum in these solid angles:

$$N_\Omega = 2 \Omega \; \delta N(\phi, \psi)$$

(81)

$$N_\Omega = A \tau^2 S M_0 F_u / c$$

(82)

Each one of these Universons transfers to the particle of matter a momentum $E_1 / c$ and the force is equal to the momentum divided by time duration $\tau$ so:
Force = $N_\Omega \frac{E_i}{c} \tau A \tau SE_i M_0 F_u / c^2$  \hspace{1cm} (83)

But, from (30) we know that:

$$\tau S F_u \frac{E_i}{c^2} = 1$$  \hspace{1cm} (30)

So:

$$\text{Force} = A M_0$$  \hspace{1cm} (84)

Which is as correct as (80).

This means that, in order to obtain the force acting on an accelerated particle of matter, it suffices, macroscopically, to determine the number of Universons captured in the solid angle $\Omega = 2\pi A \tau / c$, and then to multiply this number by $2 E_i / \tau c$. And finally, take into account fundamental expression (30).

**IS THE UNIVERSONS MODEL ABLE TO EXPLAIN GRAVITATION?**

The Universons model is not at all a « shadow » model of gravity, like the model proposed by Lesage for example, because Universons are not absorbed by particles of matter, they are only temporarily captured, then released after about $7.8 \times 10^{-14}$ second.

Two macroscopic masses of matter separated by a distance are bathing in the general flux of Universons of Dark Energy. This flux is isotropic and constant on average only. In fact the flux has random fluctuations of its intensity and directions.

However, because the Universons travel at the finite speed of light, an increase of the incident flux intensity from a direction of space is almost always acting on one of the two masses of matter before it arrives at the other one.

This situation is equivalent to the one of matter irradiated by an anisotropic flux of Universons, because the fluctuations are equivalent to a constant isotropic average flux to which is added a random fully anisotropic component.

Therefore the mass of matter being the first to receive the flux intensity increase is pushed the first towards the direction of the other mass.

Finally, the random fluctuations of the natural flux push the two matter bodies one towards the other one.

The only stable situation occurring is therefore a balance between the acceleration pushing the two masses of matter from the outside, and the acceleration caused by the emission of an anisotropic flux of Universons by each mass towards the other one.

This stable situation corresponds evidently to a Keplerian orbit of the two masses.

Effectively, if each mass is pushed in the direction of the centre of the other mass, it is submitted to an accelerated movement (its trajectory is not a straight line).

This phenomenon exists really at the level of the elementary particles of matter of the two bodies in circular orbit.

And we know that each accelerated particle re emits the Universons it captures anisotropically.

A more intense flux of Universons is re-emitted by each particle in the direction of the acceleration, which is the direction of the other mass centre of mass.

This anisotropic flux of Universons creates immediately a force (the inertia force) in the opposed direction of the flux.

Propelling phenomenon from superconducting ceramics
There is an automatic equilibrium between the spatial anisotropy of the captures impulses caused by the perturbation introduced by the other mass, and the spatial anisotropy of the impulses transferred to matter by the re emission of the Universons.

In other terms, the two anisotropies of the local flux of Universons: the one of the incident flux and the one of the re-emitted flux, compensate exactly at any instant, for any elementary particle of the matter of the two bodies.

But this equilibrium exists only if the two masses of matter are macroscopically and permanently accelerated, each towards the other one.

This is the only possible stable situation for the two masses immersed inside the natural isotropic flux of Universons with permanent random fluctuations.

Effectively, if we attempt to imagine that any one of the two masses can be the object of an acceleration oriented in any other direction of space, we get an unstable situation that converges always towards the equilibrium situation we have described previously.

In fact, the real phenomena are not at all so simple, because it is necessary to consider the instantaneous acceleration of each elementary particle of matter, and also, it is necessary to consider the fluctuations of the Universons captures and re-emissions. But the macroscopic result appears to be the one we have described.

**GRAVITATION FORCE:**

Let us try to calculate the gravitation force exerted on two matter bodies of rest masses $M_1$ and $M_2$ situated at a distance $D$. In the gravitation process, only the Universons captured successively by the two masses of matter are of interest to us, because all others are isotropically distributed.

The intensity of the natural flux of Universons being $F_u$ and using the previous notations, the number of Universons $n$ captured by the first body of mass $M_1$, each second, from the $4\pi$ steradians, is equal to:

$$n = F_u S M_1$$  \hspace{1cm} (85)

All these Universons are re-emitted. At a distance $D$ from the mass $M_1$, these re-emitted Universons propagate and are distributed along the surface of a sphere of radius $D$, so, at the surface of the sphere, the flux $F'$ of these Universons is given by:

$$F' = n / 4 \pi D^2 = F_u S M_1 / 4 \pi D^2$$  \hspace{1cm} (86)

So $F'$ is the flux of Universons, first captured by $M_1$ and arriving in the solid angle $\Omega$ on mass $M_2$. These Universons are partially captured by the particles of the second body of mass $M_2$ and the number $n'$ that are captured, during capture time $\tau$, is:

$$n' = F' S M_2 \tau$$  \hspace{1cm} (87)

$$n' = F_u S^2 M_1 M_2 \tau / 4\pi D^2$$  \hspace{1cm} (88)

These $n'$ two times captured Universons transfer to matter, when re-emitted, a momentum which is not compensated in the other direction.

So, they create a resultant force (gravitation force) which is oriented towards the incoming flux, or the direction of the mass $M_1$. The force exerted by each Universon being $E_1 / c \tau$ the value of this resultant force is:

$$\text{Force} = n' E_1 / c \tau$$  \hspace{1cm} (89)

$$\text{Force} = F_u S^2 M_1 M_2 E_1 / 4 \pi c D^2$$  \hspace{1cm} (90)
This can be written:

\[ \text{Force} = G \frac{MM'}{D^2} \quad (91) \]

With:

\[ G = F_u S^2 E_1 / 4 \pi c \quad (92) \]

Expression (91) is the well known Newton’s law of gravitation, and expression (92) ties the gravitational constant \( G \) to the parameters of the theory, mainly the parameters of the natural flux of Universons.

From (30), we know that:

\[ \tau S F_u E_1 / c^2 = 1 \quad (30) \]

So expression (92) can be written also:

\[ G = S c / 4 \pi \tau \quad (93) \]

Expression (93) ties the gravitational constant \( G \) to the parameters of the Universons capture by matter. Both expressions (92) and (93) are equivalent.

**POSSIBLE VALUES OF THE MODEL PARAMETERS:**

The momentum carried by an Universon is deduced from our laboratory experiments.

We have determined the experimental value of the energy of an Universon \( E_u \) by comparing the acceleration communicated to the known mass of an accelerometer, by an anisotropic flux of Universons emitted by a layered ceramic (emitter), to the displaced charge (number of electrons) inside a dielectric, simultaneously by the same flux.

The result of this determination is the following:

\[ E_u = 8.0 \times 10^{-21} \text{ joule} \pm 10 \% \]

This determination is confirmed by a previous one, obtained five years earlier, thanks to the experimental results from Valery V. Nesvizhevsky & al. of the Institut Laue-Langevin in Grenoble.

![Figure 32: Reproduction, with authorization, of the figure describing experiments made by Valery V. Nesvizhevsky et al.](image-url)

In this experiment, ultra cold neutrons are moving horizontally at low speed (of the order of 10 meters per second) in a narrow space between two horizontal and parallel planes along a 10 centimeters distance.
The inferior plane is a mirror for the neutrons, and the superior plane is an absorber for neutrons. The neutrons moving slowly between the two plates are submitted to the gravitational field of the Earth. They have parabolic trajectories in this narrow space, before going out where they are detected and counted.

The experiment shows that no neutron goes out when the distance between the two planes is smaller than 15 microns. Over this distance, the number of neutrons increases rapidly with the distance: 8 times more at 20 microns than at 15 microns, 100 times more at 40 microns etc.

One can try to interpret this experiment in the frame of the Universons’ theory, considering that each neutron is submitted to a non-isotropic exchange of energy with the captured Universons, this gives the gravitational acceleration of the neutrons and their parabolic trajectory. The energy that is needed to raise a neutron by 15 microns in the Earth gravitational field is 1.5 pico electron volt according to the authors.

Effectively, this energy is given by the following classical physics equation:

\[ E = m g h = 1.67 \cdot 10^{-27} \cdot 9.81 \cdot 15 \cdot 10^{-6} = 2.4 \cdot 10^{-31} \text{ Joules} = 1.5 \cdot 10^{-12} \text{ eV} \]

As no neutron goes out of the experiment when the distance between the two planes is less than 15 microns, one can estimate that this is due to the fact that they are all absorbed. This tells us that they receive, during their travel along the 10 centimeters of the parallel plates, a larger kinetic energy than the one needed for a neutron to be reflected by the inferior plate and absorbed by the superior one.

Then we can deduce that the minimum kinetic energy transferred to a neutron, in the vertical direction, by the capture of Universons (corresponding to only one Universon) is 1.5 pico electron volt.

Let us call \( E_u \) the energy transferred by an Universon to a neutron during capture. We know that the impulse communicated by the capture is equal to \( E_u / c \), where \( c \) is the speed of light.

A neutron of mass \( M_n \) gets, during capture a speed \( v \) such as:

\[ M_n \cdot v = E_u / c \]

Its kinetic energy is:

\[ E_c = M_n \cdot v^2 / 2 \]

Then finally:

\[ E_c = E_u^2 / (2 \cdot M_n \cdot c^2) \]

We know that:

\[ E_c = 1.5 \cdot 10^{-12} \text{ eV} \]

Or:

\[ E_c = 2.4 \cdot 10^{-31} \text{ joule} \]

With \( c = 3 \cdot 10^8 m / s \) and \( M_n = 1.67 \cdot 10^{-27} \text{ kg} \), we get finally:

\[ E_u = 8.5 \cdot 10^{-21} \text{ joule} \]

If the Universons energy was electromagnetic, this would correspond to a wavelength of:

\[ \lambda = h \cdot c / E_u \]

Where \( c \) is the speed of light and \( h \) the Planck’s constant.

With \( h = 6.62 \cdot 10^{-34} J \cdot s \) we would get:

\[ \lambda = 2.34 \cdot 10^{-5} \text{ metre or 23,4 microns} \]
This would be a very powerful infrared radiation easy to detect.

As this radiation does not exist, we conclude that Universons don’t bear an electromagnetic energy, but only a kinetic energy.

Consequently, Universons don’t make any difference between neutral (neutrons) and charged (protons, electrons) particles of matter, only their mass counts in their interaction.

The fundamental relations used to deduce the other parameters values are the following:

Notations:

\( A \) = Acceleration of matter. \((m \cdot s^{-2})\).
\( \tau \) = Capture time of an Universon in a particle of matter. \((\text{Seconds, s})\).
\( \Omega \) = Solid angle where there is no emission of the captured Universons. \((\text{Steradians, sr})\).
\( F \) = Cosmological, isotropic flux of free Universons. \((\text{Universons} \cdot \text{m}^{-2} \cdot \text{s}^{-1} \cdot \text{in} \ 4\pi \text{ sr})\)
\( S \) = Capture cross section of the Universons by matter. \((\text{m}^2 \cdot \text{kg}^{-1})\).
\( \text{Eu} \) = Proper energy of a captured Universon. \((\text{Joules})\).
\( c \) = Speed of light. \((m \cdot s^{-1})\). We use here \( c = 3 \cdot 10^8 \) instead of \( 2.99792458 \cdot 10^8 \).
\( G \) = Universal Gravitation Constant. \((\text{Newton} \cdot \text{m}^2 \cdot \text{kg}^{-2})\). We use here \( G = 6.67 \cdot 10^{-11} \).
\( H \) = Hubble’s constant \((\text{We use here} \ H = 75 \text{ km/s per mega parsec})\).
\( h \) = Planck’s constant. \( h = 6,626 \cdot 10^{-34} \text{ joule} \cdot \text{second} \).

\[ \Omega = 2 \pi A \tau / c \quad \text{(A)} \]
\[ \tau = c^2 / (F S \text{Eu}) \quad \text{(B)} \]
\[ G = \text{Eu} F S^2 / (4 \pi c) = S c / 4 \pi \tau \quad \text{(C)} \]
\[ \tau / S = 3.58 \cdot 10^{17} \quad \text{(D)} \]
\[ \text{Eu} \tau = h \quad \text{(E)} \]
\[ F \tau^2 = 3.8 \cdot 10^{54} \quad \text{(F)} \]

REST ENERGY OF AN UNIVERSON

\[ \text{Eu} = 8.5 \cdot 10^{-21} \text{ Joule} \]

ISOTROPIC COSMOLOGICAL FLUX OF UNIVERSONS

\[ F = 6.3 \cdot 10^{80} \text{ Universons} \cdot \text{m}^{-2} \cdot \text{Sec}^{-1} \cdot \text{in} \ 4 \pi \text{ steradians} \]

POWER OF THE COSMOLOGICAL FLUX OF UNIVERSONS

\[ P = 5.37 \cdot 10^{60} \text{ watts} \cdot \text{m}^{-2} \cdot \text{sr}^{-1} \]
CAPTURE CROSS SECTION OF THE UNIVERSONS BY MATTER

\[ S = 2,18 \cdot 10^{-31} \text{ m}^2 \cdot \text{kg}^{-1} \]

CAPTURE TIME OF AN UNIVERSON

\[ \tau = 7,8 \cdot 10^{-14} \text{ second} \]

SOLID ANGLE OF NO RE EMISSION OF THE UNIVERSONS

\[ \Omega = 1,6 \cdot 10^{-21} \text{ steradians} \cdot \text{m}^{-1} \cdot \text{s}^2 \]

AGITATION TEMPERATURE OF MATTER DURING THE INTERACTION

\[ T^o = 1,16 \cdot 10^{-8} \text{ Kelvin} \]

THE UNIVERSONS THEORY IS A MODEL OF DARK ENERGY:

The existence of the isotropic flux of Universons is confirmed by our laboratory experiments using electric discharges in layered superconducting ceramics, where electrons are strongly accelerated and emit an isotropic flux bearing a momentum, extracted from the isotropic one.

We will show, in supplementary Annex II that the Universons model explains easily several observations enigmas about gravitation:

— It explains the apparently anomalous trajectory of the free falling interplanetary spacecrafts Pioneer 10 & 11.

— It explains the constant orbital speeds of stars in galaxies.

It justifies other phenomena whose study is not detailed here but published on our website:

— It explains the double gravity peaks observed with gravimeters during Solar eclipses.

— It explains the very high speed of galaxies in clusters.

The isotropic flux of Universons is composed of quanta travelling at the speed of light, therefore much faster than matter particles of the Universe.

We can therefore suppose that this cosmological flux of energy was also created during the Big Bang and that it fills all the Universe space. This is precisely the definition of the Dark Energy concept.

Moreover, we can suppose that the total amount of energy carried by this cosmological flux is constant, without creation of new Universons along time.

Therefore, there should be a flux gradient at very large scale if the Universe has a finite energy content, and this gradient is pushing matter outwards, like any anisotropic flux in the laboratory.

A consequence of this fact should be an increase of the Universe expansion speed, a fact that seems to be confirmed by the redshift / luminosity relation of very distant supernova.
CONCLUSION OF ANNEX I:

Finally, we have demonstrated:

A — That *Universons model is compatible with the Galileo’s Inertia principle AND with the Newton’s inertia law.*

B — The *Universons theory is also compatible with Newton’s gravitation law.*

So we can hope that this model constitutes another possibility to understand these two fundamental natural phenomena.

Particularly because the predictions of this theory are corroborated by a large amount of observations, as we will show in annex II.

SUPPLEMENTARY ANNEX II

ARE THERE OTHER CONFIRMATIONS OF THE UNIVERSONS MODEL THAN OUR EXPERIMENTAL RESULTS?

Claude POHER

We would like to know if the Universons model predicts other phenomena than those we observed in the laboratory, with electric discharges into layered superconducting ceramics. This study is reproduced here because of its consequences.

There are effectively other facts predicted by our model.

EFFECT OF THE UNIVERSE EXPANSION:

We have described the interaction of an isotropic flux of Universons with elementary particles of matter. When two bodies are concerned such as this is the case in gravitation, there is a gravitational acceleration, therefore, the Universons behaviour, in this case, should be exactly the same as the one with accelerated matter. Universons are not captured in a very small solid angle Ω proportional to the acceleration. The value of Ω is given by (1). Its axis is the null incidence direction:

\[ \Omega = \frac{2 \pi A \tau}{c} \]  

(1)

The solid angle Ω corresponds to a cone of space with a particular value of its half summit angle φ defined by:

\[ \cos \phi = \frac{Vx}{c} \]  

(2)

Vx is the component of the Universon speed in the direction of the acceleration A in frame #1. Please refer to figures and variables defined in Annex I.

Both captured and uncaptured Universons must travel, after capture time, at the same speed c in free space. But captured and then re-emitted Universons are a little late in the process of recovering their c travel speed. While they are kept inside a particle of matter, the Universe expands, nevertheless, after their re emission, they must be undistinguishable from the uncaptured Universons. This cannot exist without a consequence on the momentum transferred to matter, and finally, its acceleration.

During the capture time τ, the free, uncaptured, Universons travel in the direction of the acceleration, the distance d equal to:

\[ d = \tau \cdot Vx \]  

(3)

This distance is submitted to the expansion of the Universe, as all Space is. This expansion involves the Hubble’s constant \( H \).

So that distance d becomes \( d_H \):

Propelling phenomenon from superconducting ceramics
Propelling phenomenon from superconducting ceramics

Poher C., Poher D. and Marquet P.

Supplementary Material

\[ d_H = d + dH \tau \]  \hspace{1cm} (4)

And, with (3):

\[ d_H = \tau Vx + \tau^2 Vx H \]  \hspace{1cm} (5)

The uncaptured Universons of null incidence angle travel the distance \( d_H \) at the speed of light \( c \) during the time \( \tau \):

\[ d_H = \tau c = \tau Vx + \tau^2 Vx H \]  \hspace{1cm} (6)

This gives:

\[ c = Vx + \tau Vx H = Vx (1 + \tau H) \]  \hspace{1cm} (7)

And:

\[ Vx = c / (1 + \tau H) \]  \hspace{1cm} (8)

But, as \( \tau H << 1 \), we can use the series development of (8) limited to its two first terms. So, in frame #1:

\[ Vx = c (1 - \tau H) \]  \hspace{1cm} (9)

This is, in fact, the classical «redshift» caused by the Universe expansion.

When matter is submitted to an external acceleration \( A \), its speed, at the end of the capture time becomes \( A\tau \).

And the Universons, arriving in direction \( \phi \) in frame #1, are observed from the matter particle (frame #2). Their \( Vx \) speed component becomes \( Vx - A\tau \), and (9) becomes, in Frame #2:

\[ Vx = c (1 - \tau H) - A\tau \]  \hspace{1cm} (10)

Expression (10) must be valid also for Universons, captured in the direction \( \phi \) and re-emitted in the direction \( \phi' = 0 \) which is the direction of the acceleration. Effectively, nothing might distinguish these re-emitted Universons from the ones, uncaptured, that travel along the direction \( \phi = 0 \) in frames #1 & #2. For all the Universons re-emitted in the acceleration direction, (10) changes expression (2) into:

\[ \cos \phi = 1 - \tau H - A\tau / c \]  \hspace{1cm} (11)

Or:

\[ \cos \phi = 1 - \tau (Hc + A) / c \]  \hspace{1cm} (12)

Let us recall that, because we have chosen Universons re-emitted in the direction \( \phi' = 0 \) the incidence angle \( \phi \) is precisely the half summit angle of the cone of no capture of Universons, a solid angle defined by:

\[ \Omega = 2 \pi (1 - \cos \phi) \]  \hspace{1cm} (13)

So, with (12), we get:

\[ \Omega = 2 \pi \tau (A + Hc) / c \]  \hspace{1cm} (14)

This solid angle (14), of no capture of Universons, is to be compared with (1), which was the same solid angle value before taking into account the expansion of the Universe:

\[ \Omega = 2 \pi A \tau / c \]  \hspace{1cm} (1)

We conclude evidently to the existence of a new total acceleration of the matter particle:

\[ \text{Acceleration} = A + Hc \]  \hspace{1cm} (15)

Interpretation of (15) is simple: there is always a constant acceleration \( Hc \) added to the main acceleration \( A \) applied to matter, whatever the cause of the main acceleration \( A \).

This constant acceleration \( Hc \) is produced by the expansion of the Universe, because
Universons are captured a non null time inside matter, and nevertheless, have to travel at speed $c$ in all frames of reference, after capture.

This tinny $Hc$ acceleration has important consequences, as we will show. It is an original prediction of the Universons theory.

**CONFIRMATION OF THE Hc ACCELERATION:**

The $Hc$ acceleration is quite small. The value of $H$ we will use here is:

$$H = 72 \text{ km/s per megaparsec distance.}$$

Our conclusions would not change for another value in the current range ($\pm 15\%$) of observations. So:

$$H = 2.43 \times 10^{-18} \text{ s}^{-1}$$

This means that:

$$Hc = 7.3 \times 10^{-10} \text{ m s}^{-2}$$

The gravitational acceleration on the surface of the Earth is 13 billions times the value of $Hc$, so a terrestrial laboratory verification seems improbable. We have to check the existence of this acceleration in deep space.

But even the solar gravitational acceleration in the Solar system is much larger than $Hc$, until a distance of about 2700 Astronomical units (AU) is reached. So, even far from the Sun, a high accuracy method of accelerations determination is required.

Fortunately, it seems possible to use the trajectography of distant interplanetary spacecrafts because the perturbations of their accelerations are generally minima or known. This verification is possible because the constant acceleration $Hc$ does not change with the distance of the spacecraft from the Sun, while the gravitational acceleration does.

The accurate determination of the trajectory of these spacecraft is obtained by Doppler effect on radio signals, plus round trip time measurement of the modulated radio waves, sometimes using different frequencies. This is always one of the scientific objectives of these spacecrafts missions, because it is a mean to determine the gravitational field properties of the destination planets. Trajectography is also used for the verification of the Einstein’s relativity theory with an increased accuracy, and also for the knowledge of the characteristics of the interplanetary medium and of the Solar wind.

Specialized space trajectography groups are actually able to determine acceleration perturbations of interplanetary spacecrafts with an accuracy of the order of $10^{-10} \text{ m . sec}^{-2}$ at a distance of 80 AU from the Sun.

This is exactly what we need for the verification of this prediction of the Universons theory.

Nevertheless we cannot use any spacecraft trajectory for our purpose, because all spacecrafts are submitted to many acceleration perturbations, much larger than the one we would like to verify.

Without going into very complex details, it is important to know that only spacecrafts without permanent active attitude control systems permit the determination of the perturbations with the needed accuracy. But the natural perturbation caused by the radiation pressure from the Sun, which changes the acceleration with the spacecraft attitude, has to be sufficiently small to render the verification possible. This is generally the case when the heliocentric distance becomes larger than about 17 to 20 AU.

Many perturbations must also be known:

- The gravitational acceleration from the Sun.
- The gravitational acceleration from the planets and their satellites.
- The solar radiation pressure.
- The acceleration caused by the pressure of the solar wind made of particles.
- The acceleration caused by the thermal radiation of the spacecraft cooling system.
- The thermal radiation of the radio-isotopic electric generators.
— The numerous accelerations caused by the spacecraft systems themselves, such as the attitude control system.
— The undesired micro leaks of the pressurized systems.
— The accelerations caused by the radiation pressure of the radio transmitters. Etc ...

All these perturbative accelerations must be modeled, carefully followed, and recognised by their temporal or distance variation, by a regular determination of the trajectory of the spacecraft.

Other phenomena are taken into account:
— The modifications of the interplanetary medium.
— The density of the solar corona
— The inexactitude of time synchronisation between ground stations.

The use of the trajectography of terrestrial spacecrafts must be excluded for our verification, because the uncertainty of the perturbations in Earth orbit are much larger than the effect we want to see.

Consequently, to be able to measure an acceleration of the order of $7 \times 10^{-10}$ m / s$^2$ with minimum error, we must choose spacecrafts in free flight, as far as possible from the gravitational and residual atmospheric perturbations of the solar system planets, and from the Sun.

The list of spacecrafts corresponding to our trajectory constraints is quite short. They are old interplanetary spacecrafts, the only ones far from the larger gravitational perturbations.

The existing spacecrafts with a trajectory determination and perturbations corresponding to our needs are the following:

*Pioneer 10, Pioneer 11, Galileo, Ulysses.*

(Ulysses being questionable)

Precisely, NASA has observed, since more than 20 years, for all these four spacecrafts, a constant, unmodeled acceleration, towards the Sun. This acceleration modifies the trajectories of these spacecrafts in a way incompatible with the laws of Kepler and Newton. (Figure below).

![Fig. 32 — Accelerations of Pioneer 10 & Pioneer 11, versus their heliocentric distance (From Anderson & al. 2002 [1]). A constant acceleration is added to the known solar gravitational acceleration of the two vehicles. Its average value is equal to $H_c$. No technical cause was found for the constant acceleration.](image)

This acceleration adds to the main acceleration applied to these spacecrafts, which is the solar gravitational pull.

There are **good agreements** between the supplementary acceleration measured from these four spacecrafts and the prediction of the Universons theory:

Propelling phenomenon from superconducting ceramics
Spacecrafts trajecotory confirms the prediction of the $Hc$ acceleration, caused by the Universe expansion in the Universons model.

But this prediction of a «cosmological» supplementary acceleration must also apply to the natural objects submitted to gravitation, modifying the Newton’s law when the gravitational acceleration has an amplitude of the same order of magnitude as the Hc acceleration, or even lower than that.

That is what we are going to consider now.

**PREDICTED BEHAVIOUR OF GRAVITATION AT VERY LOW ACCELERATION LEVELS IN THE UNIVERSONS MODEL :**

The Universe expansion has a particular importance in the Universons model, because any acceleration of matter is accompanied by a supplementary acceleration, which is constant, equal to the $Hc$ product, and oriented in the same direction as the acceleration $A$ applied on matted by an external cause.

The same phenomenon manifests itself evidently when the main acceleration of matter is a Newtonian gravitational acceleration $A_N$ such as :

$$A_N = \frac{G \, M_G}{D^2}$$  \hspace{1cm} (22)

Where $M_G$ is the «source» mass of the gravitational acceleration, situated at a distance $D$, and where $G$ is the universal gravitational constant.

So, in fact, in the Universons theory, the real gravitational acceleration $A_G$ is not equal to $A_N$ but to :

$$A_G = Hc + A_N = Hc + \frac{G \, M_G}{D^2}$$  \hspace{1cm} (23)

Moreover, in this theory, the Newtonian gravitational acceleration $A_N$ is caused by a flux of Universons successively captured by the two masses of matter, and this flux is the object of random fluctuations. The universal gravitational «constant» $G$ seems to be proportional to the natural Universons flux intensity, so it is also submitted to the random fluctuations of the flux. Consequently, the Newtonian gravitational acceleration $A_{N'}$ which is proportional to $G$ is submitted to the same random fluctuations.

These random fluctuations follow the Laplace-Gauss statistics, this means that they are defined by two values : on the one hand, by the mean value $A_N$ and, on the other hand by the standard deviation $\sigma_N$ which is equal, in this case, to :

$$\sigma_N = (A_N)^{1/2}$$  \hspace{1cm} (24)

In the same way, the acceleration $Hc$ is submitted to the local random fluctuations of the Universons captures from the flux which is the cause of the Newtonian gravitational acceleration. These fluctuations are also following the Laplace-Gauss statistics, which means that they are also defined by a mean value $Hc$ and a standard deviation $\sigma_H$ which is equal to :
\[ \sigma_H = (Hc)^{1/2} \]  

(25)

Nevertheless, the random fluctuations of \( A_N \) and of \( Hc \) are caused by local phenomena separated by the distance \( D \), consequently, these fluctuations are, in principle not synchronous. We can suppose that the two fluctuations are independent. This point is important to take into account.

**STANDARD DEVIATION OF THE REAL ACCELERATION \( A_G \):**

In the general case where the Newtonian gravitational acceleration is *much larger than* acceleration \( Hc \), the real gravitational acceleration \( A_G \) is also submitted to random fluctuations following the Laplace-Gauss statistics. Its histogram is represented by a bell shaped curve called “Gauss curve”. This is illustrated by curve A on figure 33.

These statistics have a probability density function which is :

\[ f(A) = \left( \frac{0.399}{\sigma} \right) \exp\left\{ (\bar{A}-A)/(2\sigma^2) \right\} \]  

(26)

Where the mean acceleration is \( \bar{A} \) and the standard deviation is \( \sigma \).

The mean acceleration is given by :

\[ \bar{A} = A_N + Hc \]  

(27)

But the \( A_G \) standard deviation \( \sigma_G \) is supposed to be the one of the sum of two accelerations with independent random fluctuations.

Let us consider the total standard deviation \( \sigma_G \) of these two random fluctuations which importance is considerable as we will show later.

First of all, we suppose that the two phenomena that are acting (\( A_N \) and \( Hc \)) have proper fluctuations that are completely independant (not synchronous). In fact, for the moment we ignore if this is true.

In this hypothesis, statistical physics says that the total standard deviation \( \sigma_G \) is the square root of the sum of the squares of the individual standard deviations of the two fluctuating accelerations. So in this hypothesis :

\[ \sigma_G = \left( \sigma^2_N + \sigma_H^2 \right)^{1/2} = \left( A_N^2 + (Hc)^2 \right)^{1/2} \]  

(28)
We can use the series development of the following expression to understand what happens:

\[(1+x)^{1/2} = 1 + (1/2) x - (1.1 / 2.4) x^2 + (1.1.3/ 2.4.6) x^3 - \ldots\]

And writing expression (28) the following way:

\[
\sigma_G = Hc \left( A_n^2 / (Hc)^2 + 1 \right)^{1/2} \tag{29}
\]

With

\[
x = \left( A_n / (Hc) \right)^2 \tag{30}
\]

Then we demonstrate easily that, if the Newtonian gravitational acceleration \( A_n \) decreases up to the point it becomes slightly larger than \( Hc \), then equal to, and finally inferior to \( Hc \), the total standard deviation \( \sigma_G \) decreases until becoming constant:

For example:

- If \( A_n = 2 \ Hc \) then \( \sigma_G = 2.23 \ Hc \)
- If \( A_n = Hc \) then \( \sigma_G = 1.414 \ Hc \)
- If \( A_n = 0.5 \ Hc \) then \( \sigma_G = 1.118 \ Hc \)
- If \( A_n = 0.1 \ Hc \) then \( \sigma_G = Hc \)

In this hypothesis, the standard deviation \( \sigma_G \) of the fluctuations of the composite acceleration would only depend on \( Hc \) at the very low levels of the gravitational acceleration.

**But this is not possible.**

Effectively, we have demonstrated previously that the creation of the acceleration \( Hc \) implies the previous existence of an anisotropy of re emission of the Universons, so the existence of a non null Newtonian acceleration \( A_n \).

But the previous results imply a standard deviation \( \sigma_G \) of the fluctuations of the resultant acceleration which is independant of \( A_n \), including when \( A_n = 0 \).

So, manifestly, expression (28) is erroneous, and the hypothesis that is at the root of this expression is false.

In reality, the fluctuations of \( Hc \) are not independent of \( A_n \), because it is each anisotropically re-emitted Universon (because of the existence of \( A_n \)) which manifests the \( Hc \) acceleration. Therefore, the amplitude of the fluctuations giving the standard deviation \( \sigma_G \) are proportional to the amplitude of the fluctuations giving the standard deviation \( \sigma_H \).

If we want that the resultant standard deviation \( \sigma_G \) becomes nil when \( A_n \) is nil, it is absolutely necessary that the real relation between these parameters should be:

\[
\sigma_G = \sigma_N \sigma_H = (A_n \ Hc)^{1/2} \tag{31}
\]

We can see now that when \( A_n \) is nil, we have also \( \sigma_G \) nil.

But this supposes evidently that the distribution of the random fluctuations of the Universons flux responsible of the acceleration \( A_n \) follows the Laplace-Gauss distribution.

**LIMITS OF THE LAPLACE-GAUSS STATISTICS:**

Let us consider what happens when the Newtonian gravitational acceleration amplitude
is reduced. The mean value of the real gravitational acceleration, which is the position of the maximum of its histogram, is evidently reduced also.

It moves towards the origin, from A to B in figure 33. The practical half width of the gauss curve of the histogram is about three times the standard deviation $\sigma$. So, the continuous reduction of the mean Newtonian acceleration, caused by the increase of distance $D$ between the two masses, can bring the Gauss curve to position B, where the left wing foot of the curve is close to zero acceleration for 3 standard deviations under the mean acceleration.

This means simply that the real gravitational acceleration will be nil for about 1% of the time when:

$$\tilde{A} = 3 \sigma = 3 \left(A_N Hc\right)^{1/2} \quad (32)$$

And with (6):

$$A_N + Hc = 3 \left(A_N Hc\right)^{1/2} \quad (33)$$

This relation has two solutions:

$$A_{N1} = 0,15 Hc \quad \text{and} \quad A_{N2} = 6,85 Hc \quad (34)$$

With $Hc = 7,29 \cdot 10^{-10} \text{ m / s}^2$:

$$A_{N1} = 1,1 \cdot 10^{-10} \text{ m / s}^2 \quad \text{which is case D solution}$$

and

$$A_{N2} = 5 \cdot 10^{-9} \text{ m / s}^2 \quad (35)$$

So, when the Newtonian gravitational acceleration reaches $5 \cdot 10^{-9} \text{ m / s}^2$, the histogram of the real gravitational acceleration reaches position B on figure 33.

On the other hand, when the Newtonian gravitational acceleration is larger than $A_{N2}$ then the histogram is situated far from the origin, like in position A of figure 33.

What happens when the Newtonian acceleration is between the two preceding values, for example when $A_N = Hc$?

Then, the histogram of the real gravitational acceleration, composed of $A_N$ and $Hc$ moves towards the origin, as in case C of figure 33, and the real acceleration becomes null when the instantaneous acceleration is smaller than one standard deviation under the summit value of the truncated bell shaped curve.

Nevertheless, we cannot take into account negative values of the gravitational acceleration. Effectively, the Newtonian gravitational acceleration is caused by an anisotropic flux of Universons coming from the direction of the center of mass of the second body. If the acceleration was allowed to become negative, this would mean that the corresponding flux would have to come from an opposed direction, from a direction where there is no other body, which is evidently impossible.

For this reason, the resultant acceleration can become nil but is not allowed to become negative. This is what is illustrated on figure 33.

Finally, when $A_N < 10^{-10} \text{ m / s}^2$ the real gravitational acceleration has an histogram analog to case D in figure 33.

Evidently, histograms of types C or D do not correspond to a distribution of the random fluctuations defined by the Laplace-Gauss statistics.

These histograms are of the Poisson type statistics. The Poisson statistics probability density being represented by:

Propelling phenomenon from superconducting ceramics
\[ f(n) = \left( \frac{\lambda^n}{n!} \right) e^{-\lambda} \]  

Where \( n \) is the number of Universons involved in the inception of the Newtonian gravitational acceleration, number which is proportional to \( A_N \) and where the \( \lambda \) parameter replaces the standard deviation, with:

\[ \lambda = (A_N Hc)^{1/2} \]  

However the mean value of the acceleration, in a Poisson distribution of the quantum fluctuations, is absolutely not the same value as in a Laplace-Gauss distribution.

This appears evident when looking at curves A and D in figure 33. In the Poisson distribution, the mean value of the acceleration is simply the value of the parameter \( \lambda \) of the distribution.

So, when the Newtonian gravitational acceleration becomes smaller than the preceding boundaries, the mean value of the real gravitational acceleration becomes equal to:

\[ A_G = \lambda = (A_N Hc)^{1/2} \]  

**SUMMARIZING:**

1 — When the Newtonian gravitational acceleration \( A_N \) is larger than \( 5 \times 10^{-9} \) m/s\(^2\) then the mean real gravitational acceleration \( A_G \) is equal to:

\[ A_G = A_N + Hc \]  

2 — When the Newtonian gravitational acceleration \( A_N \) is smaller than \( 10^{-10} \) m/s\(^2\) then the mean real gravitational acceleration \( A_G \) is equal to:

\[ A_G = (A_N Hc)^{1/2} \]  

3 — When the Newtonian gravitational acceleration amplitude \( A_N \) is comprised between B and D limits: \( 10^{-10} \) m/s\(^2\) and \( 5 \times 10^{-9} \) m/s\(^2\) then the mean real gravitational acceleration \( A_G \) is not modelled by the Laplace-Gauss statistics, and neither modelled by the Poisson statistics.

Nevertheless, it appears, experimentally approximately modelled, in this small zone, by the following hybrid expression:

\[ A_G = A_N + (A_N Hc)^{1/2} \]  

This is a combination of expressions (39) and (40), in the relatively “fuzzy” zone where the two types of statistics are at the limit of their mathematical validity. These considerations are summarized in figure 34, where the experimental confirmations are also indicated.

In statistic physics, the Laplace-Gauss distribution is the limit of the Poisson distribution, when the number of Universons involved in the Newtonian gravitational acceleration becomes very large. So it is perfectly normal to change the type of distribution when the number of Universons involved is largely modified.

The Laplace-Gauss statistics concerns quasi continuous phenomena, while the Poisson statistics concerns quantified phenomena, with a small number of quanta.

**THESE PREDICTIONS CONCERN THE DYNAMIC BEHAVIOUR OF GALAXIES:**

We are going to show, by an example, that the validity limits of Gaussian and Poissonian statistics in the accelerations random fluctuations have to be applied when considering the dynamic behaviour of astronomical objects, such as the spiral galaxies.
Let us consider a spiral galaxy where its central bulb has a mass of $5 \times 10^{40}$ kg. This corresponds to a content of about 25 billions of solar type stars, a very classical stellar density in the central region of such galaxies.

One can easily calculate, from expression (22), that the Newtonian gravitational acceleration reaches the preceding validity limits when the distance $D$ of the stars, from the galactic center, is equal to:

$$D_1 = 5800 \text{ parsecs}$$

and

$$D_2 = 860 \text{ parsecs}$$

These are distances very close to the galactic center, because most of these galaxies have a total diameter of the order of 30 000 parsecs. (One parsec is about equal to $3.10^{16}$ meters).

Consequently, according to the results of the Universons model, the quasi totality of the stars of the galactic discs of spiral galaxies are submitted to a real gravitational acceleration defined by expression (40) and not by the Newton’s relation (22).

The dynamic behaviour of these galaxies must be largely affected by this result.

**THE UNIVERSONS MODEL AND THE TULLY-FISHER LAW:**

The Universons theory predicts that the quasi totality of the stars of the galactic discs of spiral galaxies are submitted to a real gravitational acceleration defined by expression (37). Bringing in this relation the value of $A_N$ defined by expression (1), we get:
\[ A_G = \frac{(G M_G Hc)^{1/2}}{D} \]  \hspace{1cm} (44)

The circular orbital speed of the stars \( V \) is such that the centrifuge acceleration compensates exactly the real gravitational acceleration, so:

\[ \frac{V^2}{D} = A_G = \frac{(G M_G Hc)^{1/2}}{D} \]  \hspace{1cm} (45)

And it comes:

\[ V^2 = (G M_G Hc)^{1/2} \]  \hspace{1cm} (46)

So:

\[ V^4 = G M_G Hc \]  \hspace{1cm} (47)

This expression is simply the Tully-Fisher relation for spiral galaxies, a very well known law used by astronomers, discovered experimentally, from the observation of many rotation curves of galaxies and later justified by the “viriel” theorem.

But, here this empirical relation is physically justified.

In fact, the original Tully-Fisher relation was between the luminosity of the galaxies and their rotation speed. But there is a mean relation between the luminosity and the mass of the stars in a galaxy. The Tully-Fisher relation attributed a different proportionality constant between \( V^4 \) and the luminosity. This means that the Tully-Fisher proportionality constant reflected the evolution age of the stars in each type of galaxy.

But in the real Tully-Fisher relation (47), it is mainly the stars mass that is acting, because these galaxies are relatively poor in gas mass, generally less than 20%.

Expression (47) demonstrates also that the orbital speed of the stars, in the galactic disc, is independent of the galactic radius. This is confirmed by all observations, since more than 50 years, but this was unexplained until now.

THERE IS NO “DARK MATTER” HYPOTHESIS NEEDED:

Expression (47) does not use any dark matter mass hypothesis to explain the quasi constant orbital speed of the stars in the disc of spiral galaxies. This confirms the fact that the hypothetic “dark matter” has never been put into observational evidence.

Let us consider a simple example, with a spiral galaxy composed of a hundred billions stars of the solar type \((2.10^{30} \text{ kg})\) and no gas. Its total luminosity would be comparable to the luminosity of the brightest spiral galaxies really observed. Expression (47) tells us that the orbital rotation speed of the stars in the disc of such a galaxy should be 314 km/s, an order of magnitude in the range of the rotation speeds observed.

On the other hand, if such a galaxy had a total mass ten times larger, as it is suggested by the dark matter hypothesis, its rotation speed would be, according to (47), equal to 560 km/s, a value never observed. The observed rotation speeds of the real spiral galaxies are between 100 and 330 km/s.

CONFIRMATION OF THE EFFECT OF RANDOM FLUCTUATIONS:

The first spectroscopic, optical measurements of the orbital speed of stars in spiral galaxies has been done around 1920, a few years before the extragalactic nature of these objects has been recognised. The generalization of such observations to the external parts of the galactic discs had nevertheless to wait until 1970-80, thanks to the radio interferometric methods on the 21 cm line of neutral hydrogen.
Our verification is precisely based on the observation of spiral galaxies. As we have shown, the Newtonian gravitational acceleration $A_N$ of the stars, in the discs of these galaxies is largely smaller than $Hc$. This acceleration is larger than $Hc$ only for the stars orbiting at a distance smaller than about 10% of the total galactic radius. So, relation (47) must apply for about 90% of the galactic discs.

This means that the orbital speed of the stars, in this region, must be quasi independent of their orbital radius, a fact confirmed by observations since a long time, and illustrated by figure 35.

Moreover, the “plateau speed” must be roughly proportional to the fourth root of the total mass of each galaxy. This means that each individual galaxy must have its own “plareau speed” of rotation. This is also very clear in the figure 35 observations.

Finally, because the speed is proportional to the fourth root of the total mass, one must observe a relative modest dispersion of the rotation speeds between the different galaxies. In figure 35, the speed dispersion is of a factor 1.6, implying a mass dispersion of a factor 8 between the galaxies of this sample, a dispersion which is confirmed by the ratio of their relative luminosity. The galaxies of the sample used are the closest, so their rotation curve and luminosity are the most accurately known.

One can complete this verification with the help of a computer simulation, in order to calculate the orbital speed of the stars all along the galactic radius, taking into account the real distribution of the mass, deduced from the observed distribution of the luminosity of the stars along the galactic radius.

This is what has been done for the NGC 224 galaxy, in figure 36, on the basis of expression (47). This very simple simulation does not take into account the local variations of the stars density in the spiral arms of the real galaxy, which explains the undulations of the real speed curve as compared to the simulated one. But it is quite clear that the simulation result is correct.

Figure 36 computer simulation uses only the stars and gas mass, in expression (47) to calculate the rotation speed of matter in the galaxy.

The same reasoning, using expression (44), has been used to justify the apparently anomalous mass to luminosity ratio of clusters of galaxies, proportional to their overall radius, without any use of dark matter.

These demonstrative results show that the random fluctuations of the Universons theory are able to explain the dynamic behaviour of the spiral galaxies, and of clusters of galaxies, without any call to the dark matter hypothesis.
CONCLUSIONS OF SUPPLEMENTARY ANNEX II:

The Universons model predicts new facts. And these facts are effectively observed. They are tied to the Universe expansion and to the random fluctuations associated with the Universons flux quantization.

On the one hand, the Universe expansion introduces a very tinny supplementary constant acceleration $H_c$ that adds to any acceleration in the Universe, whatever the cause of the main acceleration.

On the other hand, the quantization of gravitational acceleration implies random fluctuations, and a particular behaviour at very low acceleration levels is predicted, because of the presence of the acceleration $H_c$.

Thanks to these predictions, quite old observation results, unexplained until now, find simple and evidentjustifications without calling for unobserved dark matter hypothesis. These are the quasi constant orbital speed of the stars in spiral galaxies, the proper speed of galaxies in clusters, or the observed constant supplementary acceleration $H_c$ of all distant interplanetary spacecrafts.

Evidently, these predictions have also important cosmological consequences, because they wipe out the existence of the dark matter hypothesis, concerning the main constituent of the Universe.

This is, without doubt, one of the most important aspects of the Universons model, enhanced by the reality of its predictions. There exists, everywhere in the Universe, a quantized flux of energy of an extraordinary power. Matter seems able to extract directly kinetic energy from this flux, and the flux appears to be the cause of the mass of matter in all the Universe.

This is a perspective that surpass quite largely the frame of the tentative done to explain our laboratory experiments with superconducting ceramics.
SUPPLEMENTARY ANNEX III

FLUCTUATIONS OF POSITION AND MOMENTUM OF MATTER PARTICLES CAUSED BY INTERACTION WITH THE UNIVERSONS FLUX

Claude POHER and Patrick MARQUET

Consequences of the random fluctuations in the Universons model:

This model is presented in supplementary Annex I.

The first main consequence of this model is a permanent capture and re-emission of Universons of the natural isotropic flux, by all the elementary particles of matter having a proper mass.

The total average number $N$ of Universons captured isotropically by a particle of matter at rest, during the capture time $\tau$ remains constant. The product of this number by the Universon energy $E_u$ is equal to $M_o c^2$ product of the rest mass $M_o$ of the matter particle by the square of the speed of light $c$. This fact imposes the following fundamental relations between parameters of the model:

$$N E_u = M_o c^2$$

(1)

And:

$$\tau S F_u E_u / c^2 = I$$

(2)

Expression where:

— $F_u$ is the intensity of the natural isotropic flux of free Universons. This intensity is measured in Universons per second, per square meter, coming from the $4 \pi$ steradians.

Fig. 37 — The matter particle internal “small clock”. In order to re-instate the Newtonian law $F = M_o a$, we demonstrated relations (4) and (5). $N$ is thus the number of Universons captured during time $\tau$. The number of captured Universons per second, is $f = N/\tau$. Therefore $f$ is the frequency of energy transfers, and as such it may be regarded as a quasi regular “beating” clock, even if the instants of interaction are randomly distributed, because the average energy $M_o c^2$ must remain constant.

A similar result exists obviously for the instantaneous momentum of a matter particle, with $E_u/c$ momentum steps.
— $S$ is the « specific capture cross section » of Universons by particles of matter which is not an area, but « an area per kilogram of matter particle mass ».
— $A$ is the acceleration of the matter particle.

Obviously, the instantaneous energy of an elementary particle of matter changes by an amount $+Eu$ when an Universon is captured, and it changes by an amount $-Eu$ when the Universon is re-emitted. This phenomenon should create permanent energy, position, and momentum fluctuations of all the matter particles of the Universe.

This is shown in Figure 37.

**THE DOUBLE SOLUTION THEORY OF LOUIS DE BROGLIE.**

**Roots of the double solution theory**

For almost a century, the wave-particle duality first discovered by Einstein, in his “Theory of Light Quanta”, has been the basis of present-day Quantum Physics. As an essential contribution, the “Wave Mechanics theory” of Louis de Broglie has successfully extended this duality to all known particles [4], [5].

Shortly after, de Broglie further developed the “Double Solution Theory” based on two striking observations [6]:

— Within the special theory of relativity, it is noticed that the frequency $\nu_0$ of a plane monochromatic wave is transformed as $\nu = \nu_0 (1 - \beta^2)^{1/2}$ whereas a clock’s frequency $\nu_0$ is transformed according to $\nu = \nu_0 (1 - \beta^2)^{-1/2}$ with the phase velocity $V = c/\beta = c^2/\nu$. Where $\nu = \beta c$

— It is also noticed that the 4-vector defined by the gradient of the plane monochromatic wave can be linked to the energy-momentum 4-vector of a particle by introducing Planck’s constant $h$, thus writing:

$$W = h \nu, \quad \lambda = h/p$$

Therefore, the particle has an internal vibration which is constantly in phase with that of the surrounding wave. This sounds familiar with Fig. 27 result.

**First notion of guidance**

In the spirit of the double solution theory, the quantum mechanics wave $V$ is regarded as a physical one having a very small amplitude which cannot be arbitrarily normalized and which is distinct from the $\psi$ wave having a statistical significance in the usual quantum mechanical formalism.

Wave $V$ is connected to the $\psi$ wave by the normalizing relation $\psi = C \cdot V$, where $C$ is the normalizing factor. The $\psi$ wave has then the nature of a subjective probability representation formulated by means of a the objective $V$ wave, because $\psi$ and $V$ are the two solutions of the same equation.

The complete solution of the equation representing the $V$ wave being written as:
\[ V = a(x, y, z, t) \cdot \exp \left[ (i/\hbar) \phi(x, y, z, t) \right] \quad \hbar = \hbar / 2\pi \]  

(4)

Where \( a \) and \( \phi \) are real functions. Energy \( W \) and momentum \( p \) of the particle, localized at point \( x, y, z \), at time \( t \) are given by:

\[ W = \partial_t \phi \quad \text{and} \quad p = -\text{grad} \phi \]  

(5)

Which in the case of a plane monochromatic wave, where one has \( \phi = \hbar [vt - (\alpha x + \beta y + \gamma z) / \lambda] \) yields equation (3) for \( W \) and \( p \).

— If in equation (5), \( W \) and \( p \) are given as \( W = M_0 c^2 (1 - \beta^2)^{-1/2} \) and \( p = M_0 v (1 - \beta^2)^{-1/2} \), one obtains:

\[ v = c^2 p / W = -c^2 (\text{grad} \phi) / \partial_t \phi \]  

(6)

which is called by Louis de Broglie the “guidance formula” determining the particle’s motion in the wave. *In the general case of a wave which is not plane monochromatic it can also be shown that the particle’s internal vibration is constantly in phase with the wave on which it is carried.*

— The proper mass \( M_0 \) which enters the relation giving \( M \) and \( p \), is generally not equal to the proper mass \( m_0 \) usually given to the particle. One has:

\[ M_0 = m_0 + Q_0 / c^2 \]  

(7)

Where, in the particle rest frame, \( Q_0 \) is a positive or negative variation of this rest mass, and it represents the “quantum potential” which causes the wave function’s amplitude to vary.

**Guidance formula and Quantum Potential**

Taking Schrödinger’s equation for the scalar wave \( V \), \( U \) being the external potential, we get:

\[ \partial_t V = (\hbar / 2im) \Delta V + (i/\hbar) U.V \]  

(8)

This equation implies that \( V \) be represented by two real functions linked by the two real equations which leads to:

\[ V = a \cdot \exp(i \phi / \hbar) \]  

(9)

Where \( a \) the wave amplitude, and \( \phi \) its phase, are both real. Taking this value into equation (8) gives:

\[ \partial_t \phi - U - (1/2m) (\text{grad} \phi)^2 = (-\hbar^2 / 2m) \Delta a / a \]  

(10)

\[ \partial_t (a^2) - (1/m) \text{div} (a^2 \text{grad} \phi) = 0 \]  

(11)

Equation (10) is the “Jacobi’s generalized equation”, and equation (11) “the continuity equation”.

— Why is it the continuity equation?

Making use of the guidance formula (6) and setting \( \rho = K a^2 \), \( (K = \text{constant}) \), equation (11) becomes:

\[ \partial_t \rho + \text{div} (\rho v) = 0 \]
This is the familiar form of the hydrodynamics continuity equation of a conserved fluid of density $\rho$. And $\rho \, d\tau$ can be the number of the fluid molecules in the volume element $d\tau$ and $\mathbf{v}$ the velocity.

With a normalization factor $\rho \, d\tau = a^2 (x,z,t) \, d\tau$ we get the probability of finding the single particle at time $t$ in the volume element $d\tau$, at position $x,y,z$.

This hydrodynamic model is however not adequate by itself for it contains nothing to describe the actual location of the particle: by examining a simple quantized state (Hydrogen atom), inspection shows that the guidance formula gives $\mathbf{v} = \mathbf{0}$.

As we shall see, this leads to introduce a random perturbation superimposed onto the guided motion which can be conveniently described by the Univerisons theory.

If terms involving Planck’s constant $\hbar$ in equation (10) are neglected (which amounts to disregard quanta), and if we set $\phi = S$, this equation becomes:

$$\partial_t S - U = (1/2m) (\text{grad } S)^2$$

As $S$ is the Jacobi function, equation (12) is therefore the Jacobi equation of classical mechanics.

Only the term with $\hbar^2$ is responsible for the particle’s motion being different from the classical motion.

It can be interpreted as another potential $Q$ distinct from the classical U potential:

$$Q = - (\hbar^2 / 2m) \Delta a / a$$

By analogy with the classical formula $\partial_t S = E$, and $p = -\text{grad } S$, $E$ and $p$ being the classical energy and momentum, one may write:

$$\partial_t \phi = E - \text{grad } \phi = p$$

As in non-relativistic mechanics, where $p$ is expressed as a function of velocity by the relation $p = m \, v$, one eventually finds the following result:

$$v = p / m = - (1/m) \text{grad } \phi$$

This equation is again called “guidance formula“. It gives the particle’s velocity, at position $x,y,z$ and time $t$ as a function of the local phase variation at this point.

**Dynamics of variable proper mass**

As mentioned earlier, the guided motion is performed according to relativistic dynamics of a variable proper mass.

Let us consider the relativistic Lagrange function

$$\mathcal{L} = - M_0 c^2 (1 - \beta^2)^{1/2}$$

The principle of least action $\delta \int_0^t \mathcal{L} \, dt = 0$ yields the Lagrange equations:

$$d(\partial \mathcal{L} / \partial \dot{q}_k) / dt = \partial L / \partial q_k \quad (\dot{q} = \partial_t q) \quad (k = 1,2,3)$$

Which are here:
\[ \frac{d \mathbf{p}}{dt} = -c^2 (1 - \beta^2)^{1/2} \text{grad} M_0 \]  

(18)

This shows that the particle obeys relativistic dynamics of a variable proper mass. Relation (18) may be complemented by:

\[ dW/dt = c^2 (1 - \beta^2)^{1/2} \cdot \frac{\partial M_0}{\partial t} \]  

(19)

and as:

\[ dM_0/dt = \frac{\partial M_0}{\partial t} = c^2 (1 - \beta^2)^{1/2} \cdot dM_0/dt \]

The previous equations give:

\[ dW/dt - \mathbf{v} \cdot \frac{\partial \mathbf{p}}{\partial t} = c^2 (1 - \beta^2)^{1/2} \cdot dM_0/dt \]  

(20)

taking into account

\[ \mathbf{v} \cdot \frac{d\mathbf{p}}{dt} = \left[ \frac{d(\mathbf{v} \cdot \mathbf{p})}{dt} \right] - \mathbf{p} \frac{d\mathbf{v}}{dt} = d(\mathbf{v} \cdot \mathbf{p})/dt - M_0 \mathbf{v} (1 - \beta^2)^{1/2} \cdot d\mathbf{v}/dt \]

\[ c^2 (1 - \beta^2)^{1/2} \cdot dM_0/dt = d(M_0 c^2 (1 - \beta^2)^{1/2} + M_0 \mathbf{v} (1 - \beta^2)^{1/2} \cdot d\mathbf{v}/dt) \]  

(21)

we get:

\[ d\left[ W - \mathbf{v} \cdot \mathbf{p} - M_0 c^2 (1 - \beta^2)^{1/2} \right] = 0 \]  

(22)

The bracket in (22) is equal to zero when the particle is at rest, with \( W = M_0 c^2 \), one must always have:

\[ W = M_0 c^2 (1 - \beta^2)^{1/2} = M_0 c^2 (1 - \beta^2)^{1/2} + M_0 \mathbf{v}^2 (1 - \beta^2)^{1/2} \]  

(23)

relation known as the “Planck-Laue” formula.

**Particles with internal vibration and heat content**

*The idea of Louis de Broglie considering the particle as a small clock is of central importance here.*

Not only does this concept fit in the present theory, but it also allows for a perfect description of the “in” and “out” transfers of energy by Universons to a massive particle, which eventually leads as we shall see, to a major consequence.

Let us look at the self energy \( M_0 c^2 \) as the “hidden heat content” of a particle.

One easily conceives that such a small clock has (in its proper system) an internal periodic agitation energy which does not contribute to the momentum of the whole. This energy is similar to that of a heat containing body in thermal equilibrium. Let \( Q_0 \) be the heat content of the particle, in its rest frame, and viewed in a frame where the body has a velocity \( \beta c \), the contained heat will be:

\[ Q = Q_0 (1 - \beta^2)^{1/2} = M_0 c^2 (1 - \beta^2)^{1/2} = h \nu_0 (1 - \beta^2)^{1/2} \]  

(24)

The particle thus appears as being at the same time as a small clock of frequency

\[ \nu = \nu_0 (1 - \beta^2)^{1/2} \]

and as a small reservoir of heat \( Q = Q_0 (1 - \beta^2)^{1/2} \) moving with velocity \( \beta c \).

Remember : This identity of relativistic transformation formulae for a clock frequency and for heat, is essential for the consistency of both theories.
— If $\phi$ is the phase of the wave $a.exp(i\phi/h)$, where $a$ and $\phi$ are real, the guidance theory states that:

$$\partial_\tau \phi = M_0 c^2 (1 - \beta^2)^{-1/2}$$

And

$$- \text{grad} \phi = M_0 v (1 - \beta^2)^{1/2}$$

(25)

On the other hand, equation (24) may be written:

$$Q = M_0 c^2 (1 - \beta^2)^{1/2} = M_0 c^2 (1 - \beta^2)^{1/2} - v.p$$

(26)

Combination of (25) and (26) then gives:

$$M_0 c^2 (1 - \beta^2)^{1/2} = \partial_\tau \phi + v. \text{grad} \phi = d\phi/dt$$

(27)

But since the particle is likened to a clock of proper frequency $\nu_0 = M_0 c^2 / h$, the phase of its internal vibration written as $a_i exp(i\phi_i/h)$ with $a_i$ and $\phi_i$ being real, is:

$$\phi_i = h \nu_0 (1 - \beta^2)^{1/2} \cdot t = M_0 c^2 (1 - \beta^2)^{1/2} \cdot t$$

(28)

And therefore

$$d (\phi_i - \phi_i) = 0$$

(29)

This agrees with the fundamental assumption according to which the particle as it moves in its wave, remains constantly in phase with it.

Thus, there exists a close relation between the guidance theory and relativistic thermodynamics which comes as an implicit confirmation of the Universons theory.

**Relativistic thermodynamics for the single particle**

Within the Universons theory, the particle of mass $M_0$ with proper internal energy $W_0 = M_0 c^2$ is assumed to undergo the influence of the universons which is carried along by a field hereinafter denoted by the $U$-Field.

For reasons which will become clear, this field is acting as a hidden “thermostat” yielding a heat quantity variation $\delta Q_\theta$ according to:

$$\delta Q_\theta = \delta W_0 = \delta M_0 c^2$$

The $U$-Field in contact with the particle is thus here equivalent to having a mass increase which is an adequate approach for introducing the isolated particle entropy in the present theory.

**a) Mean quantum potential state**

We have seen that the quantum potential $Q$ is defined within a contant, that is:

$$Q_\theta = M_0 c^2 - m_0 c^2$$

(30)

The mean value $<Q>$ of this potential applied to the amplitude $a$ of the associated wave function $\psi$ in the volume $V$ is well known:

$$<Q> = \int Q a^2 d\psi$$

(31)

which is shown to be always positive.
If the rest energy of a particle of variable proper mass \( M_0 \) in its rest frame, is given by:

\[ W = M_0 c^2 \]

we define \( T_0 \) as the corresponding temperature of this particle having a heat content \( Q_0 \).

In the R’ frame moving with velocity \( v = \beta c \), these quantities become:

\[ T = T_0 (1 - \beta^2)^{1/2} \quad Q = Q_0 (1 - \beta^2)^{1/2} \]

As a result, the entropy (32) is a relativistic invariant.

\[ \frac{dQ}{T} = s = s_0 \]  (32)

Moreover, we have

\[ W = M_0 c^2 (1 - \beta^2)^{-1/2} \]

\[ d_t [M_0 v (1 - \beta^2)^{-1/2}] = F \) (Force)

from this last equation, one deduces the expression of the work \( T \) transmitted to the particle over the time element \( \delta t \):

\[ \delta T = F v \delta t = v \delta [M_0 v (1 - \beta^2)^{-1/2}] = \delta W \]

Let us now evaluate this work variation assuming a slight fluctuation of the particle’s rest mass under the influence of the \textit{U-Field}.

In this case, the internal energy (stored energy) is changed by the quantity:

\[ \delta W_0 = \delta M_0 c^2 \]

Clearly, this variation corresponds to the heat quantity variation \( \delta Q_0 \) during a given finite mean time. In R’, the relativistic covariance implies:

\[ \delta Q = \delta Q_0 (1 - \beta^2)^{1/2} \]  (33)

\[ \delta W_0 = \delta M_0 c^2 \]

\[ \delta W_0 = \delta M_0 c^2 (1 - \beta^2)^{1/2} \]  (34)

we then have:

\[ \delta T = \delta W + v^2 (1 - \beta^2)^{-1/2} \delta M_0 \]  (35)

with the total variation \( \delta W_t \):

\[ \delta W_t = \delta W + c^2 (1 - \beta^2)^{-1/2} \delta M_0 \]

hence:

\[ \delta W_t = \delta T + \delta M_0 c^2 (1 - \beta^2)^{-1/2} \]  (36)

This last relation must be compared with the conservation principle of energy:

\[ \delta W = \delta T + \delta Q \]  (37)
Equation for the fluctuating mass

With the aid of relations (36) and (37), Louis de Broglie applies to a free particle with fluctuating rest mass $M_0$, the formula

$$\delta Q = - \delta \mathcal{L}$$  \hspace{1cm} (38)

where the relativistic Lagrangian is given by (16):

$$\mathcal{L} = - M_0 c^2 (1 - \beta^2)^{1/2} \text{ (first approximation)}$$

In addition, the \textit{U-Field} permanently in contact with matter, may be regarded as yielding a temperature $T$ to this non fluctuating rest mass $m_0$.

This temperature satisfies the following energy relations

$$kT = h \nu = h \nu_0 (1 - \beta^2)^{1/2} = m_0 c^2 (1 - \beta^2)^{1/2} \quad (k : \text{Boltzmann’s constant})$$

Louis de Broglie defines the entropy generated through the medium (U-Field), by writing:

$$s = s_0 + s (M_0)$$ \hspace{1cm} (39)

where $s_0$ is that part of entropy which does not depend on the fluctuating proper mass $M_0$.

The entropy variation corresponding to the fluctuation of the proper mass is then

$$\delta s = - \frac{\delta Q}{T} = \frac{\delta \mathcal{L}}{T}$$ \hspace{1cm} (40)

Sign (–) indicates that the heat is transmitted by the U-Field to the particle.

Finally, we obtain

$$\delta s = - k \frac{\delta M_0}{m_0}$$ \hspace{1cm} (41)

whereby

$$s = s_0 - k \frac{M_0}{m_0}$$ \hspace{1cm} (42)

According to Boltzmann’s relation $s = k \ln \mathcal{P}$ where $\mathcal{P}$ is the probability characterizing the system.

The probability of having the value $M_0$ for the fluctuating proper mass must then be proportional to

$$\exp \left( \frac{s}{k} \right)$$

that is:

$$\exp \left( - \frac{M_0}{m_0} \right)$$

Louis de Broglie eventually concludes that the mean value of the fluctuating proper mass $M_0$ for a single (free) particle is given by the equation:

$$\langle M_0 \rangle = \left[ \int_0^\infty M_0 e^{-M_0/m_0} dM_0 \right] / \left[ \int_0^\infty e^{-M_0/m_0} dM_0 \right] = m_0$$ \hspace{1cm} (43)

where the constant proper mass $m_0$ usually inherent to the particle, is actually the mean value of the instant variable proper mass $M_0$. 

Propelling phenomenon from superconducting ceramics
**Probable trajectory for a particle**

*a) Nearby trajectories*

Let us now consider the action along the particle’s path when no fluctuations arise. Between times $t_1$ and $t_2$, the classical action principle, reads:

$$\delta S = \int_{t_1}^{t_2} \partial \mathcal{L} \, dt = 0$$  \hspace{1cm} (44)

and for the second variation:

$$\int_{t_1}^{t_2} \delta^2 \mathcal{L} \, dt > 0$$  \hspace{1cm} (45)

We shall assume another possible physical trajectory for the particle between $t_1$ and $t_2$, where its internal energy may now fluctuate. Applied to this nearby trajectory, the action principle now becomes:

$$\int_{t_1}^{t_2} \delta (\mathcal{L} + \delta \mathcal{L}) \, dt = 0$$  \hspace{1cm} (46)

or

$$\int_{t_1}^{t_2} (\delta \mathcal{L} + \delta^2 \mathcal{L}) \, dt = 0$$  \hspace{1cm} (47)

However, subjected to the *U-Field*, the particle’s mass $M_0$ (energy) varies along this path, and the related Lagrangian $\mathcal{L}$ variation should be now written as :

$$\delta \mathcal{L} = (\delta \mathcal{L})_U + \delta U \mathcal{L}$$  \hspace{1cm} (48)

whereby, following Louis de Broglie’s convention : $(\delta \mathcal{L})_U$ represents the $\mathcal{L}$ variation when $M_0$ is kept constant. $\delta U \mathcal{L}$ is a small deviation of $\mathcal{L}$, when $M_0$ undergoes a slight fluctuation due to the *U-Field*.

For the second variation, we have :

$$\delta^2 \mathcal{L} = (\delta^2 \mathcal{L})_U + \delta^2 U \mathcal{L}$$  \hspace{1cm} (49)

Hamilton’s principle can be expressed as follows :

$$\delta S = \int_{t_1}^{t_2} \left[ (\delta \mathcal{L})_U + \delta U \mathcal{L} + (\delta^2 \mathcal{L})_U + \delta^2 U \mathcal{L} \right] \, dt = 0$$  \hspace{1cm} (50)

On the right hand side, the first integral cancels out by virtue of the above principle, and the 4th term can be neglected. (small second order variation). Finally, we find :

$$\int_{t_1}^{t_2} \delta U \mathcal{L} \, dt + \int_{t_1}^{t_2} (\delta^2 \mathcal{L})_U \, dt = 0$$  \hspace{1cm} (51)

or

$$- \int_{t_1}^{t_2} \delta U \mathcal{L} \, dt = \int_{t_1}^{t_2} (\delta^2 \mathcal{L})_U \, dt$$  \hspace{1cm} (52)

The first integral gives

$$- (t_2 - t_1) \delta U \mathcal{L}$$

where $\delta U \mathcal{L}$ represents a time averaged value between $t_1$ and $t_2$. Furthermore, relation (56) allows us to write:

$$- \delta U \mathcal{L} = \delta Q$$  \hspace{1cm} (53)
which corresponds to the time averaged internal energy transient increase, of the particle subjected to the U-Field during the finite time $\tau$.

Let us call

$$\delta(S_U)_\tau$$ (54)

the varied action containing the Lagrangian ($\delta(L,U)$).

We have thus the correspondence between the energy $E_U$ of a single Universon interacting with the rest particle, and the transient increase of its internal energy:

$$- (\delta(L,U)) = \delta Q = \delta M_0 c^2 = E_U$$ (55)

### b) Monochromatic states entropy

Between $t_1$ and $t_2$, the mean internal energy increase

$$\delta Q \quad (\sim \delta(L,U))$$ (56)

is zero along the “natural” trajectory of the particle, but from (52), and taking account (45), we see that it remains positive along the nearby or “fluctuated” trajectory.

In other words, the entropy $s$ decreases on average, when passing from the classical Hamilton varied trajectory, to the “fluctuated” path.

This can be also expressed by saying that the particle “classical path” is more probable than the ones postulated in the framework of the present theory.

What is really the physical meaning of a “natural path” compared with a trajectory of a particle with fluctuated internal energy?

For a clear distinction, we must consider the wave function $V$ defining the state of the associated particle.

A priori, “real” states present in nature, should be rather characterized by “wave packets” with a phase uncertainty.

However, current quantum theories have definitely shown that monochromatic states are the most stable states.

We shall demonstrate that the so-called “superposition states” bound to instability, are related to fluctuations, by means of statistical entropy concepts.

To this effect, let us first revert to the quantum potential $Q$ introduced by Louis de Broglie:

$$Q = M_0 c^2 - m_0 c^2$$ (57)

and consider the entropy relation

$$s = s_0 - k \frac{M_0}{m_0}$$ (58)

which leads to:

$$s = s_0 - k \frac{k Q}{c^2}$$ (59)

Besides, we know that the mean value of $Q$ in the volume $V$
remains positive.
The entropy of a superposition state will then have the mean value:
\[ s = s_o - k - k <Q> / c^2 \]  
which is clearly lower than the entropy of monochromatic states given by the standard value:
\[ s = s_o - k \]

MATCHING UNIVERSONS THEORY

a) Capture time instability

Following the above elements, we are now able to re-interpret the Universons theory. This theory essentially states that massless energetic particles (Universons) which we have identified to a scalar field (U-Field), are constantly penetrating a particle with an equal number of Universons leaving out this particle whose mass remains (in average) constant, each process taking place over a very short but finite time \( \tau \) (Fig. 37).

Within the Double Solution Theory, the variation of the positive quantum potential \( \delta Q \) causes the internal energy of the particule to increase.
This is also equivalent to saying that it represents a small transient increase of its proper mass \( \delta M_0 \) during the (finite) “capture time \( \tau \)” as suggested in (55).

In other words, the superposition states which correspond to an entropy decrease \( s \), have much reduced probability, whereas the stable states (quantized states) correspond to entropy maxima.
Those are the states for which the capture time \( \tau \) of Universons has elapsed.

We may have thereby obtained a physical explanation regarding the instablity of the Universons “capture states “ as well as the smallness but finite nature of the capture time introduced by the Universons theory.

b) Fluctuations

In order to re-instate the Newtonian law \( F= M_0 a \) C. Poher demonstrated that the number of Universons being captured by a particle of (variable) rest mass \( M_0 \) is constant and equal to
\[ N = M_0 c^2 / Eu \]
where \( Eu \) is the proper energy of a single Universon. \( N \) is thus the number of Universons captured during \( \tau \), and the number of those captured Universons per second, is obviously
\[ f = N / \tau \]

\( f \) is here considered as the “frequency” of individual transfers, and as such it may be regarded as a “regular beating clock”.

To each of these individual “in / out” processes, is associated an individual energy variation \( Eu \), and we may set :
\[ f = \nu_0 = \frac{M_0 c^2}{h} = \frac{M_0 c^2}{Eu \tau} \tag{62} \]

which yields

\[ h = Eu \tau \tag{63} \]

Thus, starting from original Louis de Broglie’s assumption, we are able to infer the fundamental relation (63).

We clearly see that the sub-quantum medium postulated by Louis de Broglie et al. exhibits random fluctuations which are consistent within the framework of Universons identified here to a specific scalar field \( U\text{-Field} \).

**CONCLUSION OF SUPPLEMENTARY ANNEX III:**

Therefore it seems that the random fluctuations of position of momentum of particles of matter, caused by the natural flux of Universons interaction is at the root of the physical cause of the wave function of all particles of matter.

Louis de Broglie has predicted this behaviour long before we have been able to show its physical cause.

This result can be considered as another confirmation of the Universons model.
SUPPLEMENTARY ANNEX IV

IS THE UNIVERSONS MODEL COMPATIBLE WITH GENERAL RELATIVITY?

Patrick MARQUET

NOTATIONS:

Indices
Throughout this text, it is adopted the Einstein summation convention whereby a repeated index implies summation over all values of this index.

4-tensor or 4-vector: small latin indices: \( a, b, \ldots = 1,2,3,4 \)
3-tensor or 3-vector: small greek indices: \( \alpha, \beta, \ldots = 1,2,3 \)
4-volume element: \( d^4x \)
3-volume element: \( d^3x \)

Manifolds
\((M, g)\): Lorentz

Metric tensor
\[ g = g_{ab} \theta^a \otimes \theta^b \] (dual basis)
\[ g = g_{ab} dx^a \otimes dx^b \] (coordinate basis)

Signature of Space-Time metric:
Hyperbolic \((+ - - -)\) unless otherwise specified

Operations
Scalar function: \( U(x^a) \)
Ordinary derivative: \( \partial_a U \)
Covariant derivative on \((M, g)\): \( \nabla_a \) or \\

Tensors
Symmetrization: \( A_{(ab)} = \frac{1}{2} (A_{ab} + A_{ba}) \)
Antisymmetrization: \( A_{[ab]} = \frac{1}{2} (A_{ab} - A_{ba}) \)
Kronecker Symbol: \( \delta_{ab} = (+1, \text{ if } a = b, \ 0, \text{ if } a \neq b) \)
Levi-Civita tensor: \( \epsilon_{abcd} \) (\( \epsilon^{1234} = 0 \))

INTRODUCTION:
Throughout the whole history of Sciences, Universal gravity has always appeared as a main incentive topic, which is widely recognized as a boost for the analytic methods of theoretical research in Physics.
We show here that the Universons model “corpuscular equations” are fully compatible with the tensor equations of General Relativity.
Part 1 : Gravitation of General Relativity

1. The classical theory

1.1. Basic principles of classical gravitation

The modern gravitation concept is usually close in spirit to the way it was first understood by Sir Isaac Newton as edited in his famous theory published in London in 1687. The Newton law for two massive points separated by a distance $r$ reads

$$ F_r = -G m m' / r^2 $$ (1.0)

where $m$ and $m'$ each characterizes the nearby bodies as their own masses.

$-G$ is a universal constant depending on the choice of units designed to express $m$ and $m'$.

Within the frame of this first theory, two massive bodies are to be “attracted” with a mutual force inversely proportional to the square of their separating distance. Such an interaction exhibits an attractive property.

The law (1.0) may be deduced from the definition of a newtonian potential $V$ satisfying Laplace’s law :

$$ \Delta V = 0 $$ (1.1)

where the operator $\Delta$ is known as the “Laplacian” : $\Delta = \partial^2 / \partial x^\alpha$

(with all spatial indices : $\alpha = 1,2,3$)

If one sets $V = G m' / r$

we have

$$ F_r = m grad V $$ (1.2)

with an acceleration given by :

$$ a = grad V $$ (1.3)

The fundamental equation of dynamics in Newton’s physics is then

$$ F_r = ma $$

and when the “gravitational field” induced at $m(r)$ results from a continuous massive distribution with proper density $\rho (r)$ :

$$ V = G \int [\rho (r) / r] dV $$ (1.4)

the potential $V$ satisfies the Poisson equation

$$ \Delta V = -4\pi G \rho $$ (1.5)

1.2 Special Relativity (SR)

1.2.a) Fundamentals of relativistic kinematics
The special theory of relativity introduces a four-dimensional formalism (3 spatial coordinates and one time coordinate), whereby one defines so-called “World velocities”

With respect to an orthonormal reference frame, the velocity components are given by

\[ u^a = \frac{dx^a}{ds} \]  \hspace{1cm} (1.6)

where

\[ ds = c \, d\tau \]  \hspace{1cm} (1.7)

\( \tau \) is here the “proper time” attached for example, to a moving particle.

In the tridimensional space, one may define the velocity vector with spatial components

\[ v^a = \frac{dx^a}{dt} \]  \hspace{1cm} (1.8)

which have to be distinguished from the 3 space-components of the world velocity

\[ u^a = \frac{dx^a}{ds} = (\frac{dx^a}{dt})(\frac{dt}{ds}) \]  \hspace{1cm} (1.8)bis

and

\[ u^4 = \frac{dx^4}{ds} = c \, \frac{dt}{ds} \]  \hspace{1cm} (with \( dx^4 = c \, dt \))

thus

\[ u^a = (v^a/c) \, u^4 \]  \hspace{1cm} (1.8)ter

Let us set \( \beta = v/c \)

we have

\[ ds = c \, dt \, (1 - \beta^2)^{1/2} \]

that is

\[ u^a = \frac{v^a}{c} \, (1 - \beta^2)^{1/2} \]

\[ u^4 = \frac{1}{(1 - \beta^2)^{1/2}} \]

With the latter components, one immediately shows that

\[ u^a u_a = 1 \]

By definition, \( u^a \) is here a “unit vector”.

1.2.b) Fundamental equation of dynamics

In special relativity (SR), the geodetic interval is known to be

\[ ds^2 = \eta_{ab} \, dx^a \, dx^b \]

where

\[ \eta_{ab} = \text{diag}\{1, -1, -1, -1\} \]

is the “Minkowskian tensor”

Within this representation, the equation of motion for a free particle is given by the classical inertia law

\[ d u^a = 0 \]  \hspace{1cm} (1.10)

The motion of this particle in a gravitational field is also classically described by the Lagrange function:

\[ L = -m_0 c^2 (1 - \beta^2)^{1/2} + m_0 v^2 / 2 - m_0 V \]  \hspace{1cm} (1.11)
2. General Relativity (GR)

Later after 1905, A. Einstein published a generalized theory of gravitation which he deduced from two major observations:

— The “Equivalence Principle” which postulates the complete identity between inertial and gravitational forces: both forces impart a test body an acceleration independent of its mass: it states that in a small region of space, inertia and gravitation are undistinguishable.

— Furthermore, inertial forces (or gravitational forces) may be absorbed by a suitable modification of the local geometry, i.e. massive bodies do not induce forces, but they distort the environmental space.

Free particles trajectories determined by gravity forces (so far euclidean), should now be represented by “geodesics” on a given “manifold”.

General Relativity then implies the existence of a non euclidean space which introduces a precise meaning as well as a limitation of the famous equivalence principle.

In a non euclidean space-time (here riemannian), the geodetic invariant reads

\[ ds^2 = g_{ab} dx^a dx^b \]  

(1.12)

where the 10 components of the metric tensor \( g_{ab} \neq 1 \) represent the gravitation potentials.

In the special theory of relativity, it is well known that the equation of motion for a particle with rest mass \( m_0 \) is derived from the least action principle

\[ \delta S = -m_0 \int ds = 0 \]

setting \( m_0 = 1 \), for (1.12) we eventually obtain

\[ d^2 x^c /ds^2 + \{^c_{ab}\}(dx^b/ds)(dx^c/ds) = 0 \]

with the “Christoffel symbols” of the second kind

\[ \{^a_{bc}\} = 1/2 \ g^{ad} ( \partial_c g_{db} + \partial_b g_{dc} - \partial_d g_{bc} ) \]

(Emphasis is made on the fact these symbols do not constitute tensors.)

Introducing the four vector velocity \( u \) with components \( u^a = dx^a /ds \), this geodesic equation generalizes the classical inertia law:

\[ \nabla u^a = d u^a + \{^a_{bc}\} u^b u^c = 0 \]  

(1.13)

The geodesic equation for a neutral particle is also expressed by the differential system satisfied by the flow lines

\[ u^a \nabla_a u_b = 0 \]  

(1.14)

2.1 Source free field equations

Typically, these are non linear equations of propagation which must contain derivatives of the \( g_{ab} \) up to order 2.

We then consider the action
Propelling phenomenon from superconducting ceramics

Poher C., Poher D. and Marquet P.

Supplementary Material

\[ S_G = \int G (-g)^{1/2} d^4x \]  \hspace{1cm} (1.15)

which must be stationary when the metric tensor is varied.
Let us set :

\[ g^{ab} = g^{ab}(-g)^{1/2} \]  \hspace{1cm} (1.16)

\[ G = G (-g)^{1/2} = g^{ab} G_{ab}(-g)^{1/2} \]  \hspace{1cm} (1.17)

inspection shows that the effective lagrangian :

\[ L_E = g^{ab}(-g)^{1/2} \left[ \{e^a\} \{d^b\} + \{d^a\} \{e^b\} \right] \]

only contributes in the variation :

\[ \delta S_E = \int [ \delta L_E ] d^4x = 0 \]

where :

\[ \delta L_E = (G_{ab} - (1/2) g_{ab} G) \delta g_{ab} (-g)^{1/2} \]

\[ \delta S_E = \delta \int L_E d^4x = \int [ (G_{ab} - (1/2) g_{ab} G) \delta g^{ab} ](-g)^{1/2} d^4x = 0 \]

hence :

\[ S_{ab} = G_{ab} - (1/2)g_{ab} G = 0 \]  \hspace{1cm} (1.18)

These are the source free field equations as deduced by Einstein in 1915.
The Einstein tensor \( S_{ab} \) is a rank 2 symmetric tensor only function of the \( g_{ab} \) and their second order derivatives. It is represented by ten partial derivative equations which are not mutually independent.

There exists only 6 independent conditions, since the space-time coordinates may be subject to an arbitrary transformation allowing to choose four out of the ten components of the metric tensor \( g_{ab} \).

In order for the four conservation identities resulting from the Bianchi identities

\[ \nabla_a S^a_{\ b} = 0 \]  \hspace{1cm} (1.19)

to be satisfied as well as the previous conditions, Elie Cartan showed that the tensor \( S_{ab} \) should have the following form

\[ S_{ab} = k G_{ab} - (1/2) g_{ab} (G - 2 \lambda) \quad (k: constant) \]  \hspace{1cm} (1.20)

\( \lambda \) is sometimes called the “cosmological constant”.

2.2 Field equations with massive source

2.2.a) Momentum-energy tensor
The field equations with as source are obtained by varying the action

\[ \delta S_M = (1/c) \delta \int L_M (-g)^{1/2} d^4x = 0 \]

We start from the invariant density \( L_M = L_M (-g)^{1/2} \) and the \( g_{ab} \) are varied inside the same compact region and vanish on its boundary to obtain :
\[ \delta S_M = (1/c) \int \left[ \partial L_M \partial g^{ab} - \partial (\partial L_M \partial (\partial g^{ab})) \right] \delta g^{ab} d^4x \]

Let us now set

\[ M_{ab} = M_{ab} (-g)^{1/2} \]

we have

\[ (1/2)M_{ab} = \left[ \partial L_M \partial g^{ab} - \partial (\partial L_M \partial (\partial g^{ab})) \right] \]

after some calculations, we eventually find:

\[ \nabla_a M_{ab} = 0 \quad (1.21) \]

which thereby constitutes the conservation law for the tensor \( M_{ab} \) with respect to any coordinates system.

2.2.b) **Field equations for the coupled system**

We now express the variation for the coupled system

\[ \delta \int \left[ (-g)^{1/2} L_E + \chi (-g)^{1/2} L_M \right] d^4x = 0 \]

and we obtain 10 non linear equations

\[ S_{ab} = G_{ab} - (1/2) g_{ab} G = \chi M_{ab} \quad (1.22) \]

which show that masses and space-time are not mutually independent.

- \( \chi \): Einstein’s constant = \( 8\pi G / c^4 \)

- The (massive) energy-momentum tensor is here given by

\[ M_{ab} = \rho c^2 u_a u_b \]

where \( \rho \) is the neutral homogeneous matter density.

2.2.c) **Weak gravitational fields**

The fundamental equation (1.22) generalizes the Poisson equation which is clearly valid in Newtonian physics, when the macroscopic velocities are slow compared to \( c \).

We now assume weak gravitational fields, which means that real space is nearly flat. This is defined as a manifold on which coordinates exist in which the metric has components

\[ g_{ab} = \eta_{ab} + h_{ab} \quad (1.23) \]

where

\[ h_{ab} << 1 \]

In this case, the velocities \( v^a = dx^a / dt \) are low compared with the light velocity. In other words

\[ dx^a / dx^4 << 1 \quad \text{or} \quad ds^2 / (dx^4)^2 = g_{44} = 1 \]

and therefore

\[ u^a = u^4 = u_4 = 1 \]

Among the energy-momentum tensor components only remains
\[ M^4 = \rho c^2 \]  
(1.24)

and the field equations reduces to:

\[ G^4 = (8\pi G/c^4) (M^4 - \frac{1}{2} \delta^4 M) \]
that is:

\[ G^4 = (4\pi G/c^2) \rho \]

If the masses which are supposed to create the gravitational field are also slow, the derivatives \( \partial_4 \) are negligible with respect to the \( \partial_\alpha \), and

\[ G^4 = G_{44} = \partial_\alpha \partial^{\alpha} \{^\alpha_{44} \} \]

with

\[ \{^\alpha_{44} \} = -\frac{1}{2} g^{\alpha\alpha} \partial_\alpha g_{44} \]

(1.25)

(1.26)

At this non relativistic approximation, the relevant action \( S \) is written

\[ S = \int L dt = -m_0 c \int (c - v^2/2c + V/c) dt \]

wherefrom we can neglect the vanishing terms for velocities nearing \( c \):

\[ ds^2 = (c - v^2/2c + V/c)^2 dt^2 \]

which is also

\[ ds^2 = (c^2 + 2V) dt^2 - (v dt)^2 \]

and thus

\[ g_{44} = 1 + 2V/c^2 \]

(1.27)

As the component \( g_{44} \) only appears in the motion equations, it was originally identified with a scalar, thus ignoring the tensorial nature of the classical gravitation law. 

Inserting the expression (1.27) into the formula (1.26), one eventually finds

\[ G^4 = \frac{1}{c^2} \Delta V \]

(1.28)

The field equations lead to

\[ \Delta V = 4\pi G \rho \]

which is just the Poisson equation (1.5) with a negative potential \( V \).

**Part 2: Compatibility of Universons model with General Relativity**

**3. The U-Field picture**

**3.1. Matter-field Interaction**

**3.1.a) Field Surface**

In order to study our conjecture, we shall borrow the simple image of a particular fictive field

Propelling phenomenon from superconducting ceramics
here denoted by U-Field, and which isotropically surrounds the massive particle at its immediate proximity. The value of this field extended over this domain can be temporarily described by the scalar value $\mathbf{S}$ likened to a surface.

Restricted to the time coordinate $x^4 = ct$, the field surface element is chosen to be related to a vector $\mathbf{P}$ by:

$$d\mathbf{S} = \mathbf{P} \, cd\tau$$  \hspace{1cm} (2.0)

In our picture, the Universons model essentially states that the U-Field may be decomposed into energetic massless elements: the free Universons which move at a velocity $c$, and each carrying a proper momentum (as well as a proper energy) given by:

$$P_u = \left(\frac{E_u}{c}\right)$$

Under certain circumstances, some of these Universons may interact momentarily with matter, by transferring their momentum. After a very short time so-called capture time ($\tau$), the impacted mass restitutes an absorbed Universon in the initial state.

When coming to contact with the particle, the surface element is simply:

$$d\mathbf{S}_\tau = \mathbf{P}_\tau \cdot c\tau$$

where $\tau$ is the capture time.

For reasons which will become apparent, we also write this surface element as:

$$d\mathbf{S}_\tau = c\tau \int G^\alpha ds_\alpha$$  \hspace{1cm} (2.1)

The $ds_\alpha$ are the components of the 3-vector “dual” to the tensor measuring the infinitesimal surface area element “deployed” on the surface of the particle in contact with the field, and $G_\alpha$ is a quantity which will be determined later.

Let us now define the “macroscopic interacting cross section $\mathbf{S}$” (units: m$^2$/Kg), of the U-field when it reaches a massive particle $m_0$. Obviously:

$$d\mathbf{S}_\tau = \mathbf{S} \, m_0$$  \hspace{1cm} (2.1)bis

so that

$$P_\tau = \mathbf{S} \, \frac{m_0}{c\tau}$$  \hspace{1cm} (2.2)

Furthermore, we shall assume that this vector is proportional to the time component of the classical world energy-momentum $P^a$ characterizing the considered mass as:

$$P_\tau = \text{const.} \, P^4$$  \hspace{1cm} (2.3)

In classical theory, the time component of the 4-momentum vector $P^a$ is:

$$P^4 = m_0 \, c \, u^4$$

$$P^4 = m_0 \, c$$

$m_0$ is the rest mass of the considered particle, and $u^4 = 1$ is as usual the time component of the world 4-velocity $u^a$ with reference to the chosen orthonormal reference frame.

3.1.b) Particle mass renewal by Universons

Let us call now $f_u$ the natural flux density of free Universons (in Universons/s.m$^2$.)
We clearly see that the “interaction cross section” \( S \) (in m\(^2\)/Kg) earlier defined, characterizes the macroscopic collision of Universons by a REST mass \( m_0 \).

As a corpuscular process, C. POHER postulates that the number \( n \) of simultaneously captured Universons per second, is given by:

\[
 n = S m_0 f_u
\]

and during a given finite time \( \tau \):

\[
 n \tau = \tau S m_0 f_u
\]

Let now \( R \) and \( R' \) be two frames, the latter having the velocity \( v = \beta c \).

The capture time \( \tau' \) of an Universon in \( R' \) is obviously different when it is observed from \( R \) according to the relativistic covariance

\[
 \tau = \gamma \tau' \quad \text{with} \quad \gamma = (1 - \beta^2)^{-1/2}
\]  

(2.4)

A simple calculation shows that everything behaves as though a rest particle attached to \( R \) would absorb a PAIR of Universons with equal energy \( (E_u) \) incoming from opposite directions.

Taken into account the standard relativistic transformations, the total mass \( m' \) equivalent to all “captured” universons during the time \( \tau \), is expressed by

\[
 m' = \tau S m_0 f_u (E_u) / c^2
\]

that is with (2.4):

\[
 m' = \tau S m_0 f_u (E_u) / c^2
\]

In the frame \( R' \) the mass \( m' \) remains constant in average, i.e. equal to \( m_0 \), hence:

\[
 m_0 = \tau S m_0 f_u (E_u)
\]

and thus

\[
 \tau S f_u (E_u) / c^2 = 1
\]

(2.5)

This last relation is most important since it relates all known characteristics of free Universons with matter. From the previous relations, we infer for the particle ’s rest mass:

\[
 m_0 = n (E_u) / c^2
\]

According to C. Poher, the rest mass of any particle is made up by the whole energy of simultaneously captured Universons and permanently renewed.

As we shall see, this hypothesis can be justified by another approach.

### 3.2 Fundamental relations of the Universons model:

#### 3.2.a First fundamental formula of the Universons model

Let us imagine two masses \( m_1 \) and \( m_2 \), \( r \) apart, and throughout the entire space for which we write:

\[
 \int dS^\alpha = \int dV, \ (4\pi \text{ steradians})
\]

the number \( n \) of Universons captured by \( m_1 \) each second is:

\[
 n = S m_1 f_u
\]

All these universons will be re-emitted, and in particular, they will be isotropically spread over the surface of a sphere with radius \( r \), where the flux \( (f_u) \) is:
these Universons are partly captured by the second mass $m_2$, and the number $n'$ of those which are absorbed during the capture time $\tau$ will be given by:

$$n' = \tau \cdot S \cdot m_2 \cdot (f_u)_r$$

that is:

$$n' = (\tau \cdot S \cdot f_u \cdot m_1 \cdot m_2) / 4\pi r^2$$

Those $n'$ Universons captured respectively by masses $m_1$ and $m_2$ will have imparted the matter a momentum which is not balanced in the opposed direction.

The magnitude of the resulting “attracting” force between both masses which is being generated by the $n'$ Universons, is therefore:

$$F_r = n' \cdot (E_u)_r / \tau c$$

(2.6)bis

(where $(E_u)_r / c \tau$ represents the force induced by each Universon)

Taking into account (2.6), we find:

$$F_r = (S^2 \cdot f_u \cdot m_1 \cdot m_2) / 4\pi r^2$$

(2.7)

One can compare this last expression with Newton’s law (1.0)

$$|F_r| = G \cdot m_1 \cdot m_2 / r^2$$

by setting

$$G = S f_u (E_u) / 4\pi c$$

(2.8)

For accelerated matter, the re-emitted process of Universons is somewhat different, and C. Poher has formally shown two important results:

— The incident angles $\theta$ of the Universons flux is not the same as the re-emitted flux angles $\theta'$, resulting in an anisotropy of the flux after capture by an accelerated particle.

— The Universon momentum imparted to this particle is higher in the direction opposed to the acceleration which explains the inertial effect whereby a force is necessary to accelerate matter.

Within a very small solid angle $\Omega$ situated in the accelerated direction about the incidence $\theta = 0$, the particle never captures any Universon, according to the formula

$$\Omega = (2\pi a \tau) / c$$

(2.9)

where $a$ is the proper acceleration of the particle.

3.2.b) Second formula of the Universons model:

According to formula (2.5), we know that

$$\tau \cdot S \cdot f_u (E_u) / c^2 = 1$$

hence (2.8) finally reads

$$G = S c / 4\pi \tau$$

(2.10)
Propelling phenomenon from superconducting ceramics

3.3 The GR picture

3.3.a) Justifying the second equation 2.10

Let us now revert to our basic postulate:

\[ P_\tau = \text{const.} \, P^4 = S \, m_0 / c \, \tau \]  \hspace{1cm} (2.11)

If one sets

\[ \text{const.} = -4\pi G / c^3 \]  \hspace{1cm} (2.11)_{\text{bis}}

we have

\[ G = (S \, m_0 \, c^3) \, 4\pi \, P^4 \, \tau \, c \]

and we find back the formula (2.10):

\[ G = S \, c / 4\pi \, \tau \]

since the principle of equivalence stipulates that \( P^4 = m_0 \, c \)

The choice of the constant (2.11)_{\text{bis}} is not arbitrary, and as will be seen, it justifies a posteriori our hypothesis (2.11).

To show this, we first consider the following identity:

\[ \{a_{bc}\} = (1/2) \, g^{ac} \partial_b g_{ac} = [(1/2)g] \partial_b g = \partial_b \ln(g)^{1/2} \]  \hspace{1cm} (2.12)

taking into account

\[ dg = g \, g^{bc} \, dg_{bc} = -g \, g_{bc} \, dg^{bc} \]

with

\[ G^{bd} \{a_{bd}\} = (-g)^{1/2} \partial_b (g)^{1/2} g^{ab} \]  \hspace{1cm} (2.13)

one easily checks that the time component of the Ricci tensor is

\[ G^4_4 = (-g)^{1/2} \partial_\alpha (-g)^{1/2} g^{a\{a}_{\alpha \{a} \} \} \]  \hspace{1cm} (2.14)

which is legitimized by the fact that all quantities are here independent of \( x^4 \).

Let us now set

\[ G^{4\alpha}_4 (g)^{1/2} = G^{4\alpha}_4 \]  \hspace{1cm} (2.15)

with

\[ G^{4\alpha}_4 = g^{a\{a}_{\alpha \{a} \} \} \]  \hspace{1cm} (2.16)

Applying Gauss’ theorem, we may consider the integral of the divergence

\[ \partial (G^{4\alpha}_4) / \partial x^\alpha \]

and transform the quantities \( G^{4\alpha}_4 \) over the body surface area

\[ \int \left[ G^{4\alpha}_4 \right] ds_\alpha \]  \hspace{1cm} (2.17)

into the integral of the Ricci tensor time component extended over to the 3-volume \( V \) filled with matter:

\[ \int G^4_4 (g)^{1/2} dV \]  \hspace{1cm} (2.18)

(according to (2.13)).
We know that the expanding Universe is strongly suggested by astronomical observations.

The current model of Robertson-Walker,(1944) demands that the different parts of the homogeneous cosmic “fluid”, have the same histories, so that each co-moving observer “sees” the same view in all directions (isotropy).

For far sources within any region of space, classical theory always states that the space-time can be represented by a \textit{spherically symmetric} metric.

Any solution of the field equations may thus be approximated to

\[
\begin{align*}
\quad ds^2 &= (ds_E)^2 - [2F/rc^2] (dr^2 + c^2 dt^2) \quad (2.19)
\end{align*}
\]

where \((ds_E)^2\) is the flat metric, and the second term is a small correction corresponding to the distance of the observer.

The metric tensor components depending on \(x^4\) are

\[
\begin{align*}
\quad g_{44} &= (1 - 2F/rc^2) \quad \text{and} \quad g_{\alpha\alpha} = 0 \quad (2.20)
\end{align*}
\]

If \(n\) is the unit vector in the direction \(r\), one switches to cartesian coordinates by replacing \(dr\) by \(dn = n_\alpha dx^\alpha\), and the spatial components of the metric tensor become:

\[
\begin{align*}
\quad g_{\alpha\beta} &= -\delta_{\alpha\beta} - \left(2F/rc^2\right)(n_\alpha n_\beta) \quad (2.21)
\end{align*}
\]

Inserting (2.20) and (2.21) into expression (2.16), and setting for the newtonian potential \(V\):

\[
\begin{align*}
\quad V &= -m_0 G/r \\
\quad F &= 2Gm_0
\end{align*}
\]

we obtain after a simple calculation:

\[
\int (G^4 (-g))^{1/2} dV = - (4\pi G) m_0 /c^2 = - (4\pi G) P^4 /c^3
\]

One clearly sees that the vector \(P_\tau\) previously introduced as

\[
\quad P_\tau = \text{const.} \ P^4
\]

confirms the value of the constant \(-4\pi G/c^3\) which we postulated above.

Moreover, in the expression (2.1)\textit{bis}, \(G^\alpha\) is readily identified as:

\[
\quad G_{4\alpha} = g_{4\alpha}
\]

and therefore:

\[
\quad P_\tau = \int G^\alpha ds_\alpha
\]

\textbf{The second formula of C. Poher is therefore consistent with General Relativity.}

\textbf{3.3.b) Justifying the Universons model first equation 2.9}

Let us now revert to the Universons field surface \(dS\) in contact with matter:

\[
\quad dS_\tau = c\tau \int G^\alpha ds_\alpha \quad (2.22)
\]
Using here spherical coordinates $r, \theta, \varphi$, the point $O$ being taken at the origin of the particle mass center, we assume without loss of generality : $\varphi = r = \text{const}$.

For the newtonian approximation (where the body motions are slow) we have the limiting case :

$$ G^\theta = g^{44} \{^0_{44}\} $$

( here $(-g)^{1/2} = 1$ )

Moreover, the considered approximation leads to

$$ g^{44} = c^2 / (c^2 + 2V) \approx 1 $$

and by referring to (1.26) :

$$ G^\theta = \{^0_{44}\} = (1/c^2) \partial V/\partial_0 $$

which is just the Newtonian potential gradient, expressing an acceleration according to (1.3).

The formula (2.22) can be then written

$$ dS_{\tau} = \frac{1}{c} \tau a_\theta ds^\theta $$

where $a_\theta$ is the particle’s acceleration with respect to the angle $\theta$ which deviates from incidence chosen here to be $0$.

On the other hand, we know that the solid angle is the “oriented surface”, viewed from $O$ (in our case $\mathbf{S}$), and represents the flux

$$ \int_S n \, dS / (O\mathbf{m})^2 $$

of the field across this surface. $O\mathbf{m} = r$, and $n$ is the unit normal at $\mathbf{m}$ of the compact surface $S$.

Furthermore, to this point $\mathbf{m}$ one can associate the point $\mathbf{p}$ intersection of the sphere centred at $O$ (particle) of radius 1, with the half distance $O\mathbf{m}$, and a surface element belonging to this sphere, that is :

$$ ds^\theta = 2\pi \sin \theta \, d\theta $$

or (with some mathematical approximation) :

$$ ds^\theta \approx d\theta $$

For $O\mathbf{m} = 1$, formula (2.24) finally becomes :

$$ dS_{\tau} / d\theta = (1/c) 2\pi \tau a_\theta $$

where $1/d\theta = \partial \theta$ constitutes the sole component of the normal $n$.

C. Poher’s conclusions are here entirely re-instated, and the angle $\theta$ is indeed directly related to the accelerated mass interacting with the Universons $(U\text{-Field})$.

### 3.3.c) Further extension

This latter demonstration still relies on the classical definition of a solid angle $\Omega$, but within the general relativity, this angle has a different form due to the use of curvilinear coordinates.

We may generalize further the formula :

$$ dS_{\tau} = c \tau \int G^a ds_a $$

by switching cartesian coordinates to spherical coordinates.
For a basis \((e_\alpha)\) these are written:
\[
\begin{align*}
e_r &= (\partial x / \partial r) e_x + (\partial y / \partial r) e_y \\
e_\theta &= (\partial x / \partial \theta) e_x + (\partial y / \partial \theta) e_y \\
&= -r \sin \theta \ e_x + r \cos \theta \ e_y
\end{align*}
\]
thus
\[
(e_\theta)^2 = r^2 \sin^2 \theta + r^2 \cos^2 \theta = r^2
\]

Accordingly:
\[
e_\theta \cdot e_\theta = g_{\theta\theta} = r^2
\]
knowing that:
\[
g^{\theta\theta} = 0
\]
\[
g^{rr} = g_{rr} = 1
\]
the Christoffel symbols of the second kind, are related to the metric tensor by
\[
\left\{ \begin{array}{c} \alpha \\ \beta \\ \gamma \end{array} \right\} = \left( \frac{1}{2} \right) g^{\alpha \delta} \left( \partial_\gamma g_{\delta \beta} + \partial_\beta g_{\gamma \delta} - \partial_\delta g_{\gamma \beta} \right)
\]
In polar coordinates we have
\[
\left\{ \begin{array}{c} 0 \\ r \\ \theta \end{array} \right\} = \left( \frac{1}{2} \right) g^{00} \left( \partial_\theta g_{rr} + \partial_r g_{\theta r} - \partial_r g_{\theta \theta} \right)
\]
that is
\[
\left\{ \begin{array}{c} 0 \\ r \\ \theta \end{array} \right\} = \left( \frac{1}{2} \right) r^2 \partial_r g_{\theta \theta} = \left( \frac{1}{2} \right) r^2 \partial_r (r^2)
\]
with
\[
\left\{ \begin{array}{c} 0 \\ r \\ \theta \end{array} \right\} = 0 \quad \forall \ \alpha \quad (b)
\]
\[
\left\{ \begin{array}{c} a \\ 00 \end{array} \right\} = 0 \quad (c)
\]
\[
\left\{ \begin{array}{c} r \\ 00 \end{array} \right\} = -r \quad (d)
\]
Within a very small solid angle \(\Omega\) situated in the accelerative direction about the incidence \(\theta = 0\), the considered particle does not capture any universon according to the formula
\[
\Omega = \frac{2 \pi a \tau}{c} \quad (e)
\]
where \(a\) is the proper acceleration of the particle.
When in contact with matter
\[
d \mathbf{S} = c \tau \int \mathbf{G}^a dS_a
\]
we shall have
\[
\mathbf{G}^a = g^{00} \left\{ 0 \right\} + g^{r0} \left\{ r \right\} + g^{\theta\theta} \left\{ \theta \right\} + g^{44} \left\{ 44 \right\}
\]
\[
= g^{00} \left\{ 0 \right\} + g^{44} \left\{ 44 \right\} + g^{44} \left\{ 44 \right\}
\]
in virtue of (a).
If \(r = 1 = \text{const.}\), which is the case of the "classical solid angle", the term (d) and the last term of (f) vanish since they no longer represent a connection symbol and only survives:
\[
\mathbf{G}^0 = g^{44} \left\{ 44 \right\}
\]
which is just the formula (2.14), for the newtonian case where the mass velocities are slow compared with \(c\), and thus corresponds to the first formula (e) written down by C. Poher, when using a "classical solid angle" \(\Omega\).
3. Conclusion of Supplementary Annex IV:

The U-Field we have just introduced has only the valor of a “continuous” picture, but this image helped us to understand the deep meaning of C. Poher’s corpuscular theory of Universons which shows to be fully compatible with General Relativity.

To conclude this work, let us stress here an important argument:

from our understanding, the Universons seemingly manifest themselves within the immediate neighbourhood of the interacting mass.

It would then be tempting to relate those to the energy-momentum pseudo-tensor of the gravitational field inherent to this mass, and which is given by the density:

$$t_d^c = \frac{1}{2\chi} \left[ \left( \frac{\partial}{\partial d} g^{ab} \right) \partial L_E / \partial \left( \partial_c g^{ab} \right) \right] - \delta_d^c L_E$$

the introduction of this density is mandatory in order to ensure the global conservation law

$$\partial_c (M^c_a + t^c_a) = 0$$

instead of (1.19). This could be the useful topic of a further work.

Let us finally remind that fields never describe the relevant particles, for only an interacting theory is able to reflect a full behavior of these elementary particles along with their physical characteristics.

It is more accurate to state that isolated fields “correspond” to different particles (here the Universons), and constitute a real basis to explicit their interactive properties.

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A FEW REFERENCES FOR SUPPLEMENTARY ANNEX IV:

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